

**What Drives Strategic Behavior?
A Framework to Explain and Predict SMEs' Transition to Sustainable Production
Systems**

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Abstract

The strategic choices of Small and Medium Enterprises in the agribusiness sector are fraught with large cost and revenue uncertainties. The transition to a new production system implies that SMEs must re-allocate resources and develop new strategies to achieve market goals. We highlight the agricultural, marketing and management literature on decision-making under risk for strategic decisions. Subsequently we discuss the various elicitation techniques to measure decision-makers' utility functions. That review indicates that one is able to measure the global utility function in a reliable and valid way. Particularly the measures based on experiments and rooted in expected utility framework seem to perform well. Furthermore, we develop various research propositions that deal with the factors that influence SMEs strategic decision whether or not to switch to sustainable production systems. We propose to investigate the global shape of the utility function of SMEs as it drives strategic decisions, and the factors that influence these decisions.

Keywords: strategic decision making, sustainability, risk behavior, utility function, global shape

The agricultural sector throughout the world is confronted with questions from society about its production practices. For instance, large-scale commercial farms in the US and Western Europe employ production systems that use significant quantities of scarce resources and often produce negative externalities. These resource and environmental issues combined with the fact that many of these production systems are not sustainable have raised concerns on the part of policy makers, agribusiness companies, activist

groups, and the farm community. Farmers that consider a switch to sustainable agriculture are concerned about the economic viability of the systems. Farmers that have made the transition have been confronted with large cost and return uncertainties, which in some cases have led them to revert to conventional production systems.

In recent years the adoption and viability of sustainable agricultural production systems has received considerable attention from researchers as well as policy makers (e.g., Francis and Youngberg, 1990, Harris, 2000). However, much of the research has been fragmented and has not considered the decision-making process of the Small and Medium Sized Enterprises (SMEs) most involved (Comer et al. 1999). A change to a sustainable production system (e.g., an organic system) is a strategic decision that requires a re-orientation of a firm's organizational structure and goals, a dramatic re-allocation of economic resources, and a willingness to accept a high degree of risk. Comprehending the decision-making process of the firms willing to make such decisions is vital for understanding of future development in the structure of the agribusiness sector.

An important dimension of the strategic decision process of a firm is the willingness of a firm to accept a high level of risk. Commonly, risk attitudes have been measured by the curvature of a decision-maker's utility function using the Pratt-Arrow coefficient of risk aversion.¹ However, Rabin (2000) and Rabin and Thaler (2001) argue that this local risk attitude measure may not be of great value in understanding strategic behavior that involves fundamental shifts in activity over a wide outcome range. Pennings and Smidts (2003) have shown that strategic behavior is more strongly related to the global shape of the utility function than to local measures of risk-

¹ In the expected utility model the curvature of the utility function reflects the risk attitude of a decision maker (Keeney and Raiffa, 1976). A concave utility function indicates risk-averse behavior and a convex utility function indicates risk-seeking behavior.

aversion. The global shape of a decision-maker's utility function seems to reflect the manager's decision structure (e.g., choice of production system), whereas the local shape of the utility function drives the tactical decision-making processes (e.g., trading behavior). Pennings and Smidts (2003) defined the global shape of the utility function as the general shape of utility function over the whole outcome domain: fully concave, fully convex or the S-shaped (convex/concave). Their S-shaped utility function is consistent with behavior proposed in prospect theory (Kahneman and Tversky 1979), but it is likely that more than just two functional forms exist.² Pennings and Garcia (2005) show that the global shape of the utility function is a predictor of actual strategic behavior. They argue that the utility can be a powerful concept when the full outcome domain of the function is examined. Their empirical analysis provides evidence that the shape of the utility function differs among real decision makers and that this heterogeneity drives differences in strategic behavior. While prediction is important, it does not necessarily *explain* actual strategic behavior. A question that needs to be answered to explain actual strategic behavior is: "What drives the global shape of the utility function?" Addressing this question will be helpful for policy makers who guide SMEs in their transition to sustainable production systems.

To gain insight into the issues, we propose a framework to study the transition of SMEs from conventional to sustainable production systems. In section 2 we begin with a discussion of different management decisions, focusing on the distinction between strategic and operational/tactical decisions. In section 3 we consider risk perception and risk attitude, and their relationship to behavior, and in section 4 we provide a selected review of research topics that have been studied in decision making

² In prospect theory, the shape of a decision maker's utility function is assumed to differ between the domain of gains and the domain of losses. The proposed convex/concave utility function predicts risk-seeking behavior in the domain of losses and risk-averse behavior in the domain of gains.

under risk in agriculture, discussing risk-attitude and utility functions. Section 5 provides a discussion of the primary techniques for eliciting utility functions. In section 6 we conclude with propositions for research with respect to SMEs' risk behavior related to the transition from a conventional to a sustainable production system.

Strategic and Operational/Tactical Decisions

The conceptual foundations of strategic management were developed in the 1960s. A central question that emerged was: How does a firm configure and direct its strategic activity to meet its economic objectives? To answer this question, one needs to distinguish among decisions based on the nature of the activity, the time involved, and the level of risk exposure (Bowman and Asch 1987).

Ansoff (1965) was the first to identify three major decision classes: *strategic*, *administrative*, and *operating* decisions. In short, *Strategic* decisions deal with the allocation of total resources among product-market opportunities. *Administrative* decisions are related to the organization, acquisition, and structuring of resources for optimum performance. The related *policy* issues are incorporated in this second class. *Operating* decisions include the budgeting and scheduling of resource applications and their related specific operational procedures. These terms are frequently associated with terms like *strategy*, *structure*, and *process*.

Strategic decisions often affect the whole enterprise or a major part of its objectives and policies for an extended period of time (e.g. 3 to 5 years). These decisions focus on planning and marshalling the use of considerable resources to achieve organizational goals and involve long-term relationships between the organization and its environment. Strategic decisions entail investment opportunities

with high risk levels. An example in agriculture is a hog farmer's decision whether or not to switch to organic production to establish a "preferred supplier" relationship with a retailer. Such a decision impacts the entire enterprise for an extended period of time and entails a high degree of uncertainty about the future stream of costs and returns.

Administrative or tactical decisions affect how an enterprise works for a more limited period of time and are primarily concerned with appropriate use of resources already available. These decisions occur within the context of the previous strategic decisions, and are made in a less risky context than the strategic decisions (e.g. application of production technology). In the context of a hog farmer, whether or not to start mixing the feed components or to continue buying ready-mixed feed is a tactical decision. This decision deals with the appropriate use of resources in a less risky environment than strategic decisions since the alternatives and related probabilities are better understood.

Operational decisions involve the day-to-day, well-established procedures such as the supervision and control of resources. The procedures used in operational decisions are routine and information is unlikely to surprise the decision maker. For a hog farmer the amount of feed that will be provided to a particular weight class of hogs is an operational decision. These decisions that are made on a daily basis and their consequences are not very risky.

Among these decisions, strategic decisions are the most central to questions involving transition from conventional to sustainable production systems. Transition to a sustainable production system implies that SMEs must change their practices drastically, in some cases total overhauling their production and marketing activities and strategies. Such a transition affects the whole enterprise, a major part of its

objectives, activities, and policies for an extended period of time, and is often made under considerable uncertainty about the vulnerability and volatility of cash flows.

While considerable attention has been paid to strategic decision making in large and diversified organizations (e.g., Marsh et al. 1988; Bourgeois and Eseinhardt 1988) hardly any work has been performed to identify the factors that drive the strategic decisions of owner-managers of SMEs (Robinson and Pearse 1984; Shuman and Seeger 1986). Research has not explicitly considered the characteristics of decision-makers in SMEs, including their strengths and weaknesses and their needs to satisfy their personal objectives (Curtis 1983). Little attention has been given to the possibility that the factors that may drive strategic behavior of SMEs may depend on the specific decision context.

Risk Perception and Risk Attitude: Their Role in Behavior

Risk and uncertainty influence almost all decisions because future pay-offs are unknown and change through time.³ Pennings, Wansink and Meulenberg (2002) show that by examining separate effects of risk perception and risk attitude on activity a more robust conceptualization and prediction of behavior can be obtained. *Risk perception* reflects the SME's interpretation or assessment of the likely exposure to uncertain pay-offs when making a decision (e.g., switching to a sustainable production system). *Risk attitude* reflects the SME's predisposition or willingness to accept uncertain pay-offs when making decisions. It is important to emphasize that risk attitude and risk perception are two different concepts. Risk attitude is the decision-maker's willingness to accept a risk exposure while risk perception is decision-maker's assessment of the likelihood of being exposed to a particular risk. Arrow (1971) and Pratt (1964) provide

³ We do not distinguish between risk (randomness with knowable probabilities) and uncertainty (randomness with unknowable probabilities), since within our context (transition to sustainable production practices) it is often unknown whether or not the probabilities are known.

insights into the relationships between risk perceptions, risk attitudes, and risk behavior. In Pratt and Arrow's work, risk behavior is a function of risk aversion and the variability in additional wealth. Recently, Pennings and Wansink (2004) showed that the Pratt-Arrow framework implies that an interaction between risk attitude and risk perception also influences behavior. Implicitly, this means that the greater the risk perceived the more a risk-averse agent will alter behavior to avoid or manage risk. Below, we focus on the role of risk attitude on decisions.

Risk Attitudes and Utility

Considerable work has been performed analyzing behavior under risk. Particularly in agricultural economics and management literature, a wide variety of research propositions on how risk attitudes influence producer behavior exist. Crucial to this work is the concept of utility which is derived from outcomes such as changes in wealth, income, and profit. The utility *function* provides information about the utility that decision makers derive from the different outcomes.

Selected Literature Overview

The dominant paradigm for studying risky situations in agricultural economics and management science is the expected utility model (Meyer 2002). The expected utility model is concerned with choices among risky prospects whose outcomes may be either single or multidimensional (Schoemaker 1982). The goal of a decision maker (e.g., farmer) is the maximization of expected utility. In the expected utility framework, the shape of the utility function is assumed to reflect a decision maker's risk preference (Pratt 1964; Arrow 1971).

There has been a continuous stream of research on decision makers' risk preferences in agricultural economics (e.g., Just and Pope 2002; Hardaker et al. 2004; Eeckhoudt, Golier and Schlesinger, 2005). Most of that research uses objective and subjective expected utility models and psychometric constructs to analyze producers' risk behavior. Several authors have shown that decision makers can be simultaneously risk-seeking and risk-averse in different domains, implying that risk attitude is context specific (e.g., Payne, Laughhunn and Crum 1980; Pennings and Smidts, 2000). We provide a short review of empirical and theoretical works that have been addressed in agriculture.

Operational risky decisions that involve the *optimum level of pesticides, use of fertilizers and biological pest controls*, are analyzed in Carlson (1970) and Thornton (1985). These studies suggest that farmer's risk aversion which is explained by a set of socioeconomic variables is a critical factor in determining the use of pesticides or fertilizers during the production process. Examples of socioeconomic variables affecting risk aversion are farmer's age, education, family structure (e.g. spouse farm or off-farm income), experience with farming, and the dynamics of farmer's social environment's structure, reputation, culture (e.g., initiatives for participation in collective business schemes in a specific region).

The degree of risk aversion is frequently cited as a determinant for the *adoption and utilization of new technologies* in farm operations. Huisjman (1986) analyses how farmers' risk-aversion causes slow adoption of new technologies. Other studies (e.g., Just and Pope 1978; Roosen and Hennessy 2003) have tried to identify the risk preferences of farmers using certain *risk-reducing inputs* (e.g. conservation tillage for reducing soil erosion) during the life-cycle of a production phase. Empirical studies of

the choice of *farm cropping plans* as a decision under risk have been conducted by, among others, Officer and Halter (1968), Scott and Baker (1972), and Lindner and Gibbs (1990). These studies explain the crop-related resource restrictions that farmers face and suggest that the choice of an optimal production level under these restrictions is, in most cases, influenced by farmers' risk preferences.

In many countries farmers have an opportunity to reduce *price risk* which affect their income by using financial and marketing arrangements. Various authors, amongst others Biswanger (1980), and Antwood and Bushema (2003), have examined the attitudes of farmers towards *income risk*. These studies examine the effects of external environmental factors (e.g., policy changes, market volatility in periods of crisis), as well as farm-specific characteristics (e.g., debt-to-asset ratio, location of farm, size, composition of decision making unit), on producers' behavior. Studies by Goodwin and Schroeder (1994), Pennings and Leuthold (2000), Pennings and Garcia (2001), among others, show that risk attitude is the highly important variable related to *hedging behavior*, both theoretically and empirically. There is a large body on *hedging* in financial and agricultural economics literature, assuming that farmers can reduce price risk by offsetting the cash value of inventories, growing crops, and processing commitments with futures contracts. Futures markets, which are an example of a *risk-reducing market institution*, are widely available in industrial countries and help farmers to overcome *price risk*. In addition to futures and options markets, the most important risk-reducing alternatives include cooperative marketing and marketing boards.

Other studies in the business economics and marketing-management literature have examined producers' decisions and risks regarding marketing-channel contracting

and financial management decisions. Smidts (1990; 1997) investigates farmers' decision-making process with respect to the *choice of a marketing strategy* for ware potatoes. Pennings and Wansink (2004) provide evidence, by integrating elements from both the marketing and finance literature, that the interaction between risk attitude and risk perception is a strong predictor of *contract behavior*. Pennings and Smidts (2000) provide valuable insights regarding the role that the risk attitudes of farmers, who are managers of SMEs, play in dynamic markets, as reflected in their market-orientation and innovativeness, their desire to reduce fluctuations in profit margins, and their actual market behavior (i.e., trading behavior, choice of marketing channel, use of price-risk management instruments). Wang, Barney and Reuer (2003) discuss how price risks are associated with specific investments and how stakeholders need to diversify their product-portfolio when a firm is in financial (dis)stress. Other studies in behavioral finance explain how certain groups of investors behave, and, particularly, what kind of portfolios they choose to hold (e.g., Barberis and Huang 2001).

The literature reviewed demonstrates that risk is an important issue in agriculture and that it impacts the economic performance of producers. Furthermore, it indicates that producers' risk attitudes influence producers' day-to-day operational behavior and short-term tactical decisions. However, our understanding of how risk attitude is related to strategic decisions is very limited, and such knowledge is imperative for policy makers. We may hypothesize that risk attitude measured by the global shape of the utility function may influence strategic decisions. The rationale for this hypothesis is that strategic decisions, particularly the ones that we focus on (i.e., transition to sustainable production systems) are made under uncertainty. The uncertainty in this context is related to the economic viability of such a transition.

Strategic Behavior and Shape of Global Utility Function

Recent research by Pennings and Smidts (2003) and Pennings and Garcia (2005) has shown that strategic decisions appear to be related to the global shape of the utility function, the shape of the function across the entire relevant outcome domain. The global shape can be visualized in a two dimensional space with on the y-axis the utility level derived from outcome level x ($u(x)$) and at the x-axis the outcome level x (Figure 1). Most studies use a Pratt-Arrow type of risk-aversion coefficient to measure risk aversion, assuming that the “curvature” is constant across the whole outcome range. All information is collapsed into one parameter (one dimension), and hence it is very likely that a lot of relevant information is lost. When the global shape is taken into account, one recognizes that the curvature of the utility function may differ over sections of the outcome range. The approach treats the utility function as a multidimensional construct.

While Pennings and Smidts (2003) show that strategic behavior can be predicted by examining the global shape of decision-makers’ utility functions, they do not explain *why a particular shape is associated with a specific strategic decision*. Pennings and Smidts (2003) used two functional forms: a fully concave or convex (which basically reflects the one-dimensional “curvature” Pratt-Arrow approach) and an S-shape (which reflects Prospect Theory). Later, we propose several research objectives relevant to the examination of the actual shapes of the global utility function and the decision-maker’s characteristics that influence the functional form of that shape. The development of an empirical research design based on these research objectives allows us not only to test the hypothesis whether the global shape of the utility function drives strategic behavior, but also to understand why it does. Thus, not only will we be able to predict strategic behavior, but we will also be able to explain

strategic behavior. The latter is crucial for policy makers and SMEs that are dealing with strategic decisions (i.e., a transformation to sustainable agricultural production systems). A question related to the why-question is: *does the global shape of the utility function of a decision maker change over time?*

The two questions raised must be addressed empirically if one wishes to understand what the drivers are of strategic decisions and how policy measures may affect these decisions. For example, if we are interested in stimulating farmers to make a strategic decision towards sustainable agriculture, we have to know the underlying factors that influence that decision. Suppose we find that the global shape of the utility function is the driver, then the question becomes how policy makers can influence that shape. Several researchers argue that preferences are constructed (Pennings and Smidts 2003) and hence are driven by variables that describe the environment (such as a competitive environment). Others have argued that the global shape of the utility function is driven by personal characteristics of the decision maker and hence is a personality characteristic (Pennings and Garcia 2005).

Before formulating research propositions and questions for a future research that may provide answers to the questions raised, we review procedures to measure risk attitude and the global shape of the utility function in a valid and reliable manner. Since the way in which risk attitude is conceptualized and measured affects our understanding of decision making under risk, it is important to understand the validity of risk-attitude measures.

Risk Attitudes and Utility Functions: Measurement Issues

Extensive research has been done on how to measure risk preferences. In the literature, two major approaches can be distinguished: the utility framework (von Neumann and Morgenstern 1947), and psychometrics (e.g., MacCrimmon and Wehrung 1986).

The expected utility (EU) model formulates decision making under risk as a choice between alternatives, each represented by a probability distribution. Decision makers are assumed to have a preference ordering defined across the probability distributions. Risky alternatives can be ordered using the utility function $u(x)$, and the curvature of the utility function $u(x)$ reflects risk attitude (Keeney and Raiffa 1976). Risk attitude refers to the curvature of the utility function for a specific domain, e.g., monetary outcomes of a business. Within this approach, utility can also be adjusted for strength of preference (Dyer and Sarin 1982). The adjusted measure, intrinsic relative risk construct, assumes that an individual's preference for risky choice alternatives is a combination of: (1) the strength of preference the individual feels for certain outcomes, and (2) attitude towards risk (Smidts 1997). The outcomes of a lottery are transformed into subjective values under certainty by the strength-of-preference function $v(x)$, and these subjective values are subsequently evaluated under risk.⁴

An observed difference between the utility and the strength-of-preference function is attributed to the influence of risk preference. Risk aversion (as indicated by $u(x)$) is thus seen as the effect of diminishing marginal value (indicated by $v(x)$) plus an aversion against the dispersion in subjective values (intrinsic risk attitude) (Smidts 1997). The traditional measure of risk attitude, the curvature of $u(x)$, thus reflects risk

⁴ In a given decision problem each possible outcome or consequence can be identified with a particular level x in the attribute set X . X denotes a subset of real numbers representing the possible levels of a single attribute such as return on investment, net asset value, response time, etc. In examining risky decision problems we treat alternative decisions as "gambles" or "lotteries" over the finite sets of outcomes from X (Farquhar, 1984).

attitude and strength of preference combined. Several studies have provided empirical support for the relevance of the intrinsic risk attitude. Significant differences between $u(x)$ and $v(x)$ were found by Krzysztofowicz (1983a, b). Recently, Smidts (1997) found strong empirical support for the hypothesis that risk attitude and strength of preference are distinct constructs in a real economic setting and a longitudinal design. Weber and Milliman (1997) also provided empirical support for the intrinsic risk construct.

Potentially, intrinsic risk attitude is a more accurate measure of the true risk preference of an individual (Weber and Milliman 1997; Smidts 1997; Pennings and Smidts 2000).

In the psychometric approach, risk attitude is most frequently measured by asking a respondent to indicate the extent to which (s)he (dis)agrees with a set of statements. MacCrimmon and Wehrung (1986), and Shapira (1995), among others, propose large-scale surveys for identifying risk preferences using psychometric scaling procedures. Several researchers developed risk attitude scales and tested their psychometric properties (Jaworski and Kohli 1993; Childers 1986).

Recently Pennings and Smidts (2000) compared the two approaches based on their convergent, discriminant, and nomological validity, using data obtained from computer-assisted interviews with 346 owner-managers who made decisions about their own businesses.⁵ While all measures demonstrate some degree of convergent validity, the utility based measures predicted actual market behavior better than the psychometric scales. In contrast, the psychometric scale showed more coherence with self-reported measures, such as innovativeness, market orientation, and the intention to reduce risk. In the light of the higher predictive validity of the utility-based

⁵ Converged validity refers to the degree to which different measurements reflect the same construct, i.e., are positively correlated. Discriminant validity is achieved when there is a divergence between measures of one construct and a related but conceptually distinct construct. Nomological validity refers to whether measures are related to other constructs in a way that is theoretically meaningful (Pennings and Smidts 2000)

measurements, Pennings and Smidts (2000) recommended elicitation methods based on the utility paradigm for understanding managerial decision making under risk.

Elicitation of the Utility Function

In this section we discuss various methods that have been used to elicit the utility function. Pennings and Smidts (2000) proposed measuring the points of the decision-makers' intrinsic utility function and then fitting a functional form. The intrinsic function, which is the utility function corrected by the strength-of-preference function, reflects decision making under risk (Dyer and Sarin 1982). The intrinsic utility function is determined by relating the strength-of-preference function $v(x)$ and the utility function $u(x)$, such that $u(x) = f(v(x))$. The strength of preference indicates how much a decision-maker values a particular level of an outcome (e.g., a return on investment of 20%). The intrinsic risk attitude measure is defined as $-u''(v(x))/u'(v(x))$ (analogue to the Pratt-Arrow coefficient of risk aversion). It represents the remaining curvature in the utility function, after eliminating the nonlinear effect related to the value function $v(x)$. The points on the utility function can be used to estimate the decision-makers' risk attitude by estimating the curvature of the utility function (Pratt-Arrow coefficient of risk aversion) and the global shape of the utility function.

The utility function can be measured using several elicitation techniques. In table 1 we identify six elicitation techniques that have been frequently proposed to measure utility and the strength of preference. The selection of the specific technique depends on a number of factors, including: degree of predictive validity, suitability for measuring risk attitudes using a survey-based instrument or experimental design, and easy of the

task for the respondent. The relevance of these criteria has been identified in the literature presented in table 1.⁶ Below, we discuss briefly these measurement techniques.

Table 1. Elicitation Techniques for Utility and Strength of Preference

<i>Measurement Techniques</i>	<i>Authors</i>
Utility Function: $u(x)$	
I. <i>Certainty Equivalence</i>	Keeney and Raiffa (1976), La Valle, (1978) Pennings and Smidts (2000).
II. <i>Conjoint</i>	Tversky (1967), Anderson and Shanteau (1970), Wind (1982), Smidts, (1990).
III. <i>Willingness to Trade-off</i>	Sarin and Weber (1993), Weber and Milliman (1997), Weber and Hsee (1998),
IV. <i>Standard Sequence</i>	Wakker and Deneffe (1996), Abdellaoui (2000)
Strength of Preference Function: $v(x)$	
V. <i>Direct Rating</i>	Huber (1974), Stevens (1975), Eliashberg (1980), Smidts (1990)
VI. <i>Midvalue Splitting</i>	Torgerson (1958), Green and Srinivasan (1978), Pliskin and Beck (1976), Smidts (1997).

One of the most commonly-used techniques to measure risk attitudes rooted in the expected utility framework is the *Certainty Equivalence (CE)* technique. The respondent is presented with an uncertain prospect, usually a *binary lottery* (e.g., lottery with two outcomes) and (s)he is asked to state a certain outcome called *certainty equivalent (CE)*.⁷ Each choice situation requires that the respondent choose between a certain outcome and a *binary lottery* (Keeney and Raiffa 1976). The respondent keeps specifying *CE*, until he becomes *indifferent* between the lottery and

⁶ For an extensive review on utility assessment methods based on other criteria, the reader is referred to Farquhar (1984) and Smidts (1990 pp. 151-163).

⁷ A *binary lottery* (i.e., lotteries with two outcomes) is denoted as $[x_1, p, x_2]$ which stands for a lottery which yields outcome x_1 with probability p and outcome x_2 with probability $(1-p)$. If either $p=0$, $p=1$ or $x_1=x_2$, the lottery is degenerate because the outcome is certain. A preference comparison of two binary lotteries involves the following expression: $[x_1, p, x_2] R [x_3, q, x_4]$ which denotes the preference relation between the lotteries, and consists of : $>$ (is more preferred than), $<$ (is less preferred than) or $=$ (is indifferent to). For example if the respondent is offered two lotteries in which four outcomes as the probabilities p and q are fixed, he has then to specify the unspecified item: the preference relation R between the two lotteries. If, on the other hand, the four outcomes (x_1 to x_4) and probabilities of them are fixed and if R is specified as $=$, then the respondent has to specify probability q so that he is indifferent between the lotteries.

the certain outcome. This indifference is arrived in an iterative manner. A sequence of points is successively adjusted until *indifference* is established. After the respondent has indicated that (s)he is indifferent between the certain outcome and the uncertain prospect, a point at the respondent's utility function is obtained. A sequence of successive bisections results in a number of points of the utility function. The curvature of the utility function that is obtained from these utility points is a measure of risk attitude.

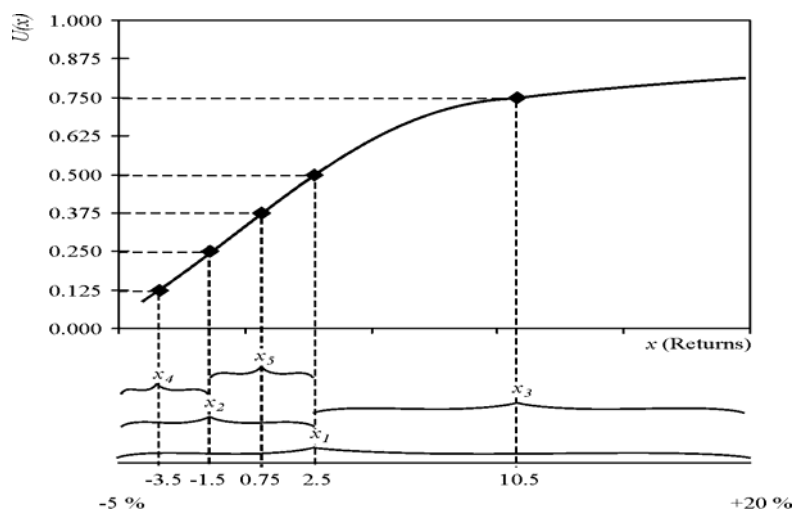


Figure 1. Utility Function Obtained by the Certainty Equivalent Method

Figure 1 shows an example of the results that one can obtain by using the certainty equivalent technique. In this example the *CE* technique is formulated in terms of relatively high/low returns on investments with a range of -5% to $+20\%$, with a probability of 0.5 (e.g., Alternative A) and a fixed return (e.g., Alternative B). Alternative A may be thought of as the transition to a sustainable production system. This alternative is risky, since the return on investment of such production system is unknown at the time that the SME makes the decision whether or not to switch to a sustainable production system. Alternative B represents the conventional production

system. In this example we assume that the return on investment for a conventional system is known (e.g., fixed return on investment). The assessment of *CE* is an iterative process. This measurement procedure can be computerized. If a SME chooses alternative A (the 50/50 high/low return), the computer will generate a randomly a higher fixed return (alternative B) than the previous, thus making alternative B more attractive or a lower fixed price making alternative A more attractive. If a SME chooses alternative B, the computer will generate randomly a lower or higher fixed return (alternative B) the next time, thus making alternative A (alternative B) more attractive. The next measurement will start after the SME indicates to be indifferent between alternative A or B. Various points can be assessed. Figure 1 shows that 5 points of the utility function are assessed. Each lottery that is played is depicted in Figure 1 as x_1, x_2, \dots, x_5 (e.g., Pennings and Smidts 2000).

An alternative method for measuring risk attitude is the conjoint technique. This technique is very popular in marketing and consumer behavior research (Green and Srinivasan 1978). The conjoint measurement allows the analysis of preferences of multi-attribute choice alternatives. Instead of providing indifference judgments, as with the certainty equivalence (lottery) technique, the respondent has to rate or rank order a set of hypothetical profiles which consist of specific sets of levels (one per factor), known as *stimulus* (Wind 1982). Each profile consists of a combination of levels for a number of attributes. Using appropriate estimation techniques (e.g., Ordinary Least Squares), the trade-off between levels of attributes can be obtained. Smidts (1990; 1997) specified two models to estimate the risk attitude of 218 Dutch farmers. These are the *Mean-Standard Deviation Model (MSD)*, which asks a respondent to make a trade-off between expected value (mean) and standard deviation (risk) and the *Ideal-Point model (IP)*, which makes

a non-linear relationship between expected value and risk possible by including the variance assigned to a hypothetical conjoint profile. In contrast to expectancy-value techniques that utilize compositional approaches, the conjoint technique is based on a *decompositional* approach, in which subjects judge a set of “total” profile descriptions. A profile in this context is a bundle of attributes that make up the product/service. This approach, which is based on some type of a composition rule (i.e. additive or multiplicative), results in a set of part-worths (i.e., values) for individual attributes that are most consistent with the subject’s overall risk preferences (Green and Srinivasan 1978).

The risk-return (i.e., risk-value) models also allow the estimation of risk attitude in a decompositional manner (e.g., Levy and Markowitz 1979). In the risk-returns models, the valuation of a risky prospect can be influenced by both the expected value of a prospect and its riskiness. Based on this notion, the decision maker’s risk preference can be estimated utilizing a technique that takes into consideration his/her *willingness to trade-off (WT)* risk against a potential outcome (e.g., return). The respondent expresses an evaluation in terms of the amount of money that he/she is willing to pay for an uncertain option (X), and makes a judgment of perceived risk (R), typically using a rating scale.⁸ The estimation of the decision maker’s risk parameter can be interpreted as the relative weight assigned to risk, relative to expected return (Weber and Hsee 1998).

Abdellaoui (2000) recently proposed a two-step procedure to successively elicit an individuals’ utility function $u(x)$ and the probability weighting function $w(x)$. In decision making under risk, the psychological weight assigned to an outcome may not

⁸ The perceived riskiness of a choice alternative may depend on a person’s reference point that can be manipulated by outcome framing and the outcome history of preceding decisions. Weber and Milliman (1997) suggest that the differences in risky choices between decision makers should not automatically be interpreted as the result of decision makers’ preferences for risk, but may also be the result of changes in their perception of the risks.

correspond to the probability of that outcome. The stimulus x in this context can be thought of as the return on investment of a sustainable production system. The $w(x)$ permits probabilities to be weighted nonlinearly, so that framing effects (caused by a special sequencing of choice questions, which may also cause probability distortion) are avoided. The first step of Abdellaoui's (2000) procedure is using Wakker and Deneffe's (1996) *trade-off technique* to elicit $u(x)$. The *trade-off technique* works as follows. Define a two-outcome lottery $[x, p; z]$ as a lottery that yields outcome x with probability p and outcome z with probability $1-p$. An individual is asked to compare lotteries $[x_0, p; Z]$ and $[x_1, p, z]$, where $x_1 < x_0 < Z < z$. The values of p, z, x_0 , and Z are fixed and x_1 is varied until the individual reveals the following indifference: $[x_0, p; Z] \sim [x_1, p; z]$, where \sim denotes indifference. Then the process is repeated and the individual is asked to state the level of x_2 , such that $[x_1, p; Z] \sim [x_2, p, z]$. Once, these indifferences are identified, it follows that $u(x_1)-u(x_0) = u(x_2)-u(x_1)$. That is, this technique allows the determination of equally spaced utility intervals or a "*standard-sequence*" of outcomes.⁹ The process can be repeated for any number of desired indifferences, x_0, \dots, x_n . As shown in Wakker and Deneffe (1996), a utility index can be constructed, such that $u(x_i) = i/n$ for $i = 1, \dots, n$. Abdellaoui (2000) showed that once a standard sequence of outcomes, x_0, \dots, x_n , has been determined using the method above, a standard sequence of probabilities can be determined in a similar fashion, such that a probability weighting function can be estimated. This allows one to determine whether an individual over- or under-weights low-, medium-, and high-probability events. Wakker and Deneffe's (1996) utility elicitation approach is advantageous, because (p. 1131) "*it is robust against probability distortions and misconceptions, which constitute a major cause of*

⁹ A standard sequence of x_0, \dots, x_n needs the construction of n differences $[x_{i-1}, p, Z] \sim [x_i, p, z], i = 1, \dots, n$.

violations of expected utility and generate inconsistencies in utility elicitation.” As such, the *trade-off* approach permits unbiased estimation of utility functions.

The *direct rating* and the *midvalue splitting* techniques are the most well-known and used techniques for the measurement of the strength of preference. Different question formats such as 5-, 7-, or 9-point category scales, graphic scales, and constant scales have been developed for making rating assessments (Stevens 1975). Also, an interval scale measurement that involves fixing boundaries of the scale (a lower and an upper bound) has been used. The respondent expresses the intensity (e.g., strength of preference) of a stimulus (e.g., return on investment for a sustainable production system) by assigning a number between the two fixed bounds (Huber 1974). In the *midvalue technique*, the respondent specifies whether a change from boundary point x_i to boundary point x_j equals in value a change from boundary point x_i to boundary point x_k considering that $x_i < x_j < x_k$. Through iteration, a value for point x_j can be found, at which the respondent is indifferent between both changes. As a result, the first midvalue is assessed (Dyer and Sarin 1982). Subsequent midvalue estimations will result in a number of points of the value function (Eliashberg 1980).

Recent research shows that the CE-technique is a convenient, reliable and valid way to assess utility functions *if* the CE-task is framed in the decision context of the respondents (Pennings and Garcia 2001), and hence respondents have well articulated preferences for the choices they are exposed to and when they use a consistent algorithm to arrive at their choices. The latter can easily be examined giving respondents different lotteries that are at the same utility level and testing whether the CEs for these lotteries are not significantly different from each other (e.g., Pennings and Smidts 2003).

Proposed Research Framework

Here we postulate several research propositions regarding the drivers of decision-makers' strategic behavior, and propose a more specific decision context for examining these propositions

In the economic literature, concave utility functions reflect risk aversion and convex ones with risk-seeking behavior. The curvature of the utility function reflects decision makers' risk attitude and it is a convenient measure for empirical researchers, as it can be estimated in a single parameter model. However, it does not account for the entire outcome range of the relevant attribute x used to obtain the utility function.

Kahneman and Tversky (1979) proposed that the shape of the utility function differs in the domains of gain and losses. Evidence that a more multidimensional shape (global shape) of the utility function could be useful for improving our understanding of strategic decision made under risk is provided by Hershey and Schoemaker (1982), Pennings and Smidts (2003), and Pennings and Garcia (2005). Therefore we propose that: *the global shape of the utility function will provide more information about the strategic decision regarding the transition to sustainable production systems than the unidimensional (local) measure of the utility function (i.e., the Pratt-Arrow coefficient of risk aversion).*

Previously, we identified that risk perception may have a moderating effect on the relationship between risk attitude, and strategic behavior. *We propose that policy that reduces the perceived risk of SMEs when they make strategic decisions will stimulate the transition to sustainable production process of risk averse SMEs.* The rationale behind this proposition is that risk averse SMEs dislike the risk that is embedded in the strategic decision which will negatively influence the transition

towards sustainable production systems. This negative influence of risk attitude is lowered when SMEs perceive less risk.

The occurrence of a multidimensional S-shaped utility function may imply different risk attitudes and behavior of a decision maker across the outcome domain (e.g., profit). *We propose that these different risk attitudes across the outcome domain may affect different operational or tactical behavior (e.g., whether or not to apply a particular pesticide) depending on the outcome x , but that this does not influence strategic behavior.*

Decisions makers may have different shapes of the global utility function. Currently four shapes have been examined: fully concave, fully convex, S-shaped and inverse S-shaped, but many more shapes may actually exist. *We propose to examine a variety of functional forms using a systematic statistical procedure, and hence examine the extent of heterogeneity in the different shapes.* After having identified the different functional forms *we propose to examine whether the heterogeneity is played out in different strategic behavior (e.g., choice of production system).*

While recent empirical work highlights that the global shape of the utility function may drive decision makers' risk-strategic behavior, it does not explain which factors drive the utility function (preferences) of decision makers. The latter is extremely important for policy makers. *We propose that the shape of the utility function may be influenced by personal characteristics of the decision maker (e.g., age, education, entrepreneurial capability), firm structure (e.g., financial position of the firm), and the firm's environment.* The environment, in this context, refers to factors such as the use of information about the business environment (e.g., new ideas for product/services design, competitors' behavior) (Kohli and Jaworski 1990), legal

framework, and governmental policy. *We propose studying these environmental factors that drive the global shape of the utility function, as they may suggest policy tools to influence the strategic decision regarding the transition to sustainable production systems.*

As identified, a distinction is made between the operational/tactical and strategic decisions. Strategic decisions entail a high degree of uncertainty and are made for a relatively long time window. A question related to what drives decision makers' strategic behavior is: does the global shape of the utility function change over time? *We propose to examine whether the global shape of the utility function changes over time and to examine the role of environmental factors (e.g., policy) in this change.* These environmental factors may be considered as crucial for future research activity as they directly relate to policy that can be implemented to stimulate the transition to sustainable production systems.

To this point, we have talked about sustainability in terms of production systems. However, an SME will be concerned about the economic sustainability of such a decision. Therefore *we propose to examine SMEs' perception regarding economic sustainability when making a decision to switch to sustainable production systems and how this perception is related to the global shape of the utility function.*

Decision Context

While research has been performed on the operational and tactical decisions related to the adoption of sustainable technologies no research has examined the transition to a sustainable production system as a strategic decision (Comer et al. 1999).

To test the relationships between the shape of the utility function and strategic behavior, a decision context is required in which the decision maker has a prominent influence on the structural and organizational decisions that have a long-term effect on the firm's structure and performance. The agribusiness sector meets this requirement. U.S. and European agricultural sectors consist of owner-managers who determine their SMEs' organization and who are work in a volatile economic environment. We may distinguish two production systems: the "conventional production system" (CPS) and the "organic production system" (OPS). A CPS is defined as an industrialized production system characterized by mechanization and use of synthetic inputs. An OPS is defined as an ecological production management system that promotes and enhances biodiversity and biological cycles. A consequence of the production system chosen is that owner-managers of conventional SMEs who choose for the OPS are confronted with high risks related to the economic viability of the investment. Often, it is unclear whether OPS products will yield revenues that are able to cover the increased costs. Specifically the context that we propose for future research is livestock production and horticulture. Both sectors have been challenged, as many local national governments are concerned about the sustainability of these two sectors that are important exporting sectors. The hog industry has been an innovative industry that has reached a high yield/input ratio. However, concerns have been raised whether this industry is sustainable. While various research institutes and universities, governmental organizations and industry groups have focused on how to create a sustainable hog market, no understanding is available about how hog farmers make that strategic decision to employ a sustainable production system. This knowledge is crucial when policy makers want to create sustainable food production systems.

The interest in sustainable systems also reaches agricultural marketing channels. For example, in the flower sector interest has been shown by growers, auctions, wholesalers, product boards, financial institutions, growers' associations, and several European Ministries of Agriculture (i.e., Dutch) in developing sustainable marketing channels. Various European organizations (i.e., FAO, CIHEAM) addressed the issue of sustainable production channels. However, no research exists on how we can explain and predict whether or not a SME (e.g., grower or farmer) switches to sustainable production systems. This understanding is crucial, and should be the starting point, when one wishes to develop sustainable agricultural marketing channels. Here we argue that we should examine the global shape of the utility function of SMEs as it drives strategic decisions, which allows us to segment SMEs and to identify the characteristics and environmental factors that drive a particular shape. If we, for example, find that SMEs with S-shaped utility functions are more inclined to switch the sustainable productions systems and that this shape is driven by SMEs low debt-to-equity ratio, effective policy can be formulated that would help SMEs to find (private) equity to lower the debt-to-asset ratio. In conclusion, this concise review provides the framework to address the crucial issue of how to explain and predict SMEs transition to sustainable production systems.

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