ON MEASURING PREFERENCES

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On Measuring Preferences

Betreffende het meten van voorkeuren

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Introduction

In the last decades, lab experiments have become a widely accepted tool to investigate economic behaviour. The controlled conditions of lab experiments allow for measuring behaviour in great detail. This has led to the rejection of the descriptive accuracy of core models (such as expected utility theory) and assumptions (such as the selfishness assumption typically made in neoclassical analysis), but also to the formulation of new theories and a renewed interest in concepts which are difficult or impossible to measure with field data.

The use of lab experiments has led to an increase in the popularity of nonparametric methods. Nonparametric methods are less powerful than parametric methods, which make them impractical to use with field data in many cases, but this is less of a problem if we can perform carefully designed experiments. Nonparametric models make no simplifying assumptions about functional form, an important advantage when we are interested in accurately measuring preferences. Parametric assumptions form a layer between behaviour we want to measure and the data that we have, where ideally we want to connect the data directly to the measured behaviour.

One problem of nonparametric methods is that testing various forms of utility maximisation, which is equivalent to people having a consistent set of stable preferences, requires all data to be observed. To be precise, consider a choice problem where one can choose between some alternative $\boldsymbol{x}^1$ and $\boldsymbol{x}^2$ each consisting of different elements $x_1^i, \ldots, x_k^i$, $i = 1{,}2$. We can interpret the elements $x_1^i, \ldots, x_k^i$ as different consumption goods in separate bundles of goods in a consumer context, or as different attributes of the alternatives, or as allocations of money between different people. If at least one of these elements is unobserved, e.g. we observe all consumer spending of some individual except for spending on coffee, then we cannot test the utility maximisation hypothesis. This result was first posited by Varian (1988, *Journal of Economic Theory*, 46(1)).

In chapter 1 of this thesis, a counterexample is presented against the proof of Varian's result. The theorem is correct, however, and a new proof is provided. Furthermore, the importance of this result is demonstrated with an empirical application.

The result presents a real problem because we typically do not observe all data. A dataset may, for example, contain data on grocery spending, but not on spending in restaurants. Even lab experiments suffer from this problem.

Consumption in the lab may influence consumption outside the lab and vice versa, but we do not observe consumption outside the lab. Consider a person who must make a choice from several bundles of goods to be consumed in the lab. This person may choose to buy a drink on campus after the experiment ends if they have chosen to consume crisps in the lab, whereas they may choose to buy a sandwich if they have chosen an apple in the lab. This means preferences over consumption in the lab and consumption outside the lab may not be separable. In chapter 2, conditions are derived under which the utility maximisation hypothesis can still be tested in experiments without an assumption of separability.

In chapter 3 a new nonparametric method to measure changing preferences is introduced and an experimental test of this method is reported. One of the consequences of the greater empirical focus of economics is that it has become clear that social preferences play an important role in decision making (here, the term 'social preferences' is used in a loose sense, simply meaning that you do not only care about you gets yourself but also about what other people get, for whatever reason). As a consequence, behaviour is often different from that predicted based on an assumption of selfishness. Social preferences need to be incorporated in economic models.

Some social preferences, such as a concern with fairness or altruism, can easily be modelled similarly to preferences over apples and bananas. The neoclassical model is defined over goods, but does not specify what 'goods' are, so one good may simply be the money the decision maker receives and the other good may money for some specific other individual. Reciprocity, however, is different. Reciprocal preferences imply preferences depend on what (the decision maker's belief is) the other person's intention is. That is, preferences change between different contexts in which decisions are made.

Modelling changing preferences is difficult with nonparametric methods. With parametric assumptions, changing preferences can be captured with a change in parameters. Nonparametric methods do not have this structure; because preferences can be *anything* as long as they satisfy some elementary consistency properties, they cannot be neatly summarised in a small set of parameters. The method proposed in chapter 3 to model changing preferences is based on a simple axiom, called the Agreement axiom, which is introduced in the same chapter. It can be used in many different situations but here it is applied to reciprocal preferences, where one's preferences depend on the kindness of the other person.

Suppose you can choose between different distributions of money for yourself and another person. The axiom then means that if you prefer some allocation x over some allocation y when the other person is unkind, even though you get less in allocation x than in allocation y, then you should certainly prefer x to y in a context where the other player is kind. Because x gives a lower monetary payoff to yourself, choosing x must stem from some notion of fairness or altruism. This motive should be of even greater importance when the other person is kind, which means x should then also be preferred to y. With the Agreement axiom, preferences in one context (when another person is kind) may be different from preferences in another context (when another person is unkind), but they are still informative about each other.

Besides introducing a method based on the Agreement axiom, the results of an experimental test of this method are also presented in chapter 3. In the experiment, one subject could choose between two allocations, where one allocation gave a higher monetary payoff to a second player than the other allocation. The latter allocation may be seen as less kind than the former. This provides the context between which preferences of the second player may be expected to change. The second player made choices from budgets for both the eventuality that the first player chose the kinder allocation and the eventuality that the first player chose the less kind allocation. Importantly, subjects were informed that only the choice of the first player or one of the choices of the second player would be implemented (from the set that corresponded to the first player's choice) so that the second player's choice was only ever relevant as a response to the first player's intention, never to a practically implemented choice by the first player. This allows for testing whether the kindness of the first player influences the preferences of the second player while avoiding income effects, and for testing whether preferences change in line with the Agreement axiom.

The expanded measurement possibilities lab experiments provide have also led to a renewed interest in risk preferences that go beyond the traditional risk attitude of risk aversion. One example of these are higher order risk preferences. Prudence is one type of higher order risk preference. Where risk aversion is about whether or not you want to take risks, prudence is about in which situation you want to face a risk given that this risk is unavoidable. Suppose there are two states (these can be different periods of time or different outcomes of a random process), where wealth is lower in one state than in the other. Preferring to face the risk in a state where wealth is higher than where wealth is lower is called prudence (the opposite attitude is called imprudence). Under expected utility it is equivalent to a (positive) sign on the third derivative of the utility function. Temperance is another type of higher order risk preference and is equivalent to a negative sign on the fourth derivative of the utility function under expected utility. This is a preference for combining or segregating risks: given that you have to face two independent risks, a preference for facing both risks in the same state is called intemperance, and preferring to face them in two separate states is called temperance.

In chapter 4, an experiment is reported in which these higher order risk preferences were measured. Detailed empirical results from lab data in the past have shown measuring preferences is much more complicated than implied by traditional models. In the case of decision making under risk, the traditional model, expected utility theory, suggests that it does not matter whether outcomes are presented as gains or as losses. Measuring risk attitudes under expected utility is therefore not complicated by reference points relative to which outcomes are coded as gains or losses. In practice, however, it is well known that such coding of outcomes matters for risk preferences: people tend to be risk averse for gains, but they tend to be risk loving for losses. This is called the reflection effect.

Model-free definitions of higher order risk preferences have been proposed, which means we do not have to rely on assuming expected utility when measuring these preferences. However, in many studies higher order risk preferences are measured without separating gains and losses, even though empirical results suggest risk preferences can be very different between the domain of gains and losses (as demonstrated by the reflection effect), and may be driven by loss aversion for lotteries that mix gains and losses. In an experiment reported in chapter 4, losses and gains are therefore separated to investigate whether this affects not only risk aversion but also people's higher order risk attitudes. The greater proportion of risk loving attitudes typically found under losses should also allow us to test a hypothesis that a simple preference may underlie higher order risk preferences, which is that people like to combine 'good' outcomes with 'bad' outcomes. This hypothesis predicts that being temperate or intemperate is directly related to whether one is risk averse or risk loving, but that people are prudent regardless of whether they are risk averse or risk loving. This hypothesis tends to be difficult to test because of the few risk loving subjects observed for mixed or gain lotteries.

In chapter 5 an experiment is reported which investigates ambiguity and higher order risk preferences and how they relate to insurance choices. An important unsolved puzzle in the insurance literature is why take-up of long-term care insurance products is as low as it is. Long-term care insurance is different from most types of insurance in that its benefits are accrued only far away in the future, which makes its value inherently more risky and uncertain because the insurance may not perform (at least not to the extent expected by the decision maker). Recent theoretical predictions show that nonperformance risk decreases the value of insurance in ways that do not affect the risk-averse expected utility maximisers traditionally assumed in theoretical work. In particular, prudence and ambiguity aversion decrease demand for insurance with nonperformance risk. These predictions are tested.

The final part of this thesis is a conclusion based on the findings reported in the four chapters.

Chapter 2

Afriat in the lab

Joint with Jan Heufer

Abstract

Varian (1988) showed that the utility maximisation hypothesis cannot be falsified when only a subset of goods is observed. We show that this result does not hold under the assumptions that unobserved prices and expenditures remain constant. These assumptions are naturally satisfied in laboratory settings where the world outside the lab remains unchanged during the experiment. Hence for so-called induced budget experiments the Generalised Axiom of Revealed Preference is a necessary and sufficient condition for utility maximisation in general, not just over lab goods. Lab experiments are therefore a valid tool to put the utility maximisation hypothesis to the test.

1 Introduction

In the past twenty years, laboratory experiments have become an important tool for economists to test theories and elicit preferences. Induced budget experiments, in which subjects are asked to make choices from budgets provided by the experimenter, make particular use of the opportunity to collect data that is otherwise difficult to come by.[1] Such experiments have become increasingly popular.[2]

Choices on such budgets can be tested for consistency with the Generalised Axiom of Revealed Preference (GARP), which is a necessary and sufficient condition for the existence of a utility function that rationalises the observed choices (Afriat 1967; Varian 1982). Choices on budgets with many different prices collected under clean laboratory conditions provide well-suited data for this test. Experiments therefore seem to offer a unique opportunity to put the utility maximisation hypothesis to the test as observing a violation of GARP falsifies the hypothesis.

[1]To the best of the authors' knowledge, the term 'induced budget experiment' was introduced by Banerjee and Murphy (2011) "[t]o contrast them from *induced value* experiments, i.e. those in which demand and supply are determined by the experimenter and the object of interest is the performance of an allocation mechanism" (p. 3864).

[2]Examples include Sippel (1997), Harbaugh and Krause (2000), Mattei (2000), Andreoni and Miller (2002), Février and Visser (2004), Fisman et al. (2007), Choi et al. (2007), Banerjee and Murphy (2011), Dawes et al. (2011), Visser and Roelofs (2011), Bruyneel et al. (2012), Becker et al. (2013), Burghart et al. (2013), Ahn et al. (2014), and Choi et al. (2014).

However, testing a data set for consistency with GARP only characterises utility maximisation when the demand for all available goods is observed. Varian (1988) shows that if we only observe demand for a subset of goods, then GARP is no longer necessary. In his conclusion, Varian (1988) calls his finding "a negative result, similar in spirit to the Sonnenschein-Mantel-Debreu results" (p. 184) and laments "[t]he sad fact" that unless the entire demand is observed, the utility maximisation hypothesis imposes no restrictions on observable data. Based on the same result, Cox (1997) argues that if only demand data on a subset of goods is available, tests "cannot discriminate between inconsistencies with the utility hypothesis and inconsistencies with weak separability" (p. 1055).

Clearly even the best laboratory experiments can only include a subset of the set of goods available to subjects before, during, and after the experiment. It therefore seems necessary to include the caveat that the analysis of experimental data is only about a sub-utility function for goods in the lab. However, we will show that this is not the case: Our theorem shows that consistency of the observed data with GARP is still a necessary and sufficient condition for utility maximisation over all (observed and unobserved) goods if unobserved prices and expenditure remain constant. In particular, these conditions are naturally satisfied in the lab, as the world outside the lab typically remains unchanged during the course of an experiment. Thus, consistency with GARP of the choice set collected in the lab or under similar conditions is still a necessary and sufficient condition for the maximisation of a utility function over all goods, and the utility maximisation hypothesis can be falsified using laboratory experiments.

2 Testing Utility Maximisation with Subsets of Goods

Let $\mathbb{R}^k_+$ be the *consumption space*, where $k \geq 2$ is the number of different goods. A decision maker *demands* a bundle of goods $\mathbf{x}^i \in \mathbb{R}^k_+$ when facing the *price vector* $\mathbf{p}^i \in \mathbb{R}^k_{++}$ such that *expenditure* equals $\mathbf{p}^i\mathbf{x}^i$. We then say that $(\mathbf{x}^i, \mathbf{p}^i)$ constitutes one *observation*, although we will later assume that we do not necessarily observe all parts of $\mathbf{x}^i$ and $\mathbf{p}^i$. We assume that we have N observations, and the entire set of observations is denoted by $\Omega = \{(\mathbf{p}^i, \mathbf{x}^i)\}_{i=1}^N$.

An observation $\mathbf{x}^i$ is *directly revealed preferred* to $\mathbf{x}$, written $\mathbf{x}^i \,\mathrm{R}^0\, \mathbf{x}$, if $\mathbf{p}^i\mathbf{x}^i \geq \mathbf{p}^i\mathbf{x}$. It is *revealed preferred* to $\mathbf{x}$, written $\mathbf{x}^i \,\mathrm{R}\, \mathbf{x}$, if $\mathbf{x}^i \,\mathrm{R}^0\, \mathbf{x}^a$, $\mathbf{x}^a \,\mathrm{R}^0\, \mathbf{x}^b$, …, $\mathbf{x}^c \,\mathrm{R}^0\, \mathbf{x}$; in that case, R is called the *transitive closure* of R^0. It is *strictly directly revealed* *preferred* to $\mathbf{x}$, written $\mathbf{x}^i \, \mathrm{P}^0 \, \mathbf{x}$, if $\mathbf{p}^i\mathbf{x}^i > \mathbf{p}^i\mathbf{x}$. A utility function $u : \mathbb{R}^k_+ \to \mathbb{R}$ *rationalises* Ω if $u(\mathbf{x}^i) \geq u(\mathbf{x})$ whenever $\mathbf{x}^i \, \mathrm{R} \, \mathbf{x}$. The set Ω satisfies the *Generalised Axiom of Revealed Preference* (GARP) if $\mathbf{x}^i \, \mathrm{R} \, \mathbf{x}^j$ implies $\left[\text{not } \mathbf{x}^j \, \mathrm{P}^0 \, \mathbf{x}^i\right]$ for all $i, j \in \{1, \ldots, N\}$. GARP completely characterises the utility maximisation hypothesis, as Afriat's Theorem shows.

Afriat's Theorem (Afriat 1967, Diewert 1973, Varian 1982) *The following conditions are equivalent:*

1. *The set of observations* Ω *satisfies GARP.*
2. *There exists a non-satiated utility function that rationalises* Ω*.*
3. *There exists a continuous, monotonic, and concave utility function that rationalises* Ω*.*

However, Varian (1988) found that if demand for even just one good is not observed, GARP loses all bite. To state this formally, let us partition the set of goods and the set of prices into two sets each, with the first subsets consisting of $\ell \geq 1$ goods and prices, respectively, and the second subsets consisting of $m \geq 1$ goods and prices, respectively, with $\ell + m = k$. For the goods, let

$$\begin{aligned} \mathbf{y}^i &= (y^i_1, \ldots, y^i_\ell), \\ \mathbf{z}^i &= (z^i_1, \ldots, z^i_m), \\ \mathbf{x}^i &= (y^i_1, \ldots, y^i_\ell, z^i_1, \ldots, z^i_m), \end{aligned}$$

and for the prices, let

$$\begin{aligned} \mathbf{q}^i &= (q^i_1, \ldots, q^i_\ell), \\ \mathbf{r}^i &= (r^i_1, \ldots, r^i_m), \\ \mathbf{p}^i &= (q^i_1, \ldots, q^i_\ell, r^i_1, \ldots, r^i_m). \end{aligned}$$

From now on, $\mathbf{y}^i$ and $\mathbf{q}^i$ will be observed demand and prices, while $\mathbf{z}^i$ and $\mathbf{r}^i$ may or may not be observed. Let $\Omega_O = \{(\mathbf{q}^i, \mathbf{y}^i)\}_{i=1}^N$. We define GARP for Ω_O similarly to GARP for Ω.

Theorem 1 (Varian 1988) *Suppose we observe* Ω_O *and* $\{\mathbf{r}^i\}_{i=1}^N$ *but not* $\{\mathbf{z}^i\}_{i=1}^N$*. Then we can always find* $\{\mathbf{z}^i\}_{i=1}^N$ *such that* Ω *satisfies GARP regardless of whether or not* Ω_O *satisfies GARP.*

Varian's (1988) proof of Theorem 1 was incomplete; in chapter 1 of this thesis a new proof is provided. Note that Theorem 1, as well as Theorem 2 below, are slightly more general versions of the ones stated by Varian (1988) who formulates the results in terms of a single unobserved commodity (i.e., $m = 1$). The versions here follow from simple extensions of Varian's (1988) proof.

Suppose demand for all goods is observed but the prices for some of the goods are unobserved. In that case, GARP only maintains its bite for subsets of the data where demand is the same for all goods with unknown prices, as the next theorem shows. This condition is very strong; it seems fairly implausible that a researcher would observe demand without observing prices and that this demand remains constant. In any case, researchers will typically not know in advance whether demand will be constant and can therefore not rely on it.

Theorem 2 (Varian 1988) *Suppose we observe Ω_O and $\{\mathbf{z}^i\}_{i=1}^N$ but not $\{\mathbf{r}^i\}_{i=1}^N$. For every subset $\mathcal{I}$ of indices $\{1,\ldots,N\}$ such that $\mathbf{z}^i = \mathbf{z}^j$ for all $i, j \in \mathcal{I}$, $\{(\mathbf{p}^i, \mathbf{x}^i)\}_{i\in\mathcal{I}}$ satisfies GARP if and only if $\{(\mathbf{q}^i, \mathbf{y}^i)\}_{i\in\mathcal{I}}$ satisfies GARP. For every $\mathcal{J} \subseteq \{1,\ldots,N\}$ such that $\mathbf{z}^i \neq \mathbf{z}^j$ for all $i \neq j$, $i, j \in \mathcal{J}$, we can always find $\{\mathbf{r}^i\}_{i\in\mathcal{J}}$ such that $\{(\mathbf{p}^i, \mathbf{x}^i)\}_{i\in\mathcal{J}}$ satisfies GARP regardless of whether or not $\{(\mathbf{q}^i, \mathbf{y}^i)\}_{i\in\mathcal{J}}$ satisfies GARP.*

In what follows, we assume that unobserved prices and unobserved expenditure are the same across observations, while allowing for unobserved demand to change. Our theorem shows that these assumptions restore the power of GARP.

Theorem 3 *Suppose we only observe Ω_O, and that $\mathbf{r}^i = \mathbf{r}^j = \mathbf{r}$ and $\mathbf{r}\,\mathbf{z}^i = \mathbf{r}\,\mathbf{z}^j$ for all $i, j \in \{1,\ldots,N\}$. Then Ω satisfies GARP if and only if Ω_O satisfies GARP.*

Proof of Theorem 3 Let R_y^0 be the directly revealed preference relation on $\mathbb{R}_+^\ell \times \mathbb{R}_+^\ell$ constructed using Ω_O, that is, $\mathbf{y}^i \,\mathrm{R}_y^0\, \mathbf{y}^j$ if $\mathbf{q}^i\mathbf{y}^i \geq \mathbf{q}^i\mathbf{y}^j$, and let R_y be the transitive closure of R_y^0. Let P_y^0 be the corresponding strictly directly revealed preference relation, that is, $\mathbf{y}^i \,\mathrm{P}_y^0\, \mathbf{y}^j$ if $\mathbf{q}^i\mathbf{y}^i > \mathbf{q}^i\mathbf{y}^j$. We have that $\mathbf{x}^i \,\mathrm{R}^0\, \mathbf{x}^j$ if

$$\begin{aligned} &\mathbf{p}^i\mathbf{x}^i \geq \mathbf{p}^i\mathbf{x}^j \\ \Leftrightarrow\ &\mathbf{q}^i\mathbf{y}^i + \mathbf{r}\mathbf{z}^i \geq \mathbf{q}^i\mathbf{y}^j + \mathbf{r}\mathbf{z}^j, \end{aligned}$$

and with $\mathbf{r}\mathbf{z}^i = \mathbf{r}\mathbf{z}^j$ we obtain $\mathbf{q}^i\mathbf{y}^i \geq \mathbf{q}^i\mathbf{y}^j$ which is the condition for $\mathbf{y}^i \,\mathrm{R}_y^0\, \mathbf{y}^j$. Thus, $\mathbf{x}^i \,\mathrm{R}^0\, \mathbf{x}^j$ if and only if $\mathbf{y}^i \,\mathrm{R}_y^0\, \mathbf{y}^j$, and similarly, $\mathbf{x}^i \,\mathrm{P}^0\, \mathbf{x}^j$ if and only if $\mathbf{y}^i \,\mathrm{P}_y^0\, \mathbf{y}^j$. Then a violation of GARP based on R and P^0 (i.e., Ω violates GARP) implies a violation of GARP based on R_y and P^0_y (i.e., Ω_O violates GARP) and vice versa. Thus, [Ω violates GARP] $\Leftrightarrow$ [Ω_O violates GARP]. ■

Our assumptions on unobserved prices and expenditures are typically satisfied in laboratory experiments. For all practical purposes, the world outside the lab remains unchanged during the course of an experiment. It is therefore reasonable to assume that prices for goods outside the lab remain constant. Furthermore, even if subjects plan to buy different bundles of goods outside the lab depending on which lab budget is implemented, their choices in the lab do not influence unobserved *expenditure* outside the lab.

To have multiple observations we also need to assume that subjects choose bundles from each budget separately instead of making one choice on an aggregated budget. If subjects are expected utility maximisers, a random lottery incentive mechanism guarantees this. Empirically, Hey and Lee (2005) found generally reassuring evidence suggesting that subjects do indeed make each choice "as if it were a separate question—in isolation from all the other questions in the experiment" (p. 233).

Finally, note that if subjects can take money with them from the lab, we know exactly how much it is and can therefore account for it. Ultimately, the crucial point of Theorem 3 is not that expenditure on unobserved demand is constant, but that the *unobserved* component is constant.

3 Conclusion

Much of the recent revitalisation of and increased interest in revealed preference theory appears to be the consequence of the new tools offered by experimental economics. Indeed, we find that there are good reasons to be optimistic about applying revealed preference theory to experimental data. While it remains lamentable that we can technically never falsify utility maximisation with typical household demand data, the problem is ameliorated for experimental data. Laboratory experiments are therefore a uniquely powerful tool to test the hypothesis of utility maximisation.

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Conclusion

In the chapters of this thesis a wide array of results have been presented on measuring preferences, from purely methodological to purely empirical results, as well as combinations of both. The main messages from each chapter are summarised and connected to each other in this conclusion.

In chapter 1, a counterexample was presented against Varian's (1988, *Journal of Economic Theory*, 46(1)) result which shows that we cannot test the utility maximisation hypothesis if the consumption of at least some goods is unobserved. A new proof was provided. In an empirical application, it was shown that testing the utility maximisation hypothesis on a dataset with unobserved goods results in incorrect conclusions both at the aggregate and at the individual level.

In chapter 2, it was shown that as long as unobserved incomes and prices are constant between choices, testing for utility maximisation on only the data observed in the experiment is equivalent to testing for utility maximisation over both lab goods and goods available outside the lab. In typical experiments, subjects make several choices (only one of which is implemented) in a short space of time. The assumption that unobserved spending and prices do not change in the short time between these choices will typically hold. This is a different assumption from the usual one that everything outside the lab remains constant: it allows consumption after the experiment to depend on whichever choice in the experiment is implemented. Testing for utility maximisation based on lab data thus remains valid even if, for example, a subject plans to buy water outside the lab after consuming salted crisps in the lab, but to buy chewing gum outside the lab after eating a tuna sandwich. That is, testing for utility maximisation in experiments does not require an assumption of separability between lab consumption and consumption outside the lab, and is therefore valid in a very general sense.

In chapter 3, a new axiom called the Agreement axiom was proposed and a nonparametric method based on it was introduced. It was applied to a social choice context, specifically to model reciprocal preferences. Existing models use specific functional form assumptions for simplicity, but these assumptions are unwarranted when one is interested specifically in measuring preferences. Furthermore, previous evidence in the literature on reciprocity did not test whether behaviour reflects a true preference. The evidence is based on testing whether average giving by a first player to a second player is higher when the first player is given a low endowment by the second player or by a randomisation device. Measuring average differences has no power to reject the interpretation that a consistent set of preferences is behind these differences. The results of the experiment reported in chapter 3 indicate that people indeed have different preferences depending on whether the other player has been kind or (relatively) unkind to them, and that they largely act in accordance with the Agreement axiom. This is important, because allowing for different sets of social preferences depending on how kind the other player is perceived is much more general than requiring people to have only a stable set of social preferences. Because we can connect preferences from different contexts, we can learn something about preferences without having to measure them for all possible contexts.

In chapter 4 it was shown that higher order risk preferences, like risk aversion, are different in the domain of gains and losses. People are risk averse, prudent and intemperate for gains, but risk loving (or risk neutral), imprudent and temperate for losses. When measuring these preferences it is therefore important to consider whether one wants to measure these preferences for gains, losses, or both, depending on the research question, as this will greatly influence the measured risk attitude. No evidence was found in support of the hypothesis that people prefer to combine good with bad: there were no significant correlations between risk averse choices and temperate choices, and the imprudence found for losses and the combination of risk aversion and intemperance for gains is direct evidence against the hypothesis.

In chapter 5, several theoretical predictions were tested about how people respond to nonperformance risk in insurance. These theories predict that specific risk and ambiguity preferences, in particular risk prudence and ambiguity aversion, decrease demand for insurance with nonperformance risk, depending on whether the probability of the insurable risk and the nonperformance risk are known or unknown. The findings from the experiment support these predictions: risk prudence is negatively correlated with taking up insurance, and ambiguity of the insurable risk decreases demand for insurance. The ambiguous nonperformance risk associated with long-term care insurance may therefore be part of the reason why people underinsure against long-term care risks.

Science is an endless process of breaking down and building back up in a never-ending attempt to build something more robust. The results in this thesis show that some typical (implicit) assumptions are problematic, such as that coding outcomes as gains or losses does not matter when measuring higher order risk preferences, or that social preferences only depend on final outcomes. But the results also go some way in dealing with these problems: we know *how* higher order risk preferences are different between the gain and loss domain, and how social preferences change depending on the context. Furthermore, a methodological result shows how we can measure preferences: lab experiments are valid to test the consistency of preferences even without assuming some form of separability of preferences over consumption in the experiment and consumption before or after the experiment.

Samenvatting — Summary in Dutch

Het gebruik van laboratoriumexperimenten is de afgelopen decennia steeds populairder geworden in economisch onderzoek. De gecontroleerde omstandigheden van laboratoriumexperimenten maken het mogelijk gedrag heel precies te meten. De resultaten van experimenten tonen aan dat menselijk gedrag veel complexer is dan werd aangenomen in economische theorie, maar de gedetailleerde resultaten van experimenten hebben ook geleid tot het formuleren van nieuwe theorieën en hernieuwde interesse in concepten die moeilijk te meten zijn met velddata.

Een bekend resultaat is dat de nutsmaximalisatiehypothese niet kan worden getoetst als een deel van de consumptie niet wordt geobserveerd. Dit resultaat is voor het eerst aangedragen door Varian (1988, *Journal of Economic Theory*, 46(1)). In hoofdstuk 1 van deze scriptie wordt een tegenvoorbeeld gepresenteerd tegen het originele bewijs van deze stelling. De stelling is desondanks correct, en in het hoofdstuk wordt ook een nieuw bewijs voorgesteld. In een empirische toepassing wordt het belang van deze stelling gedemonstreerd.

In hoofdstuk 2 worden omstandigheden afgeleid waarbij data van laboratoriumexperimenten kan worden gebruikt om de nutsmaximalisatiehypothese te testen. Een complicerende factor hierbij is dat wat mensen kiezen in een experiment kan afhangen van wat ze voor het experiment hebben geconsumeerd of wat ze van plan zijn na het experiment te consumeren, en dat dit kan afhangen van welke keuze in het experiment precies wordt geïmplementeerd (meestal wordt in experimenten één keuze ook daadwerkelijk geïmplementeerd). De keuzes die buiten het lab worden gemaakt worden echter niet geobserveerd in het experiment, en zoals blijkt uit hoofdstuk 1 kan de nutsmaximalisatiehypothese niet worden getoetst als een deel van de consumptie niet wordt geobserveerd. Hoofdstuk 2 laat zien dat onder specifieke voorwaarden de nutsmaximalisatiehypothese toch kan worden getoetst, en dat verwacht mag worden dat aan deze voorwaarden wordt voldaan in laboratoriumexperimenten. Experimenten zijn dus valide om de nutsmaximalisatiehypothese mee te testen.

In hoofdstuk 3 wordt een niet-parametrische methode geïntroduceerd om veranderende voorkeuren te meten. Met niet-parametrische methodes is het lastig om veranderende voorkeuren te modelleren; anders dan bij parametrische methodes is er geen beperkt aantal parameters die gedrag representeren en veranderen als voorkeuren dat doen. De methode die wordt voorgesteld in hoofdstuk 3 is gebaseerd op een nieuw axioma wat in hetzelfde hoofdstuk wordt geïntroduceerd, die het Overeenstemmingsaxioma wordt genoemd. In dit hoofdstuk wordt de methode toegepast op sociale voorkeuren, specifiek op wederkerige voorkeuren. Deze voorkeuren hangen af van wat iemand denkt dat de intenties van iemand anders zijn. Met wederkerige voorkeuren veranderen de sociale voorkeuren tussen verschillende situaties. Stel dat je de keuze hebt om geld te verdelen tussen jezelf en iemand anders. In deze context betekent het Overeenstemmingsaxioma dat als je een allocatie x prefereert boven een allocatie y als de ander onaardig is tegen jou, ondanks dat je minder krijgt in allocatie x dan in allocatie y, dat je dan zeker x moet prefereren boven y als de ander aardig is tegen jou. Omdat het egoïstische motief suggereert te kiezen voor y, moet de voorkeur voor x boven y als de ander onaardig is stammen uit een zekere waarde die je hecht aan eerlijkheid, of uit altruïsme. Deze motieven moeten echter een nog sterkere rol spelen als de ander aardig is, dus zou je in dat geval ook x moeten verkiezen boven y. De voorkeuren tussen deze twee situaties stemmen dus overeen op een specifieke manier.

In hoofdstuk 3 wordt ook een experiment gerapporteerd om wederkerige voorkeuren te testen. Hierbij wordt de methode gebaseerd op het Overeenstemmingsaxioma toegepast. De bevindingen zijn dat voorkeuren inderdaad verschillen afhankelijk van of een andere persoon aardig of (relatief) onaardig gedrag vertoont. Belangrijker, deze verschillen kunnen worden gemodelleerd met het Overeenstemmingsaxioma. De voorkeuren in de ene situatie zijn dus informatief voor voorkeuren in de andere situatie.

In hoofdstuk 4 wordt een experiment gerapporteerd waarin risicovoorkeuren van een hogere orde worden gemeten. Voorzichtigheid (in het Engels: prudence) is zo'n risicovoorkeur van een hogere orde. Waar risicoaversie de voorkeur betreft om juist wel of juist niet risico's te nemen, gaat voorzichtigheid over de situatie waarin je het liefst een risico loopt gegeven dat deze onvermijdelijk is. Stel dat er twee situaties zijn (bijvoorbeeld verschillende tijdsmomenten, of uitkomsten van een stochastisch proces), waarbij het vermogen lager is in de ene situatie dan in de andere. Voorzichtigheid betekent dan dat je liever het risico loopt in de situatie waarin je vermogen hoger is dan in de situatie waarin je vermogen lager is. Een andere risicovoorkeur is gematigdheid (in het Engels: temperance). Dit betreft de voorkeur om risico's te verspreiden over verschillende situaties in plaats van alle risico's in één situatie te combineren.

Gedetailleerde resultaten van eerdere experimenten hebben aangetoond dat het meten van risicovoorkeuren veel ingewikkelder is dan geïmpliceerd wordt door het traditionele model van risicovoorkeuren, verwachtenutsmaximalisatie. Dit model suggereert dat het niet uitmaakt of uitkomsten worden gepresenteerd als winsten of verliezen. In de praktijk blijkt dit echter een grote invloed te hebben op de gemeten risicovoorkeuren: mensen hebben de neiging risicoavers te zijn voor winsten, maar risicozoekend voor verliezen. In veel onderzoeken waarin risicovoorkeuren van een hogere orde worden gemeten worden winsten en verliezen echter niet uit elkaar gehouden. In het experiment gepresenteerd in hoofdstuk 4 wordt dit wel gedaan, en het blijkt dat de risicovoorkeuren van een hogere orde verschillen tussen winsten en verliezen: mensen zijn voorzichtig en ongematigd voor winsten, en onvoorzichtig en gematigd voor verliezen.

Het grotere aantal proefpersonen met risicozoekende voorkeuren voor verliezen maakt het ook mogelijk de hypothese te toetsen dat mensen een voorkeur hebben voor het combineren van ‘goed’ met ‘slecht’. Deze hypothese kan verklaren waarom mensen de soms vrij complexe ogende risicovoorkeuren van een hogere orde hebben. De hypothese leidt tot de specifieke voorspelling dat mensen die risicoavers zijn gematigd zijn, en dat zij die risicozoekend zijn ongematigd zijn, maar dat iedereen voorzichtig is. De onvoorzichtigheid gevonden voor verliezen in het experiment in hoofdstuk 4, en de combinatie van risicozoekende voorkeuren en gematigde voorkeuren voor verliezen, en de combinatie van risicoaverse voorkeuren met ongematigde voorkeuren voor winsten vormen bewijs tegen deze hypothese.

Tot slot wordt er in hoofdstuk 5 een experiment gerapporteerd waarin risico- en ambiguïteitsvoorkeuren worden gemeten. Een belangrijk onopgelost vraagstuk in de verzekeringsliteratuur is waarom de vraag naar langdurigezorgverzekeringen zo laag is. Dergelijke verzekeringen verschillen van de meeste vormen van verzekeren in dat de voordelen hiervan pas ver in de toekomst worden verwezenlijkt, wat de waarde van dergelijke verzekeringen inherent meer risicovol en ambigu maakt omdat de verzekering mogelijk niet naar verwachting de verplichtingen zal nakomen. Recente theoretische resultaten laten zien dat dergelijk niet-nakomingsrisico de aantrekkelijkheid van verzekeringen kan verlagen op manieren die de risicoaverse verwachtenutsmaximaliseerders die traditioneel worden aangenomen in theoretisch onderzoek niet beïnvloeden.

Wetenschap is een eindeloos proces van afbreken en opnieuw opbouwen in een poging meer robuuste modellen te bouwen. De resultaten in dit proefschrift laten zien dat het meten van voorkeuren ingewikkelder is dan gedacht, omdat veelgemaakte (impliciete) aannames problematisch blijken te zijn, zoals dat het presenteren van uitkomsten als winsten of verliezen niet uitmaakt, of dat sociale voorkeuren alleen afhangen van de uiteindelijke (absolute) financiële uitkomsten. De resultaten in dit proefschrift bieden ook aanknopingspunten om met deze problemen om te gaan: we weten nu hoe risicovoorkeuren van een hogere orde verschillen tussen winsten en verliezen, en hoe sociale voorkeuren veranderen afhankelijk van wat de intenties van een ander zijn. Tot slot laat een methodologisch resultaat zien hoe we voorkeuren kunnen testen: laboratoriumexperimenten zijn valide om de consistentie van voorkeuren te testen, zelfs als deze samenhangen met ongeobserveerde keuzes buiten het laboratorium.

The Tinbergen Institute is the Institute for Economic Research, which was founded in 1987 by the Faculties of Economics and Econometrics of the Erasmus University Rotterdam, University of Amsterdam and VU University Amsterdam. The Institute is named after the late Professor Jan Tinbergen, Dutch Nobel Prize laureate in economics in 1969. The Tinbergen Institute is located in Amsterdam and Rotterdam. The following books recently appeared in the Tinbergen Institute Research Series:

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