The Shape of Utility Functions and Organizational Behavior

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Based on measurements among 332 owner-managers, we investigate how the *global* shape of the utility function (i.e., S-shaped versus concave or convex over the total range of outcomes) relates to choice behavior. We find that the global shape of the utility function differs across decision makers (about one-third of the owner-managers exhibit an S-shaped utility function) and that the global shape is linked to organizational behavior (i.e., the production system employed), a result that does not change when using different methods to identify the decision maker's global shape of the utility function. The decision maker's risk attitude (risk averse or risk seeking) does not affect the choice of the production system. Whereas the degree of risk aversion, based on the *local* shape of the utility function, may be important in explaining owner-managers' trading behavior (Pennings and Smidts 2000), more structural organizational behavior appears to be linked to the *global* shape of the utility function.

(*Heterogeneity in Utility Functions; Organizational Behavior; S-Shaped Utility Function; Real Decision Makers; Reference Points*)

1. Introduction

In the expected utility (EU) model, the utility function $u(x)$ describes the risk attitude of decision makers (Keeney and Raiffa 1976). The curvature of the utility function $u(x)$ reflects whether decision makers are risk averse (a concave utility function) or risk seeking (a convex utility function). Local measures of the utility function curvature, such as the well-known Pratt-Arrow coefficient of risk aversion, indicate how strongly decision makers exhibit their risk attitude. A lot of research in decision making under risk has focused on relating *local* measures of risk aversion to choice behavior. Pennings and Smidts (2000), for example, found that the degree of risk aversion is important in explaining owner-managers' trading behavior (i.e., the choice of relatively safe fixed-price contracts versus risky spot market transactions). In this paper, however, we are interested in the *global* shape of the utility function $u(x)$ and how that global shape relates to choice behavior. Global shape is defined here as the general shape of the utility function over the entire outcome domain: fully concave, fully convex, or S-shaped (convex/concave).

An S-shaped utility function has been proposed in prospect theory (Kahneman and Tversky 1979). 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

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proposed convex/concave utility function predicts risk-seeking behavior in the domain of losses and risk-averse behavior in the domain of gains. Evidence for convex/concave utility functions across the total outcome domain has been found by Fishburn and Kochenberger (1979), Hershey and Schoemaker (1980), Budescu and Weiss (1987), and Kuhberger et al. (1999), among others.

In this paper, we conjecture that structural decision behavior is more strongly linked to the global shape of $u(x)$ than to local measures of risk aversion. In particular, the occurrence of an S-shaped utility function may imply fundamentally different behavior because decision makers will code outcomes into gains and losses, as compared to decision makers with fully concave or fully convex utility functions, who do not appear to think in terms of gains and losses.

Our objective is twofold. First, we analyze the extent of heterogeneity in the global shape of the utility function of real-business decision makers. Second, we test whether the shape of the utility function is linked to differences in organizational behavior. Organizational behavior is operationalized here as the owner-manager's design of the production process. We will show that the global shape of the utility function is related to organizational behavior, whereas the local measure is not.

First, we empirically demonstrate the relationship between the global shape of the utility function and organizational behavior. Next, we discuss the causal direction of this relationship: Is organizational behavior driving the shape of the utility function or is it the other way around?

2. Decision Context

To test the relationship between the shape of the utility function and organizational behavior, a decision context is required that is not masked by situational variables and where the decision maker has a prominent influence on the organizational form of the firm. The decision context of Dutch hog farmers meets these requirements. Dutch hog farmers are owner-managers who determine how they organize their firm and who are all exposed to the same economic environment (i.e., the volatile cash market of slaughter hogs). In hog farming, two production systems are distinguished: the "open production system" (OPS) and the "closed production system" (CPS). In the OPS, both piglets and feeds are bought; piglets are raised to be slaughter hogs in three to four months (during that period the hogs are fattened until their slaughter weight is about 90 kilograms) and sold in the cash market or through forward contracts. The CPS is similar to the OPS, except that the owner-manager breeds piglets instead of buying them.

A consequence of the chosen production system is that owner-managers who choose the OPS are more often and more explicitly confronted with input costs than are managers who choose the CPS. In particular, the expense of buying piglets (the costliest input in the production process) may make the input costs more salient to the OPS managers, and thus may affect their decision making and risk preferences. It may induce them to think more often or more easily in terms of gains and losses, with the costs of production as a reference point. We therefore may expect that OPS managers will be more inclined to think in terms of gains and losses, and thus will more often exhibit an S-shaped utility function. CPS managers, on the other hand, are not naturally provided with a reference point and are thus less stimulated to think in gains and losses terms. We therefore may expect that CPS managers will more often exhibit a fully concave or fully convex utility function describing their risk preferences.

3. Method

3.1. Assessing the Utility Function

We assessed the utility function of 332 hog farmers by means of computer-guided interviews. The utility function was measured using the certainty equivalence method (Keeney and Raiffa 1976, Smidts 1997). The certainty equivalents were obtained through choice-based matching (Keeney and Raiffa 1976, Fischer et al. 1999). In designing the lottery task for the hog farmers, we took into account the research findings on the sources of bias in assessment procedures for utility functions (Hershey et al. 1982, Hershey and Schoemaker 1985, Tversky et al. 1988). The main sources of bias arise when the assessment does not match the subjects' real decision situation. An important decision for hog farmers to make on a regular basis concerns the selling strategy of their slaughter hogs. They can choose a fixed-price forward contract or sell the hogs in the (risky) spot market. The lottery task fits this decision context, and the price per kilogram live hog weight is the main attribute. Another important research design issue involves the dimensions of the lottery; that is, the probability and outcome levels to be used in eliciting risk preferences. The outcome levels range from 2.34 to 4.29 Dutch guilder (1.06 Euro to 1.95 Euro) per kilogram live weight, representing all price levels of slaughter hogs that have occurred in the last five years. We chose a probability of 0.5 in the lotteries, expressing this stochastic nature of commodity prices (prices can rise or fall with equal probability), because various researchers have shown the stochastic behavior of commodity prices (Schwartz 1997, Hilliard and Reis 1999).

The measurement procedure was computerized and took about 20 minutes. The respondents were given a choice between three alternatives: Alternative A was a 50/50 chance of receiving a relatively high price or a relatively low price; Alternative B was a fixed price; and Alternative C indicated indifference. The assessment of the certainty equivalent was an iterative process. If the respondent chose Alternative A (the 50/50 high/low price), the computer would generate a higher fixed price (Alternative B) than the previous one, thus making Alternative B more attractive. If the respondent chose the fixed price (Alternative B), the computer would generate a lower fixed price the next time, thus making Alternative A (the 50/50 high/low price) more attractive. The choice between A and B was repeated until the respondent chose C (indicating indifference), after which a new lottery would start.

Nine points were assessed, corresponding to utilities of 0.125, 0.250, 0.375, 0.500, 0.625, 0.750, and 0.875 (plus two consistency measurements on utilities 0.500 and 0.625). For details on a similar elicitation procedure, see Pennings and Smidts (2000). Furthermore, accounting data was available from the firms involved, including information about their production systems (OPS versus CPS).

3.2. Assessing the Shape of the Utility Function

To assess the shape of the utility function we apply two different methodologies. This allows us to test the robustness of our empirical results. If there is truly a relationship between the shape of the utility function and the production system employed, both methods should yield the same result, ensuring that our results are method invariant. In particular, we show that the relationship between the shape of the utility function and the choice of the production system does not depend on the particular choice of the family of utility curves fitted to the assessed certainty equivalents. Below we discuss the two methods.

3.2.1. Fitting a Continuous Function: The EXP-IPT Method. In the first method, henceforth referred to as the EXP-IPT method, we fit the observations for each subject (the nine assessed certainty equivalents) to both the negative exponential function (EXP) and the log of the inverse power transformation function (IPT), the latter being an S-shaped utility function. The Appendix shows the function specifications. The exponential function is fully concave or fully convex over the entire outcome domain. The exponential function is often used in empirical studies, as it meets the general conditions of acceptable utility functions specified by Arrow (Tsiang 1972). The IPT-function specification was selected to represent an S-shaped utility function. The IPT function is quite flexible as regards the point of inflexion, which can be anywhere between its upper and lower bounds. Moreover, the IPT function offers wide variations in the degree of symmetry for a given point of inflexion (Meade and Islam 1995, Bewley and Fiebig 1988).[1] Because it is the certainty equivalents and not the utility levels that are measured with error, the inverse functions are estimated (Smidts 1997; see Appendix).

Based on the fit (i.e., by means of a pairwise comparison of the Mean Squared Error (MSE)), we classify the farmers into two groups: the EXP group (fully concave or convex utility function) and the IPT group (S-shape utility function). Subsequently, we examine the relationship between group membership and the production system that they employ.

[1] The authors are grateful to Nigel Meade and Towhidul Islam for providing detailed information on the properties of the IPT function.

3.2.2. Two-Piece Utility Function Method. In the second method to assess the shape of the utility function, we decompose the utility function into two exponential segments, one for consequences above the reference point (gain domain) and the other for consequences below the reference point (loss domain). We owe this idea to an anonymous reviewer. As a natural reference point we took the average cost of production, which was 2.90 Dutch guilder per kilogram live weight (that is, approximately 1.31 Euro). Certainty equivalents obtained from lotteries in which the relatively high level of the lottery (x_H) was below the natural reference point ($x_H < x_{REF}$) were used to estimate the EXP function for the loss segment, whereas lotteries in which the relatively low level of the lottery (x_L) was above the natural reference point ($x_L > x_{REF}$) were used to estimate the EXP function for the gain segment. Certainty equivalents that were obtained from lotteries in which x_H was above the natural reference point and x_L below the reference point (i.e., the range of the lottery includes the reference point: $x_L < x_{REF} < x_H$) were used in the estimation of both segments.

Similar to estimating the EXP function for the total outcome range, we normalized $u(x)$ on a 0–1 scale. This was done for each segment separately: $u(x_{LOWEST}) = 0$ and $u(x_{REF}) = 1$ for losses, and $u(x_{REF}) = 0$ and $u(x_{HIGHEST}) = 1$ for gains. The utilities of these separate segments are linked by scaling all assessments relative to $u(x_{REF})$, calculated for the specific individual respondent. We estimated $u(x_{REF})$, i.e., u(2.90 Dutch guilder), on the basis of the best-fitting overall function (EXP or IPT) for that individual.

By estimating the EXP function for each segment, we obtain two parameters for each respondent: c_g for the gain domain and c_l for the loss domain (c in the exponential function represents the Pratt-Arrow coefficient of absolute risk aversion). These parameters allow us to describe the farmer's shape of the utility function as a combination of c_g and c_l. We can classify farmers regarding four different shapes of the utility function: $c_l > 0$ and $c_g > 0$ implying a concave utility function for both gains and losses, $c_l < 0$ and $c_g < 0$ implying a fully convex utility function, $c_l > 0$ and $c_g < 0$ implying a reversed S-shaped utility function, and $c_l < 0$ and $c_g > 0$ implying an S-shaped function.

4. Heterogeneity in the Shape of Utility Functions

The results for each method of assessing the shape of the utility function will be presented first, followed by a discussion of the robustness of the classification of the farmers by comparing the two methods.

4.1. Results of the EXP-IPT Method

First, we assume the farmers to be homogeneous as regards the shape of the utility function. We therefore estimate both the exponential function and the IPT function for each farmer (see Table 1, top panel).[2]

Parameter c in the exponential function represents the Pratt-Arrow coefficient of risk aversion. Based on the exponential function, many farmers (55%) appear to be risk averse (parameter $c > 0$), while others are risk prone ($c < 0$), which is in line with previous findings (Pennings and Smidts 2000). The estimates of the IPT function show that hog farmers, on average, have an S-shaped (convex, concave) function (i.e., $\beta > k$) in the IPT function; see Appendix for specification. The estimates of the IPT function allow us to derive the average point of inflexion for the IPT group, which appears to be 2.93 Dutch guilder per kilogram live weight hogs. This number corresponds closely to the production costs of 2.90 Dutch guilder per kilogram, as estimated by experts from the industry at the time of the research. Table 2 provides information regarding the distribution of the point of inflexion for the IPT group.

Because both functions have three parameters and are estimated with an equal number of data points for each subject, we can compare the functions' fit on the basis of the MSE. Table 1 shows that, on average, the exponential function fits the owner-managers' utility function slightly better than the IPT function.

To test for heterogeneity as regards the functional form of their utility function, we split the owner-managers in two groups, based on their fit of

[2] Two measurements at $u(x) = 0.5$ and two at $u(x) = 0.625$ were obtained to test the internal consistency of the assessments. When tested, the differences between the assessed certainty equivalents for the same utility levels were not significant ($p > 0.99$ (pairwise test)) for both consistency measurements, indicating that respondents assessed the certainty equivalents in an internally consistent manner.

Table 1 Results of Estimating the Utility Function per Individual for the Exponential Function and the IPT Function: The Homogeneous and Heterogeneous Cases

Estimation results for the homogeneous case ($n = 332$)						
	Exponential function			IPT function		
	a	b	c	α	β	κ
Parameter[a]						
Mean	−1.486	1.461	−0.283	−3.973	9.680	0.954
Median	−0.007	0.016	0.053	−4.094	7.227	−0.159
Fit indices[b, c]						
Mean MSE	0.005			0.008		
Median MSE	0.003			0.005		
Mean R^2	0.907			0.871		
Median R^2	0.928			0.886		
Estimation results for the heterogeneous case						
	$n = 229$			$n = 103$		
Parameter						
Mean	−2.276	2.296	−0.124	−4.480	10.384	1.071
Median	−0.031	0.042	0.053	−4.569	6.673	−0.446
Fit indices						
Mean MSE	0.004			0.002		
Median MSE	0.002			0.002		
Mean R^2	0.957			0.956		
Median R^2	0.974			0.969		

Notes. [a]For function specifications, see Appendix. [b]MSE = Mean Squared Error (predicted versus observed certainty equivalents, scaled on a 0–1 scale). [c]R^2 is calculated by squaring the Pearson correlation between the actual values and the values predicted from the model.

the two functions. One group consisted of owner-managers whose utility function is best described by the exponential function (the so-called EXP group; $n = 229$); the other group consisted of subjects whose function is best described by the S-shaped function (the so-called IPT group; $n = 103$), based on the pair-wise comparison of the MSE. Table 1 (lower panel) presents the estimation results for both groups. A comparison of the estimation results from the homogeneous case with those from the heterogeneous case shows that the average fit for *both* functions has increased and that the parameter estimates have changed substantially by taking heterogeneity into account. In particular, the mean MSE of the IPT function drops from 0.008 for the total group to 0.002 for the 103 IPT subjects (see also the substantial increase in R^2). For the EXP group, the increase in fit is less dramatic but still evident (see, e.g., ΔR^2). The split is definitely not random, as the MSE and the parameters of the exponential function differ significantly between the "real" EXP group and the "real" IPT group (all $p < 0.05$); similar results were found for MSE and parameters of the well-fitting and badly fitting IPT subjects.

Table 2 Descriptive Statistics on the Point of Inflexion in Dutch Guilders per Kilogram Live Weight for the IPT Group

	Point of inflexion based on the hog farmers' IPT-utility function
Mean	2.93
Std. deviation	0.277
Percentile 25	2.75
Percentile 50	3.00
Percentile 75	3.10

These results show that owner-managers differ regarding the global shape of their utility function. Next, we examine the global shape of the utility function using the two-piece utility function method, allowing us to determine whether or not the results of the EXP-IPT method are robust.

4.2. Results of the Two-Piece Utility Function Method

Table 3 shows the results for the two-piece utility function method. The estimation results indicate that 38.8% ($n = 129$) of the farmers have utility functions that are concave for both the loss and gain domains (i.e., $c_l > 0$ and $c_g > 0$), and hence are said to be risk averse across the total outcome domain. A smaller group of farmers (27.4%) can be described as being risk prone across the entire outcome domain (i.e., $c_l < 0$ and $c_g < 0$). Only a few farmers (3.6%) show a reversed S-shaped utility function (i.e., $c_l > 0$ and $c_g < 0$). About 30% of the farmers exhibit an S-shaped utility function. These results confirm our previous finding that owner-managers differ regarding the global shape of their utility function. Furthermore, our observation that decision makers differ regarding the global shape of their utility function confirms the work done by Fishburn and Kochenberger (1979),

Table 3 Results of the Two-Piece Utility Function Method

Parameter[a]	Loss domain a_l	b_l	c_l	Gain domain a_g	b_g	c_g
Estimates for farmers who exhibit a concave utility function ($c_l > 0$ and $c_g > 0$) ($n = 129$; 38.8%)						
Mean	2.548	−2.560	2.317	3.585	−3.636	2.161
Median	1.117	−1.205	2.182	1.129	−1.287	2.059
Median MSE	0.003			0.003		
Median R^2	0.963			0.962		
Estimates for farmers who exhibit convex utility function ($c_l < 0$ and $c_g < 0$) ($n = 91$; 27.4%)						
Mean	−5.851	5.854	−2.437	−5.355	5.341	−1.738
Median	−0.371	0.135	−2.131	−0.344	0.346	−1.437
Median MSE	0.007			0.003		
Median R^2	0.956			0.969		
Estimates for farmers who exhibit a reversed S-shaped utility function ($c_l > 0$ and $c_g < 0$) ($n = 12$; 3.6%)						
Mean	4.213	−4.232	1.641	−0.487	0.477	−2.605
Median	1.271	−1.288	1.444	−0.078	0.087	−2.694
Median MSE	0.000			0.005		
Median R^2	0.961			0.968		
Estimates for farmers who exhibit an S-shaped utility function ($c_l < 0$ and $c_g > 0$) ($n = 100$; 30.1%)						
Mean	−0.359	0.364	−2.509	3.911	−3.928	1.956
Median	−0.096	0.105	−2.449	1.205	−1.349	1.741
Median MSE	0.002			0.003		
Median R^2	0.969			0.967		

Notes. [a]An exponential function is estimated separately for gains and losses; for function specification, see Appendix. [b]MSE = Mean Squared Error (predicted versus observed certainty equivalents, scaled on a 0–1 scale). [c]R^2 is calculated by squaring the Pearson correlation between the actual values and the values predicted from the model.

who used a two-piece utility function method with 30 respondents. They also found all four shapes of utility functions, and 46% of their subjects exhibited an S-shaped function.

The results in Table 3 allow us to measure the loss aversion of the farmers by examining the ratio of the slope of the utility function in the loss domain and the slope in the gain domain (Kahneman et al. 1990, Tversky and Kahneman 1991). For the farmers with an S-shaped utility function the average loss-aversion coefficient is 1.8, indicating that risk preferences are exhibited somewhat more strongly for losses than for gains. The average loss aversion of our subjects is somewhat smaller than the loss-aversion coefficients found in other studies, which are in the neighborhood of 2 (Kahneman et al. 1990, Tversky and Kahneman 1991).

4.3. Method Comparison: Robustness of Classification

To examine whether the EXP-IPT method and the two-piece utility function method identify similar

Table 4 Correspondence in Classification of the EXP-IPT Method and the Two-Piece Utility Function Method

Two-piece utility function method	The EXP-IPT method: EXP function	IPT function
Concave function ($c_l > 0$ and $c_g > 0$)	**96.9**% (n = 125)	3.1% (n = 4)
Convex function ($c_l < 0$ and $c_g < 0$)	**95.6**% (n = 87)	4.4% (n = 4)
Reversed S-shaped function ($c_l > 0$ and $c_g < 0$)	25.0% (n = 3)	**75.0**% (n = 9)
S-shaped function ($c_l < 0$ and $c_g > 0$)	14.0% (n = 14)	**86.0**% (n = 86)

global shapes of the utility function, we compare the two methods. Table 4 shows the high correspondence in classification. Farmers who have a fully (i.e., over the total outcome range) concave or convex utility function according to the two-piece utility function method are farmers that were best described by an EXP-utility function according to the EXP-IPT method. That is, 96.9% of the farmers that have a fully concave utility function ($c_l > 0$ and $c_g > 0$) and 95.6% of the farmers that have a fully convex utility function ($c_l < 0$ and $c_g < 0$) are farmers for whom the EXP function fits best. Farmers that have an S-shaped or reversed S-shaped utility function according to the two-piece utility function method are farmers that have an IPT-utility function according to the EXP-IPT method. That is, for 75% of the farmers with a reversed S-shaped utility function and 86.0% of the farmers with an S-shaped utility function, the IPT function fits best. These results show that classifying respondents as regards the shape of the utility function is not dependent on the method used, providing evidence that the identification of the global shape of the utility function for farmers is robust.

5. Shape of the Utility Function and Organizational Behavior

After showing heterogeneity in the shape of the utility function of real-business decision makers, we investigate whether the shape of the utility function is reflected in the decision maker's organizational behavior using both methods to identify the global shape of the decision maker's utility function.

5.1. Shape Identified by the EXP-IPT Method and Organizational Behavior

We examine whether or not the production system chosen by hog farmers (OPS versus CPS) is related to the shape of their utility function (EXP versus IPT). Table 5 shows the descriptive statistics of the relationship.

Table 5 shows that the functional form of a hog farmer's global utility function (EXP versus IPT) is related to the production system employed (OPS versus CPS). Overall, 45.5% of the farmers employed the

Table 5 Relationship Between the Shape of the Utility Function (IPT vs. EXP) and Production System Employed (OPS vs. CPS) for the Total Sample and the Risk-Averse and Risk-Seeking Segments

	OPS %	CPS %	Total %
Total	45.5	54.5	100 ($n = 332$)
EXP group	29.7	70.3	100 ($n = 229$)
IPT group	80.6	19.4	100 ($n = 103$)
Total	*100*	*100*	*100* ($n = 332$)
EXP group	*45.0*	*89.0*	*69* ($n = 229$)
IPT group	*55.0*	*11.0*	*31* ($n = 103$)
Risk-averse decision makers ($c > 0$; $n = 183$)			
EXP group	29.2	70.8	100 ($n = 120$)
IPT group	80.9	19.1	100 ($n = 63$)
Risk-seeking decision makers ($c < 0$; $n = 149$)			
EXP group	28.4	71.6	100 ($n = 109$)
IPT group	80.0	20.0	100 ($n = 40$)

Notes. Where the EXP group consists of respondents for whom the shape of their utility function is best described by the exponential function (fully concave or fully convex), the IPT group consists of respondents for whom the shape of their utility function is best described by the log of the inverse power transformation function (S-shaped; see Appendix for function specifications). OPS denotes the open production system, CPS denotes the closed production system, and c is the risk parameter in the exponential function.

OPS production system and 54.5% employed the CPS system. Of the farmers with a concave or convex utility function (the EXP group), 29.7% employed OPS and 70.3% employed CPS. In contrast, of the farmers with an S-shaped utility function (the IPT group), 80.6% employed OPS, while 19.4% used CPS. Looking at these same results from an opposite direction, Table 5 (percentages in italics) shows the majority of the farmers that employ the OPS production system (those who buy piglets) have utility functions that are best described by the S-shaped IPT function (55.0% versus 45.0%). In contrast, hog farmers that employ CPS (those who breed their own piglets) have utility functions that are best described by the EXP function (89.0% versus 11.0%).

To check whether a fundamental difference exists between risk-averse and risk-seeking decision makers, Table 5 (lower panel) also includes the relationship between the shape of the utility function (IPT versus EXP) and the production system employed (OPS versus CPS) for both risk-averse ($c > 0$) and risk-seeking decision makers ($c < 0$). The relationship between the global shape of the utility function and the production system employed turns out to be similar for both segments. Thus, whether a decision maker is risk averse or risk seeking does not seem to affect the relationship between global shape and choice of the production system.

To statistically test the relationship between the global shape of the utility function and the production system employed, we conducted a logistic regression analysis with the dichotomy of CPS versus OPS as the dependent variable and group membership (EXP versus IPT) as the independent variable. In the analysis, we controlled for the hog farmers' age, education, and debt-to-asset ratio.

Table 6 shows that the model significantly improves the fit when compared to the null model, which includes only an intercept ($p < 0.001$; Nagelkerke $R^2 = 0.28$, correctly classified choices 75%). The regression coefficient of the shape of the utility function was clearly significant ($p < 0.001$) in the logistic regression. The variables age ($p = 0.18$), education ($p = 0.44$), and debt-to-asset ratio ($p = 0.76$) appeared not to be significant. These results again confirm the relationship between the global shape of the utility function and production system employed. To test whether a fundamental difference exists between risk-averse ($c > 0$) and risk-seeking ($c < 0$) decision makers, we ran separate logistic regressions for both groups. The results were similar to those of the total sample (see Table 6). No difference in the effect of utility function shape shows up between risk-averse and risk-seeking individuals. Interestingly, the debt-to-asset ratio is significant for the risk-seeking group, a finding that is consistent with the financial literature, which suggests that the expected costs of financial distress caused by a firm's insolvency (i.e., high debt-to-asset ratio) influences that firm's decision making, especially when that firm engages in risky events (e.g., risk-seeking group) (Smith and Stulz 1985).

In the previous analysis, a split was made between risk-averse and risk-seeking individuals. To further test whether the degree of risk aversion indeed does not influence choice behavior, we ran a logistic regression analysis for the EXP group and the IPT group, separately. Within the EXP group, the degree of risk aversion (parameter c) was used to predict the choice of a particular production system. No significant relationship of parameter c on choice behavior was found ($p = 0.109$). Within the IPT group, no effect of degree of risk aversion (assessed at the average cost price of

Table 6 **Results of Logistic Regression in Which the Shape of the Utility Function (IPT vs. EXP) Predicts the Production System Employed by Hog Farmers (OPS vs. CPS)**

	Production system employed by hog farmers: OPS (=1) or CPS (=0)					
	Total sample		Risk-averse segment ($c > 0$)		Risk-seeking segment ($c < 0$)	
	B	p	B	p	B	p
Shape of the utility function: (IPT = 1; EXP = 0)	2.41*	0.00	2.60*	0.00	2.47*	0.00
Age	−0.02	0.18	−0.04	0.51	0.00	0.90
Education	0.35	0.44	0.26	0.34	0.34	0.13
Debt-to-asset ratio	−0.03	0.76	−0.23	0.08	0.25*	0.05
Fit statistics						
Nagelkerke R^2	0.28		0.30		0.31	
Correctly classified choices	75.2%		73.2%		74.2%	

Notes. The cutoff value in the misclassification test is 0.500. An asterisk indicates that each parameter significantly ($p < 0.05$) improves the fit when compared to the null model, which only includes an intercept. Nagelkerke's R^2 is similar to the R^2 in linear regression and measures the proportion of variance of the dependent variable (i.e., production system employed by hog farmers) from its mean, which can be explained by the independent variables (the shape of the utility function, age, education, and debt-to-asset ratio).

The debt-to-asset ratio was measured on a 10-point scale with 1 = debt-to-asset ratio 1%–9%, 2 = 10%–19%, etc. The maximum level of education was measured on a 5-point scale ranging from high school to university degree. Age is measured in years.

2.90 Dutch guilders) was found on the choice of production system ($p = 0.245$) either. These results again indicate that while the degree of risk aversion may be important in explaining farmers' *trading* behavior (e.g., choosing between fixed-price contracts or spot market selling, cf., Pennings and Smidts 2000), more structural *organizational* behavior is related to the global shape of the utility function.

The EXP-IPT method indicates a strong relationship between the global shape of the utility function and organizational behavior, a result that does not seem to change when further improving the utility measurement by reducing measurement error.[3] Next we examine whether we find similar results when relating the global shape of the utility function based on the two-piece utility function method to organizational behavior.

5.2. Shape Identified by the Two-Piece Utility Method and Organizational Behavior

Examining the relationship between the shape of the utility function and the decision maker's organizational behavior translates for this method in examining whether the production system chosen by hog farmers (OPS versus CPS) is related to the shape of their utility function (i.e., fully concave, fully convex, reversed S-shaped, and S-shaped). Table 7 shows that farmers with a fully concave or convex utility function predominantly employ the CPS (72.1% and 76.9% respectively). This finding confirms the results obtained from the EXP-IPT method that 70% of the farmers described by an EXP function are associated with CPS.

[3] To find out whether our findings were sensitive to measurement error, we divided the total sample into three groups instead of two: the EXP group, the IPT group, and an "ambivalent" group of approximately 10% of the total sample that had shown minimal differences in the MSEs for the EXP and IPT function (ΔMSE < 0.001). If any of these "ambivalent" subjects had been misclassified into either the EXP or IPT group based on their MSE values, removing them from the analysis should increase the percentage of correct classification. Running the logistic regression analysis for the "unambivalent" EXP and IPT groups revealed practically the same results as described above (77% correctly classified instead of 75%). These results indicate that MSE is a sensitive measure with which to differentiate and classify respondents. Our findings appear to be robust for the utility measurement.

Table 7 Relationship Between the Shape of the Two-Piece Utility Function and the Production System Employed (OPS vs. CPS); Percentages Computed Both Horizontally and Vertically

Loss domain	Gain domain	Global shape of utility function	OPS %	CPS %	Total %
$c_l > 0$	$c_g > 0$	Concave	27.9	72.1	100 ($n = 129$)
$c_l < 0$	$c_g < 0$	Convex	23.1	76.9	100 ($n = 91$)
$c_l > 0$	$c_g < 0$	Reversed S-shaped	66.6	33.3	100 ($n = 12$)
$c_l < 0$	$c_g > 0$	S-shaped	86.0	14.0	100 ($n = 100$)
Total			45.5	54.5	100 ($n = 332$)
$c_l > 0$	$c_g > 0$	Concave	23.8	51.4	38.9 ($n = 129$)
$c_l < 0$	$c_g < 0$	Convex	13.9	38.7	27.4 ($n = 91$)
$c_l > 0$	$c_g < 0$	Reversed S-shaped	5.3	2.2	3.6 ($n = 12$)
$c_l < 0$	$c_g > 0$	S-shaped	57.0	7.7	30.1 ($n = 100$)
Total			100	100	100 ($n = 332$)

Farmers with a reversed S-shaped, and particularly those with an S-shaped, utility function predominantly employ OPS (66.6% and 86.0%, respectively). These results again confirm the relationship we found using the EXP-IPT method, namely, that 80% of the farmers having a utility function that could best be described by an IPT function are associated with employing OPS. In Table 7 (lower panel), we also present the percentages computed vertically. It shows that 57% of the OPS farmers have an S-shaped utility function versus only 7.7% of the CPS farmers; 90% of the latter have a fully concave or fully convex utility function.

Our results provide evidence that there is a strong relationship between the global shape of the utility function and organizational behavior, a result that does not seem to change when using different methods to identify the decision maker's global shape of the utility function.

5.3. What Is Driving What?

Having shown that the global shape of the utility function is related to organizational behavior, we speculate about the causal order of the effect: Does the shape of the utility function affect organizational behavior, or does the chosen organizational structure dictate the shape of the utility function? We cannot provide a definite answer to the causal order of variables because our findings are based on a cross-sectional analysis. We therefore speculate about the reason why the S-shaped utility function is related to the OPS and the fully concave or convex function is related to the CPS.

First, we reflect on the reason why the current organizational context may be driving the global shape of the utility function. In the OPS, owner-managers buy piglets and feed and sell slaughter hogs in the cash market three to four months later. These owner-managers are well aware of their production costs because all their costs are direct expenditures. They know their production costs and, hence, the price levels in the cash market that constitute profit and loss. An S-shaped utility function with its point of inflexion reflects this. In the CPS, owner-managers raise their own piglets. As such, they do not incur the expense of buying piglets, the costliest input in the production process. For this reason, they tend not to think in terms of gains and losses as often.

To test this idea further, we ran the logistic regression (see Table 6) the other way around; that is, the production system (OPS versus CPS) became the dependent variable and the shape of the utility function (EXP versus IPT) the independent variable. The model fit slightly improves from Nagelkerke $R^2 = 0.28$ to Nagelkerke $R^2 = 0.31$, which might be an indication that contextual elements such as the production system influence the shape of the utility function.

The reasoning above is consistent with the recent literature on constructed preferences, which argues that due to limited processing capacity, decision makers often do not have well-defined preferences, but preferences are constructed on the spot by an adaptive decision maker (e.g., Bettman et al. 1998, Butler 2000). However, we cannot rule out the possibility that the shape of the utility function actually drives organizational behavior. Traditionally, economists have considered utility functions to be constant and individual specific; that utility maximization drives (optimal) behavior. It is very difficult, and it may even be impossible, to derive a formal utility-maximization argument that shows that an IPT farmer would find OPS more attractive than an EXP farmer. Instead, we provide some conceptual reasoning related to why the shape of the utility function may affect organizational behavior. In the context of our study, one could argue that farmers with an S-shaped utility function think in gains and losses strongly in the short run. The OPS production system, in which they very rationally buy inputs (piglets and feeds) and raise the piglets to be slaughter hogs, fits their thinking in costs and benefits very well. The OPS system even provides them with the option to stay out of business when prices are low. In contrast, CPS, in which the farmer is responsible for breeding the piglets, requires a lot of expertise in this very specialized area of breeding. The breeding process also takes a lot of time and requires thorough mental attention; breeding processes are less mechanical, more variable, and more difficult to plan than the processes of raising hogs. A CPS farmer is therefore more akin to a "real" farmer in the traditional understanding of the word. Such a person may therefore think in gains and losses in a more long-term manner and will perceive farming as a way of life and a means to provide a continuous stream of income, with a focus on wealth in the long run (Willock et al. 1999). Consequently, the CPS system will appeal much more to his/her way of thinking than will the OPS system.

6. Discussion

The empirical results show that the *global* shape of the utility function may differ across decision makers and that this difference is linked to organizational behavior. Structural behavior appears to be more strongly related to the global shape of the utility function than to the degree of risk aversion, which is based on the *local* shape of the utility function. Another way of looking at our results is in terms of reference points. Structural behavior appears to be more strongly related to the presence of a reference point, with the subsequent coding of outcomes into gains and losses, than to the degree of risk aversion.

This interpretation of the occurrence of a reference point can be substantiated further by noting that of the owner-managers with a CPS production system (those who breed their own piglets), practically all (89%) exhibit a fully concave or convex utility function, and only 11% exhibit an S-shaped utility function (see Table 5). Of the farmers with an OPS production system (those who *buy* their piglets), 55% exhibit an

S-shaped utility function and 45% have a fully concave or convex utility function. Apparently, breeding piglets hardly ever induces farmers to think in terms of gains or losses. These farmers simply do not have a clear reference point available. In contrast, buying piglets makes a substantial percentage of farmers think in terms of gains and losses, whereas others may decide to treat these costs as sunk costs and do not act upon them.

Though we consider it behaviorally likely that the organizational context is indeed driving the occurrence of a reference point, we also speculated on the idea that the natural tendency to think in gains and losses is driving the decision makers' organizational behavior (see §5.3). As our cross-sectional design does not enable us to establish the causal order of effects, further research by means of a longitudinal design is required.

In a longitudinal design, one could also study the stability of the utility function across time. Previous studies indicate that the stability of the degree of risk aversion may be relatively low. In his study of 253 farmers (growers of potatoes), Smidts (1997) assessed risk attitudes by means of the certainty equivalent technique in two consecutive years. He found a significant temporal shift in the risk attitude towards less risk aversion in the second year; the test-retest correlation with this one-year interval was $r = 0.45$. Similarly, Schoemaker and Hershey (1992) reported a test-retest correlation of $r = 0.55$ for the certainty equivalence technique with a three-week interval. We speculate here that the risk parameter in the utility function (i.e., the local shape) is temporally less stable than the global shape of the utility function. Because our findings suggest that the global shape is linked to more structural organizational behavior, decision makers will not easily shift between S-shaped utility functions and a fully concave or convex function. Only a structural change in behavior would affect the global shape of the utility function. Similarly, if the global shape of the utility function drives organizational behavior, we would find frequent changes in organizational behavior in the case of a temporally unstable global shape of the utility function. Empirical evidence on the temporal stability of the global shape can only be achieved in a longitudinal design.

In this study, we applied two different methods in assessing the shape of the utility function. The correspondence between the methods in classifying the decision makers was high. The method of fitting a two-piece utility function is quite flexible, allows the estimation of loss aversion, and discriminates organizational behavior even slightly better than the EXP-IPT method (see §5.2). However, the EXP-IPT method does have the advantage of a more straightforward fitting procedure, and it requires fewer parameters to be estimated. This approach also has the important advantage that the reference point (the point of inflexion) is inferred from the elicitations, instead of imposed. The IPT-function also appeared to be flexible enough to detect the large diversity of (reversed) S-shaped utility functions in our sample of real-business decision makers.

Recently, Wakker and Deneffe (1996), Wu and Gonzales (1996), Bleichrodt and Pinto (2000), and Abdellaoui (2000), amongst others, have developed methods to remove from utility measurements the bias due to nonlinear probability weighting. Although there are large differences between individuals, a general finding is that the probability of $p = 0.5$ (the p we used in our lotteries) tends to be underweighted.[4] Moreover, Abdellaoui (2000) showed that the tendency to underweight $p = 0.5$ is somewhat larger for gains than for losses, which confirms the difference in weighting functions for gains and losses, as proposed by the Cumulative Prospect Theory (Tversky and Kahneman 1992). These results would imply that by correcting for probability weighting, we might find the S-shaped functions to flatten; for gains the utility function becomes less concave and for losses it becomes less convex. Thus, probability weighting may have an impact on the shape of the utility function. In our analysis, not correcting for probability weighting implies that some subjects currently classified in the IPT group should have been classified in the EXP group. Considering, however, that our predictive results do not

[4] Bleichrodt et al. (2001) conclude that the certainty equivalence technique is not distorted by loss aversion, but it is distorted by probability transformation. This bias is relatively small at $p = 0.5$.

change upon removing the 10% of "ambivalent" subjects, the effect of probability weighting will probably not be large enough to affect our findings substantially. To further test this effect of probability weighting on our results, we added to the EXP group the 10% of the IPT group (11 subjects) closest to EXP (based on MSE) and then repeated the logistic regression. If these subjects had indeed been misclassified due to probability weighting, the predictive validity should increase. The analysis shows that the percentage of correct classifications decreased slightly from 75% to 73%. Therefore, we conclude that taking into account probability weighting would not have influenced our results substantially. Similar results were found for the two-piece utility function method.[5] Finding an insignificant effect of probability weighting on the relationship between the global shape of the utility function organizational behavior is perhaps not that surprising since our farmers understand the 50/50 lotteries very well as they reflect their daily decision-making domain: selling hogs in the cash market in which prices can go up or down with equal probability. Interestingly, in a pilot study with a number of focus group discussions with farmers, we observed that farmers truly think that the chance of market prices going up or down are equal. Often when talking about prices going up or down they would say: "You know, it is hard to tell whether the price will go up or down, it is like flipping a coin." This notion is confirmed in the financial literature (Schwartz 1997).

Recently, various researchers have demonstrated the role of loss aversion in decision-making behavior of consumers and investors (e.g., Hardie et al. 1993, Odean 1998). These studies are done in a buy/sell context; extending it to choices that involve organizational behavior should be an interesting avenue to explore. In a first effort to account for loss aversion, we included loss aversion in the logistic regression (see Table 6) for the segment of hog farmers with an S-shaped utility function and examined whether loss aversion contributed to the predictive validity. It appears that loss aversion was not a significant variable in the equation and that the predictive validity did not change. These results suggest that loss aversion is not (directly) related to organizational behavior.

In management science, a distinction is made between tactical decisions and strategic decisions. In the light of this taxonomy, we may conclude that the global shape of a decision maker's utility function seems to reflect the manager's strategic decision structure (e.g., choice of production process), whereas the local shape of the utility function seems to drive tactical decision making—e.g., trading behavior; fixed-price versus spot contracts (Pennings and Smidts 2000). It would be interesting to study to what extent our findings can be generalized to similar structural decisions and to different decision contexts.

An issue that needs to be addressed in future research is the causal relationship between the global shape of the utility function and organizational behavior. Work is in progress using a panel of decision makers such that a longitudinal research design is possible. Such a research design would also allow us to study decision makers that switched between organization structures (e.g., farmers switching from OPS to CPS or vice versa) and investigate whether the shape of their utility function changes (i.e., from IPT to EXP or vice versa) after this change in organizational structure. A challenge for this type of research is that one needs a long time interval, as decisions regarding organizational behavior (e.g., production process employed) are strategic in nature and hence are made for a relatively long time window.

[5] To further explore the possible effect of probability weighting, we used the cost of production as an indicator of the reference point. Based on whether the lottery was played above or below the reference point, we used $w(p) = 0.42$ (for gains) and $w(p) = 0.45$ (for losses), found in studies by Tversky and Kahneman (1992). We then estimated the utility functions again. It appears that although the coefficients in both the exponential and the IPT function change, the classification of hog farmers does not.

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Appendix. Function Specifications

Exponential function	IPT function
$U(x) = a + b\,\mathrm{EXP}(-cx)$	$U(x) = \dfrac{1}{1 + \mathrm{EXP}[-\alpha - \beta(1/\kappa)\log(1+\kappa x)]}$
	Point of inflexion
	$U(x) = 1/2(1 - \kappa/\beta)$
Estimation functions	
$x_i = -\dfrac{1}{c}\ln\left[\left(\dfrac{u(x_i)-a}{b}\right)\right] + \varepsilon_i$	$x_i = \dfrac{1}{\kappa}\left\{\mathrm{EXP}\left[\left(-\dfrac{1}{\beta}\left(\log\left(\dfrac{1}{u(x_i)}-1\right)+\alpha\right)\right)\cdot\kappa\right]-1\right\} + \varepsilon_i$

Note. We followed Smidts (1997) in our estimation of the parameters.

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