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Abstract	Based on measurements with 332 owner-managers, the *global* shape of the utility function (i.e., S-shaped versus concave or convex over the total range of outcomes) appears to discriminate organizational behavior. Whereas the degree of risk aversion, based on the *local* shape of the utility function, may be important in explaining owner-manager's trading behavior, the global shape of the utility function appears to drive more structural organizational behavior.	
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The Shape of Utility Functions and Organizational Behavior

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Abstract

Based on measurements with 332 owner-managers, the *global* shape of the utility function (i.e., S-shaped versus concave or convex over the total range of outcomes) appears to discriminate organizational behavior. Whereas the degree of risk aversion, based on the *local* shape of the utility function, may be important in explaining owner-manager's trading behavior, the global shape of the utility function appears to drive more structural organizational behavior.

(*Organizational Behavior; Risk Aversion; Prospect Theory; Utility Theory*)

1. Introduction

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 (Kahneman and Tversky 1979, Tversky and Kahneman 1992). The proposed S-shape predicts risk-seeking behavior in the domain of losses and risk-averse behavior in the domain of gains. Thus, the *local* shape of the utility function is predictive of behavior. In this paper, we show that the *global* shape of the utility function is related to organizational behavior. Global shape is defined here as the general shape of the utility function over the total domain: concave, convex or S-shaped.

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 can account for differences in organizational behavior. Organizational behavior is operationalized here as the owner-manager's design of the production process.

2. Decision Context

To test the impact of the shape of the utility function on organizational behavior, a decision context is required in which the decision-maker has a prominent influence on the organizational form of the firm and where the decision context is not masked by situational variables. 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 'closed production system' (CPS). In the OPS, both the piglets and feeds are bought; piglets are then raised to slaughter hogs in three months, and sold in the cash market or through forward contracts. The CPS is similar to the OPS, except that the owner-manager breeds the piglets instead of buying them.

3. 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 and Smidts 1997). In designing the lottery task for the hog farmers, we took into account the findings of research on the sources of bias in assessment procedures for utility functions (Tversky, Sattath and Slovic 1988). The main sources of bias arise when the assessment does not match the subjects' real decision situation (Hershey, Kunreuther and Schoemaker 1982, Hershey and Schoemaker 1985). 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 range of outcome levels represents all price levels of slaughter hogs that have occurred in the last five years. Since prices have been argued to follow a random walk path, we chose a probability of 0.5 expressing this random walk (prices can rise or fall with equal probability). The lottery technique was computerized and took the respondents about 20 minutes to complete. Nine points were assessed, corresponding to utilities of 0.125, 0.250, 0.375, 0.500, 0.625, 0.750, 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 vs. CPS).

We fit the observations for each subject (the nine assessed certainty equivalents) to both the negative exponential function (EXP) and to the inverse power transformation function (IPT), the latter being an S-shaped function (see appendix for function specifications). 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 is sufficiently general to locate the point of inflexion anywhere between its upper and lower bounds, and it can offer wide variations in the degree of symmetry for a given point of inflexion (Meade and Islam 1995 and Bewley and Fiebig 1988). Since it is the certainty equivalents and not the utility levels that are measured with error, the inverse function is estimated (Smidts 1997).

4. Results: Global versus Local Shape of the Utility Function

First, we assumed the subjects to be homogeneous as regards the shape of the utility function. We therefore estimated both the exponential function and the IPT function for each subject (see Table 1 upper part). [1] Based on the exponential function, many farmers (55%) appear to be risk-averse (parameter $c > 0$), while others are risk prone ($c < 0$). This is in line with our 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, that is, they change from risk-seeking to risk-averse when going from low prices to high prices, as predicted in prospect theory. It

[1] Two measurements at $u(x) = 0.5$ and two at $u(x) = 0.625$ were obtained in order 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), showing that respondents assessed certainty equivalents in an internally consistent manner.

appears that the average point of inflexion is 2.37 Dutch Guilder per kilogram live weight hogs. This number corresponds closely to the production costs of 2.40 Dutch Guilder per kilogram, as estimated by experts from the industry.

[INSERT TABLE 1 ABOUT HERE]

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

In order to test for heterogeneity as regards the functional form of their utility function, we split the owner-managers in two, based on their fit of 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), and 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 pairwise comparison of MSE. Table 1 (lower part) presents the estimation results for both groups. Comparing the estimation results for the homogeneous case with those of 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 .008 for the total group to .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 'real' IPT-group (all $p < .05$); similar results were found for

MSE and parameters of the well- and badly fitting IPT-subjects. The results therefore show that owner-managers differ regarding the global shape of their utility function.

After showing heterogeneity in the shape of the utility function of real business decision-makers, we investigated whether the shape of the utility function was reflected in the decision-maker's organizational behavior. In our context, this translates into whether the chosen production system by hog farmers (OPS or CPS) is related to the shape of their utility function (EXP vs. IPT). We conducted a logistic regression analysis with the dichotomy of CPS vs. OPS as the dependent variable and group-membership (EXP vs. IPT) as the independent variable. In the analysis, we controlled for the hog farmers' age, education and debt-to-asset ratio. The model significantly improves the fit when compared to the null model, which includes only an intercept ($p < .001$; Nagelkerke $R^2 = .28$, correctly classified choices 75%). The regression coefficient of the shape of the utility function was significant ($p < .001$) in the logistic regression. The variables age ($p = .18$), education ($p = .44$), and debt-to-asset ratio ($p = .76$) appeared not to be significant.

The analysis shows that the functional form of a hog farmer's global utility function (EXP vs. IPT) explains to a large extent for the production system employed (OPS or CPS). Of the EXP-group 28.9% employed OPS, and 71.1% therefore employed CPS), whereas in the IPT-group 80.2% employed OPS, while 19.8% used CPS.

Within the EXP-group, we also tested whether the degree of risk aversion (parameter *c*) influenced the probability of employing a particular production system, using a logit analysis. No relationship was found ($p = .109$). Also, within the IPT-group no effect of risk aversion (assessed at the average cost price of 2.40 Dutch Guilders) was found on the choice of production system ($p = .245$). These results indicate that, while the degree of risk aversion may be important in explaining farmers' trading behavior (through a fixed price contract or the spot market, see Pennings and Smidts 2000), the global shape of the utility function is driving more structural organizational behavior.

Since we were interested in finding out whether our findings were robust for measurement error, we also divided the total sample in three groups instead of two: the EXP-group, the IPT-group, and an 'ambivalent' group that had minimal differences in the MSEs of the EXP and IPT-function (ΔMSE <0.001), approximately 10% of the total sample. If subjects would be misclassified on the basis of the MSE, then the percentage of correct classification should increase when removing these 'ambivalent' subjects from the analysis. Running the logistic regression analysis again for the 'evident' EXP and IPT-groups, revealed basically the same results as described above (77% correctly classified instead of 75%). These results indicate that MSE is a sensitive measure to differentiate and classify respondents. Our findings appear to be robust for the utility measurement. That is, the global shape of the utility function is a strong predictor for organizational behavior, a result that does not seem to change when further improving the utility measurement by reducing measurement error.

We speculate here about the reason why the IPT-function is related to the OPS and the exponential function to CPS. Owner-managers of the open production system buy piglets and feed, and sell the slaughter hogs in the cash market after three months. These owner-managers are well aware of their production costs, since all their costs are direct expenditures. They know their costs of production and, hence, the price levels in the cash market that ensure profit (gains in prospect theory terms) and the prices that mean a loss. The IPT-function, with its S-shape and its point of inflexion reflects this. Owner-managers who raise their own piglets (i.e., CPS) do have the costs of raising but not the expenditures of buying piglets (the costliest input in the production process). Therefore, they tend not to think in terms of gains and losses as often.

5. 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. That is, the global shape of the utility function appears to contain necessary and sufficient information to discriminate between organizational behaviors. Reference points form another way of looking at our results. The existence or absence of a reference point discriminates between the production process employed by our decision-makers. That is, structural behavior appears to be more strongly related to the occurrence of a reference point (and the subsequent coding of outcomes into gains and losses), than to the degree of risk aversion.

In management science, a distinction is made between tactical decisions and strategic decisions. In the light of this taxonomy, we may conclude that the decision-maker's global shape of the 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; choosing fixed price contracts versus the spot contracts) (Pennings and Smidts 2000).

A limitation of the current study is that we did not correct for the possibility of probability weighting in the assessment of the utility function. 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 = .5 (the p we used in our lotteries) tends to be underweighted.[2] Moreover, Abdellaoui (2000) showed that the tendency to underweight p = .5 is somewhat larger for gains than for losses, which confirms the difference in weighting functions for gains and losses as proposed by 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 would imply 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 change upon removing 10% of 'ambivalent' subjects, the effect of probability weighting will probably not be large enough to substantially affect our findings. To test further 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 were indeed misclassified because of probability weighting, then the predictive validity should increase. The analysis shows that the percentage of correct classifications slightly decreased from 75% to 73%. Therefore, we conclude that taking into account probability weighting would not have influenced our results substantially and it again confirms that the MSE is a sensitive measure to

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[2] Bleichrodt, Pinto and Wakker (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 =.5.

differentiate and classify respondents. In future research, however, it would be interesting to take probability weighting into account in assessing the global shape of the utility function and to study how this ‘corrected’ global shape of the utility function relates to organizational behavior.

This research concerns the individual decision-making of agricultural producers. Further research on the heterogeneity of the global shape of the utility function of decision-makers and its relation to tactical and strategic decisions in other contexts is recommended to confirm and extend our findings.

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

	Exponential function			*IPT-function*		
Estimation results of the homogeneous case (n = 332)						
Parameter [a]	a	b	c	α	β	κ
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						
Parameter		n = 229			n = 103	
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		

[a] For function specifications, see Appendix; [b] MSE = Mean Squared Error; [c] R^2 is calculated by squaring the Pearson correlation between actual values and the values predicted from the model.

Appendix

Function Specifications

Exponential function	IPT-function
$U(x) = a + bEXP(-cx)$	$U(x) = \dfrac{1}{1 + EXP[-\alpha - \beta(1/\kappa)\log(1+\kappa x)]}$

Estimation functions

$x_i = -\dfrac{1}{c}\ln[(\dfrac{u(x_i) - a}{b})] + \varepsilon_i$	$x_i = \dfrac{EXP[(-\dfrac{1}{\beta}(\log(\dfrac{1}{u(x_i)} - 1) + \alpha)) * \kappa] - 1}{\kappa} + \varepsilon_i$

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

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