Adapting to a Fundamentally Uncertain World

Research Programme

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I. Introduction - Mission of the School

The programme of the proposed school is best characterised by a triangle. At each corner, one of the disciplines has its core competence. Psychologists are the specialists in the cognitive processes underlying human behaviour, including behaviour under conditions of highly actual or perceived uncertainty. Uncertainty as a subjective state leads to a slow down in decision and action. Economists are the specialists of restrictions and of conflicts resulting from them. Strategic interaction frequently leads actors into an impasse although there would be room for gains from cooperation. In problems of strategic interaction, one rational actor optimises against one or more other rational actor/s who themselves optimise against her/him. Legal scholars are the specialists of institutions. The layered character of the legal order has broadened the scope of the discipline. Constitutional law, European Community law or the law of the World Trade Organisation force legal scholars to compare governance by law to alternative formal, informal and mixed institutions.

By themselves, no one of these disciplines is competent enough to generate a truly meaningful understanding of behaviour in a fundamentally uncertain world. While there is important generic knowledge of how participants react to perceived fundamental uncertainty in psychology, most of this knowledge is confined to (experimental) situations that are free from strategic interaction and from institutional embeddedness. Likewise, while there is substantial theoretical and experimental knowledge about strategic interaction in economics, it normally has been generated assuming a fairly certain world, and with a psychologically naïve model of individuals. Finally lawyers, and their companions from institutional analysis and design, have generated a vast body of knowledge on the comparative performance of institutions. Most of this knowledge has an interdisciplinary base, be that in economics or, less frequently, psychology. However, as a rule, the more conceptually rigorous this work is, the stricter the assumptions about the situation. This gives short shrift to the role of law, and institutions, in helping people navigate in contexts of high perceived uncertainty. This state of affairs makes each of the three disciplines a natural complement of the two others.

II. State of the Art

1. Psychology

Ever since the paradigm shift from behaviourism to more cognitive conceptualizations of man, humans have been viewed as being motivated by a fundamental desire to understand and control the physical and the social world. (Heider 1958) introduced the concept of man as an intuitive scientist or a naive psychologist, a concept that has been developed further by attribution theorists (Weiner 1972; Kelley and Michela 1980) and adopted by cognitive psychologists (Peterson and Beach 1967). Uncertainty and the coping with it are part of the physical as well as the social world. Strategies used by individuals or groups to make decisions under uncertainty are the domain of cognitive psychology which attempts to formulate respective models and to identify important determinants of choice that transcend the consequentialist doctrine of expected utility theory (Messick 1999). In addition to the physical world, a large amount of uncertainty is produced by fellow humans with whom we interact. Social psychology has a rich research tradition examining the functional rule of social categorization and steretotyping processes, group formation, attributions, and conformity for reducing the unpredictability generated by other individuals (e.g. Brown and Gaertner 2001; Hogg and Tindale 2001).

a. Cognitive Psychology

In psychological decision research, either epistemic or utilitarian motives have been attributed to decision makers (e.g. Tetlock 2002). They share the assumption that good judgment can be achieved by following formal or optimal rules that define correct or useful decisions. Both logic and probability theory have been used as benchmarks for good reasoning under certainty and uncertainty, respectively. Since the seventies, it has been taken as true by many that humans often fall short of these norms in both domains (Kahneman, Slovic et al. 1982; Stein 1996). Rather than adhering to the formal rules, people appear to use shortcuts or "heuristics". These scale down complexity and psychologically reduce uncertainty by concentrating on only few pieces of information and simple integration principles. Whether these heuristics reflect biases and lead to inferior performance in the real world has been the target of a hot rationality debate (Gigerenzer 1996; Kahneman and Tversky 1996; Stein 1996). One promising new direction has been taken by researchers who try to reinterpret human behaviour and heuristics as rational in relation to redefined benchmarks (Anderson 1990). For example, (Oaksford and Chater 1994) showed that the pervasive failure of participants to solve the four-card deductive reasoning task of (Wason 1966) can be viewed as a strategy of optimal Bayesian data selection if participants interpret the task as *probabilistic* rather than deterministic. Since this interpretation clearly matches the everyday reasoning situation, the apparent "failure" to find the deductive solution may rather demonstrate the ability to find a *useful* solution! (see Oaksford and Chater 2003: for subsequent refinements of their theory). Hence, "narrow norms" in traditional research may have painted a premature and probably incorrect picture of human irrationality by neglecting people's goals, problem representation, and task content (Gigerenzer 1996).

Yet, some have questioned the combinatorics associated with the Bayesian approach, even one that corresponds to everyday reasoning situations. Simplifying decision heuristics have

been studied systematically in the domains of preferences (Payne, Bettman et al. 1993) as well as inferences (Gigerenzer, Todd et al. 1999; Gigerenzer 2004). Dispensing with the prevailing coherence view of rationality, the research program of Gigerenzer et al. (1999) emphasizes a correspondence view which measures the "ecological rationality" of simple heuristics by their success rather than by their formal properties. Borrowing from Simon's (Simon 1956; Simon 1990) concept of bounded rationality, the ecological rationality of a heuristic cannot be defined per se, but only in relation to its structural fit with the environment and task structure. People are believed to select appropriate heuristics from an "adaptive toolbox" in different environments. Computer simulations have shown that even simple inference heuristics show surprisingly high success rates as compared to less parsimonious optimal strategies across a range of situations (Czerlinski, Gigerenzer et al. 1999) and, more importantly, they are more robust when applied to new samples. In addition to theoretical analyses, the approach has stimulated a body of empirical research demonstrating the proposed adaptive selection of simple heuristics (e.g. Bröder 2003; Schooler and Hertwig 2005; Rieskamp and Otto 2006) as well as boundary conditions for adaptive strategy selection such as reduced cognitive capacity (Bröder and Schiffer 2003) or behavioral routines (Betsch and Haberstroh 2005; Bröder and Schiffer 2006), or slow adaptations to changing environments (Rieskamp 2006).

The developments in cognitive psychology are relevant for normative, descriptive, and prescriptive reasons because they (a) caution researchers to define formal models as "normative" without considering people's idiosyncratic goals and their internal problem representations (Rieskamp, Busemeyer et al. 2006). They show (b) under which circumstances people are likely to use certain strategies and heuristics, and (c) may inform policy makers to react adequately on expected environment-behaviour interactions.

b. Social Psychology

On the one hand, interacting with people increases unpredictability and uncertainty because "the others" pursue their own (unknown) goals which we cannot control. (Heider 1958), (Kelley and Michela 1980) and (Gilbert and Malone 1995) developed models describing causal attribution processes which individuals apply to reduce this perceived uncontrollability. In addition to these attribution strategies, social cognition research has extensively studied the function of social categorization processes (Brown and Gaertner 2001) as well as stereotyping and prejudice (Dovidio, Glick et al. 2005). Categorizing oneself as a member of a group reduces cognitive complexity as well as uncertainty about behavioural norms and provides the opportunity for adequate social comparisons. At the same time stereotypes provide a basis of information about other groups that can likewise serve to reduce uncertainty. Hence, a social environment can provide cues that reduce uncertainty about appropriate behaviour through group norms (Mummendey and Wenzel 1999; Kessler, Mummendey et al. 2000). A massive body of research shows that these strategies are indeed applied under uncertainty (e.g. Ruscher, Fiske et al. 1991; Hogg 2000).
Whereas these processes fulfil useful functions for the individual in a socially complex world, they also have tremendous side effects. Social psychology is of course also concerned with the unwanted prejudice, social discrimination and group conflicts resulting form social categorization (Kessler and Mummendey 2001; Mummendey and Otten 2001; Sassenberg, Moskowitz et al. 2006).

Another branch in social psychology investigates experimental games, i.e. situations with strategic interactions between partners. A main focus of this research lies on social dilemma

situations (Suleiman, Budescu et al. 2004), i.e. games in which individual, group level and collective interests conflict (Bornstein 2003). Such games have been investigated in different embeddings and „frames“, like prisoners dilemma games, public-good-games, team games or resource games using different group sizes. This branch is very closely related to similar work in experimental economics. In these strategic interactions, decision payoffs depend crucially on the other partners' decisions which are unpredictable in principle. Since game theoretic prescriptions also do not always correctly predict behaviour, other social factors are relevant for reducing the uncertainty about the others' decisions, for example trust and reputation. One particular research interest is why and under which circumstances participants deviate from selfish behaviour and cooperate. Besides personality constructs like social value orientations (Liebrand and McClintock 1988; De Cremer and van Lange 2001), a major research topic has been the impact of perceived belongingness (i.e., ingroup and outgroup), expected reciprocity, trust and reputation (Caporael, Dawes et al. 1989; de Heus and Messick 2004; Yamagishi, Kanazawa et al. 2005). Another important factor for high cooperation rates is the reduction of social uncertainty by raising the perceived efficacy, i.e. the probability that one will make a difference (Liebrand, van Lange et al. 1996). Due to the multitude of psychological mechanisms besides game-theoretic expectations, (Colman 2003) argues that game theoretic rationality does not transfer comfortably to strategic interactions („interactive decisions“) and therefore is not a characteristic of social interaction in general. He suggests a „psychological game theory“ that might help to overcome the profound problems of traditional game theory. Social psychological work integrating game theory and social categorization research as a step towards psychological game theory is currently on the way. This research examines the impact of identity related preferences on resource conflicts within intra- and intergroup structures modelled as team games (Bornstein 2003) and embedded games (Wit and Kerr 2002).

Hence, Social Psychology offers a rich knowledge base about individual and social mechanisms of uncertainty reduction as well as their side effects and converges with experimental economics in developing taxonomies of reasons for cooperative behaviour in strategic interactions outside simple consequentialist doctrines.

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2. Economics

a. The Textbook Approach

In its mainstream, the discipline of economics is not defined with respect to the economy as an issue area, but with respect to a paradigm. Social phenomena are explained by the reaction of utility maximising individuals to restrictions, be that a limited budget, scarce resources or, most importantly, the anticipated reactions of interaction partners. The ensuing research program rests on behavioural assumptions. The standard set of assumptions is strikingly optimistic in some respects, and extraordinarily pessimistic in other respects.

Economics textbooks introduce a picture of decision making that appears almost impossible to realize by human beings. The agents featuring in these models possess unlimited cognitive abilities, and equal perseverance in employing them. When faced with uncertainty, they unswervingly switch to subjectively expected utility and apply the complex Bayesian algorithm (Bayes 1738) to the available information (Savage 1954). If they stand a chance to acquire additional information by costly search, they treat this as an investment problem and stop searching precisely when the marginal cost of additional information equals the expected marginal benefit (Stigler 1961). Much academic effort has been invested to further extend the domain of this program, e.g. to include situations where agents subsequently acquire knowledge about the alternative states of the world (Machina 1987).

In other dimensions, the picture of man as drawn by economics textbooks is conspicuously pessimistic. Agents may reveal their preferences by their actions. But as long as they have not done, others stand no chance to second-guess them. Preferences could just be anything. Ex ante, all agents are equal. Alternatively, actors of different "types" are introduced, usually by a fictitious move of Nature in a game tree (Harsanyi 1967-1968). But this move has nothing to do with the problem of social interaction to be solved. It is included only to close the game informationally. The “player” as a collection of types is just a game-theoretic construct and has no real analogue since the actual agent knows his type.

From two angles, textbook economics has come under attack: from experimental and behavioural economics, and from evolutionary economics.

b. Behavioural Economics

For more than fifty years, economists have wanted to know whether the assumptions on which their models are built, and the predictions derived thereof, are borne out by reality (Chamberlin 1948; Hoggatt 1959; Sauermann and Selten 1959; Smith 1962). Experimental economics has grown into an industry (for summary accounts see Kagel and Roth 1995; Camerer 2003). While much of this work has been concerned with motivational issues, and the selfishness assumption in particular (see e.g. Fehr and Gächter 2000; Fehr and Fischbacher 2003), the cognitive side has not been neglected either. From the pioneering work of Herbert Simon on (Simon 1957), man has been portrayed as only boundedly rational. In close cooperation with psychologists from the Kahneman/Tversky school (Kahneman, Slovic et al. 1982; Kahneman and Tversky 2000), long lists of deviations from the cognitive assumptions in the standard model have been compiled (for a summary account see Camerer 2003).

These efforts have led to substantial improvements of the textbook apparatus (e.g. Camerer and Ho 1999). However, most of both the empirical studies and the theoretical work is undertaken in the spirit of adding more complexity to the textbook model – which has been referred to as the neoclassical repair shop (Güth 1995). Admittedly, this is not true for all of experimental and behavioural economics. For instance, much research effort has been invested in experimentally exploring how subjects learn in settings with little initial information and feedback (e.g. Nagel and Vriend 1999; Bosch-Domènech and Vriend 2003; Altavilla, Luini et al. 2005). It is obvious from the very setup of these studies, and even more from the results, that optimisation is out of the question here. Others have shown that decision makers deliberately ignore valuable information and available alternatives. Rather alternatives that have been applied successfully in the past are employed once the current problem has been identified as similar to the earlier one (Gilboa and Schmeidler 1995). Alternatively, decision makers simply imitate alternatives that have been applied successfully by others (Mason, Phillips et al. 1992).

c. Evolutionary Economics

While behavioural economics questions the assumptions of the textbook model, evolutionary economics criticizes the focus on static allocation problems and provides a conception for economic dynamics based on decisions under uncertainty. Going back to (Schumpeter 1912; Schumpeter 1942) and (von Hayek 1945; Hayek 1982), it points to the crucial importance of evolutionary mechanisms among which the metaphor of mutation, selection and retention has gained utmost importance. This metaphor is applied to describe the importance of innovation, innovative competition and innovation diffusion (Nelson and Winter 1982; Metcalfe 1994). Consequently, economics as a discipline should be able to address ill-defined problems. This research interest goes along with a different definition of the situation. In the textbook approach, uncertainty may only be introduced in a strictly controlled way (Knight 1921). Typically, there are defined events with known probabilities. In that case, the expected value of each event may be calculated. The textbook approach fails if the problem space is not defined ex ante (Kirzner 1994). Yet this is precisely the effect of innovation and creativity (Dosi 1988; Dosi and Egidi 1991), of fundamental doubt about mental models in a population, or simply of caprice of nature.

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3. Institutional Analysis and Design

Institutional design may capitalise on behavioural knowledge at three levels: problem definition, institutional intervention, and the design of political institutions.

a. Problem Definition

Institutional intervention is warranted only if there is a true individual or social problem. This is why problem definition serves as an interface between institutional design and normative theory. If such theory is individualistic, it must make behavioural assumptions. The traditional approach to this is welfare economics, based on *homo oeconomicus* assumptions (Feldman 1980; Jones 2005). Normative theory based on behavioural economics is only just starting (Bernheim and Rangel 2005). To the best of our knowledge, it has not had recourse to the alternative behavioural paradigm as yet. There is one noticeable exception, however, in the legal discourse. Lawyers have been attracted by the biases programme (Kahneman, Slovic et al. 1982) not the least since it seemed to give a conceptual handle on consumer protection legislation (Jolls, Sunstein et al. 1998). This has led to a vigorous battle over paternalism (Rachlinski 2003). In this battle, a key argument is taken from the alternative paradigm. What looks like a bias if compared to the predictions of rational choice theory may be quite functional if there is fundamental uncertainty (Gigerenzer, Todd et al. 1999). More generally,

behavioural law and economics has been criticised for adopting too narrow an approach to human behaviour since it starts from an artificial definition of the situation (Mitchell 2002).

Although they do not directly apply the alternative paradigm, it is worth mentioning a number of normative issues that lend themselves to being reconstructed along these lines. When deciding under perceived uncertainty, subjects fall prey to all kinds of "irrational" behaviour (Noll and Krier 2000; Parisi and Smith 2005), including informational cascades (Kuran and Sunstein 1999). This has been seen as a policy problem in areas as diverse as epidemic diseases (Schulte 2002) and speculative bubbles (Scheinkman and Xiong 2003). Many policymakers believe that culturally heterogeneous societies are more difficult to govern. A potential reason for this are the culturally contingent, characteristic responses to perceived fundamental uncertainty (Nisbett, Peng et al. 2001; Sperber and Hirschfeld 2004; Kahan and Slovic 2006).

b. Institutional Intervention

In doctrinal work, (legal) institutions are a given. Due to the hermeneutical character of the law, however, courts and administrators must understand the effect on the behaviour of addressees in order to properly apply and develop institutions. Institutional designers, and constitutional lawyers for that matter, openly compare the governance effect of institutions. In so doing, lawyers and institutional designers may have recourse to institutional theory. If such theory is individualistic, it must make behavioural assumptions. Again, the traditional approach starts from the *homo oeconomicus* assumptions. This holds for most of law and economics (Posner 2003; Cooter and Ulen 2004; Shavell 2004), and for most of institutional economics (Eggertsson 1990; Furubotn and Richter 1997). The recent move towards "behavioural law and economics" (Sunstein 2000) criticises the behavioural assumptions. But this criticism is mainly based on the biases programme in psychology (Kahneman and Tversky 2000), and on findings from experimental economics (Kagel and Roth 1995). Specifically, behavioural law and economics typically (implicitly) assumes a fairly certain world. There is also a tradition of law and psychology, that is not linked to the rational choice model. But law and psychology has not focused on the law as a governance tool. Characteristic issues in this literature are mental defects in defendants (Cronin 2005), the performance of the jury (Hastie 1993), and the reliability of eye witnesses (Sporer, Malpass et al. 1996).

The most noticeable move into the direction of this project is a recent interest, in institutional economics, in behaviour under uncertainty (Dequech 2006). The strongest force in this is the growing interest of Austrian (Schumpeter 1912; von Hayek 1969) and evolutionary economics (Nelson and Winter 1982) in institutions (Langlois 1986; North 1990). This has led to a richer definition of the effect of institutions, stressing that they are not only constraints, but may serve a cognitive function (Hodgson 1988). In close parallel, in the legal literature the "expressive" function of law has been stressed (Sunstein 1996; Bohnet and Cooter 2001). It sometimes is extended to the idea that the law not only gives its addressees orientation, but that it even shapes their preferences (Sunstein 1998).

c. Political Institutions

Institutional intervention is not a matter of calculus. There are two basic reasons for this, one of which has a direct bearing on this project. There are competing normative concerns, like allocative efficiency, innovation and growth, distribution, fairness or egalitarianism. It is not possible to reduce them to just one normative currency. Moreover, political decisions are always taken under uncertainty. It is never possible to exclude exogenous interventions such that today's problem disappears and makes an institution superfluous or counterproductive. Often, institutional designers also have limited knowledge and a merely partial understanding of the policy problem. This is all the more pronounced if the problem itself originates in actual or perceived uncertainty. Now political institutions are themselves open to purposeful design, as epitomised by constitutional policy. Again, analysis and design can be undertaken from an individualistic perspective. If one does, one needs assumptions about the behaviour of actors in the political arena, be that policymakers, administrators, judges, lobbyists or the ultimate addressees. A prominent approach relies on rational choice theory and the underlying rationality assumptions for the purpose (Scharpf 1997).

To the best of our knowledge, there is no explicit behavioural critique of the rational choice approach in the analysis of political institutions thus far. However, there is an old tradition in political psychology, some of which asks related questions. It for instance has been said that political parties have a role in narrowing down choice spaces such that individual voters may take a meaningful decision, given an overwhelmingly complex and uncertain task (Jackman and Sniderman 2002). Also, policymakers have been reminded that the addressees of legal intervention possess the ability of reacting creatively. If they do, intervention may not only become futile but even counterproductive, given the original intention (Wegner 1997).

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III. Previous Work

1. Psychology

Among the partners of the proposed school, the psychology of individual heuristic decision making is the primary topic of the MPI at Berlin and of Arndt Bröder at the MPI in Bonn. The Jena psychologists are experts in the social psychology of group behaviour and social categorization. The cognitive scientists at Indiana University are bridging individual decision making with group-level actions and outcomes.

a. Cognitive Psychology

The Center for Adaptive Behavior and Cognition at the Berlin MPI explores models of bounded rationality. In particular it focuses on cognitive heuristics with which people make judgments and decisions in the face of uncertain situations. The strategies are assumed to be the result of an adaptation of the human mind to its environment. Consequently, the study of people's decision heuristics examines the link between decision makers and their environments (Gigerenzer, Todd et al. 1999). People are assumed to learn to select the heuristic that works best in a particular environment (Rieskamp and Otto 2006). By exploiting the characteristics of the environment, the heuristics can be simple and require only limited information and hence allow decisions to be made fast and frugally.

The study of the simplicity of heuristics has also implications for the general topic of model comparison. In psychology, the question as to which model performs better in a given task is almost always answered by data fitting, for instance, by determining which of several models has the higher explained variance for a known set of observations (Roberts and Pashler 2000). The shortcoming of this type of model is that they give a premium to models with more (as opposed to less) free parameters. However, these models face the danger of overfitting, that is, they model noise in order to gain high "explained" variance. The predictive accuracy of much simpler heuristics is often significantly higher than that of elaborate techniques like multiple regression (Czerlinski, Gigerenzer et al. 1999).

A central research goal is to determine the conditions in which specific heuristics perform well and in which they do not. The building blocks of heuristics have been described in (Gigerenzer, Todd et al. 1999; Gigerenzer and Selten 2001; Gigerenzer 2004). The challenge is to analyze the ecological adaptiveness of heuristics in relation to increasing amounts of uncertainty. This hierarchy of uncertainty includes:

- Zero-level uncertainty: all data is known
- Sample uncertainty: the future sample data is not known, but only a sample from the past
- Population uncertainty: the future sample data is not known, but only a sample from the past, and we have no reason to assume that the samples are from the same population
- Extended uncertainty: new alternatives, new consequences, and other surprises can happen.

At Indiana University, Peter Todd's lab group focuses on simple decision heuristics that people use to search for resources in time and space, particularly when the distribution of those resources is uncertain or unknown. Rob Goldstone's laboratory applies formal computational and mathematical tools used in studying complex biological or physical systems to understanding human collective behavior. People participate in group-level patterns that they may not understand, or even perceive. The goals are to conduct experiments that reveal the patterns that groups of people spontaneously create, and to develop computational models that show how these patterns emerge from simple interactions among people. For instance, mushroom hunters forage their environment for tasty fungi (Goldstone, Ashpole et al. 2005), speed-daters search for mates and drivers patrol downtown for convenient parking spaces (Todd 2006), web-users surf the internet for desired data, and businesses mine the land for valuable minerals. When an organism forages in an environment that consists, in part, of other organisms that are also foraging, the organism faces a situation of strategic interaction. However, the foraging behavior of the other organisms may follow partly predictable and exploitable patterns.

b. Social Psychology

The positive and negative outcomes of social categorization for intergroup behavior have been the research focus of the Department of Social Psychology in Jena. Topics such as tolerance (Mummendey and Wenzel 1999), collective action and relative deprivation (Kessler and Mummendey 2001), stereotyping (Sassenberg and Moskowitz 2005), prejudice as an outcome of competition (Sassenberg, Moskowitz et al. 2006) and social exclusion (Kessler, Neumann et al. 2006) are just some of many examples. These topics are approached from different theoretical backgrounds such as social identity theory (Tajfel and Turner 1979), social cognition/social information processing and self-regulation approaches (Higgins 1997). More recently, game theory has also been taken into account. This variety of theories taken into account is the main one of the sources of the strength of the social psychology group in Jena.

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2. Economics

a. Behavioural Economics

Economic activities of boundedly rational decision makers have been the research focus of the Jena MPI. The main interest is in the strategic interaction among boundedly rational agents. A general framework for boundedly rational reasoning has been developed by (Güth 2000). Particular aspects that have been addressed by the MPI Jena are the evolutionary stability of bounded rational strategies on evolving markets (Güth and Kliemt 2000; Güth and Napel 2006). Other work builds on the theory of satisficing behaviour with its three constituent elements of aspiration formation, satisficing and aspiration adaptation by (Selten 1998). In this theory, aspiration levels are vectors of values for a goal variable. These aspiration levels vary in discrete steps. This theory has been tested experimentally in the area of investment decision-making (Fellner, Güth et al. 2005), who rely on stochastic decision environments and state-specific aspirations. Other experiments investigate, for instance, how firms orient themselves in an oligopolistic market (Güth, Müller et al. 2006), discrimination based on social relatedness (Güth, Levati et al. 2004; Güth, Levati et al. 2005), and the effects on labour markets (Berninghaus, González et al. 2004; Alewell, Friedrich et al. 2006).

At the Jena Department of Economics, the behavioural aspect is centerstage in Kirchkamp´s work. His current research focuses on learning and cooperation in networks (Kirchkamp 2006), on the evolution of learning and strategy rules (Kirchkamp 1999) and the spatial dimension of learning (Kirchkamp 2000).

The researchers from the Jerusalem Center of Rationality are particularly interested in uncertainty resulting from the variability inherent in stochastic, indifferent nature. Such is the case of foraging animals and their predators or producers and freeloaders trying to exploit them. To model such environments the Center has developed a family of games (Avrahami, Güth et al. 2001; Avrahami, Güth et al. 2005), and observed people's behaviour in them. It was found that behaviour is best captured by Selten's learning-direction theory (Selten, Abbink et al. 2005) – a game-theoretic analysis according to which ex-post rationality, driven by regret, plays a crucial role in determining player's eventual strategies. More recent analyses indicate that considerations of envy can further improve our understanding of behaviour in

such situations. Finally, that same framework has led to new insights in behavioural law and economics (e.g., the relationship between increased surveillance by police and the prevalence of criminal activity in neighbourhoods differing in affluence; (Guttel and Medina 2005).

Another line of research undertaken in Jerusalem with psychological, economic and legal implications originated from the observation that, of necessity, due to paucity of data, time constraints, or structural limitations of the cognitive system, people often use small-sample data to assess the state of the world. Theoretical analyses and empirical observations demonstrated that this seemingly innocuous constraint results in an attenuation of the perception of variability, and hence of risk (Kareev, Arnon et al. 2002). That, in turn, can help explain unwarranted risk-taking in economics and by criminals.

b. Evolutionary Economics

The Jena Department of Economics concentrates on the theoretical and empirical analysis of economic change (Cantner 2000; Cantner and Hanusch 2002), as do two of the three departments at the Jena MPI (Audretsch 2003; Witt 2003). A focus is on the question how economic agents design their innovative activities. This is explicitly done from an evolutionary perspective whose adaptation dynamics are either mechanical, e.g. when simply relying on replicator dynamics or genetic algorithms, or derived from a behavioural perspective. The latter is an attempt to connect economic models of competition in research and development with contemporary psychological findings about innovative behaviour and the underlying creativity (Cantner and Pyka 2000; Cantner and Hanusch 2001). Experimental work related to innovative activities attempts to get insight into strategic aspects when problems are ill-defined (Cantner, Güth et al. 2004; Cantner, Nicklisch et al. 2005). A broad account of empirical work tries to characterize the dynamics of structural change within and between specific industries or regions (Freytag 2000; Cantner and Graf 2004; Cantner and Krüger 2004). Finally, market failure related to innovative activities is analysed (Freytag 1995; Freytag and Sally 2000).

A special methodological challenge characterizes all this work, nonlinearities (Lorenz 1993; Lorenz 2007). The models developed to address nonlinearities have been applied to market competition (Cantner and Hanusch 2002; Pasche 2004). They should be useful in order to investigate the dynamic properties of rule based behaviour more generally.

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3. Institutional Analysis and Design

Among the partners of the proposed school, institutional analysis and design is mainly done at the Bonn MPI, but the work of the Bloomington Workshop in Political Theory and Political Analysis, of the Jena Department of Economics and of the Jena MPI also has a bearing on this. Both Bonn and Bloomington are focusing on one class of policy problems. In economics, they are usually modelled as public goods. Further developing the theory of public goods is the main task of the economics unit at the Bonn Institute (Hellwig 2005). In psychology, the concept of social dilemmas is closely related. (Beckenkamp 2002) contrasts the two literatures. Lawyers typically work closer to concrete policy problems. One such problem is waste management, on which the Bonn Institute has worked extensively. Modern waste management legislation not only aims at preventing immediate harm from the environment. It also strives for protecting scarce natural resources. This is a classic decision under high uncertainty both for policymakers and their addressees (Engel 2002; Fiebig-Bauer 2006).

a. Problem Definition

In two past activities, decision-making under high perceived uncertainty is centrestage. In a rational choice perspective, strategic interaction is reconstructed as a conflict of interests. Given the richness and the plasticity of the human mental apparatus, coordination may fail for a different reason: actors have been unable to predict their interaction partners' behaviour. Consequently, much institutional intervention may be understood as an exercise in generating predictability (Engel 2005). Both the Berlin and the Bonn MPI have joined forces for organising a Dahlem conference on the relevance of heuristics for law. If one starts from the assumption that most actors do not optimise most of the time, but rely on radically simple rules for search and decision-making, this casts a very different light on the reconstruction of perceived social dilemmas (Engel 2006). Further work critically assesses paternalism (Englerth 2006; van Aaken 2006), explains market definition in antitrust as an exercise in artificially creating certainty (Engel 2004b) and extends welfare economics to a world of adaptive preferences (von Weizsäcker 2005).

(Ostrom and Walker 2003) review the experimental research from economics, psychology, and political science related to trust and reciprocity. The U.S. National Research Council asked economists, psychologists, anthropologists, and political scientists to summarize the lessons that have been learned both from the experimental lab and from the field related to the study of resource commons (National Research Council 2002). (Ostrom 2005) reviews the lessons learned from behavioural economics for the study of human decision-making related to designing institutions under situations of uncertainty and then adapting them over time.

b. Institutional Intervention

The shift to a fundamentally uncertain world affects the analysis of all institutions (Mantzavinos, North et al. 2004). Given the composition of the Bonn group, however, the effects of uncertainty on the law have been centrestage. Command and control regulation has

been shown to shape attitudes (Baehr 2005), to capitalise on and mould fairness preferences (Magen 2006) and to trigger learning processes in its addressees (Engel 2004a). None of this would work in a certain world. In a multidisciplinary effort, the reactions of law to different kinds and degrees of uncertainty have been explored (Engel, Halfmann et al. 2002). An early paper has demonstrated how German administrative law implicitly rests on the idea that administrators must routinely fail to reach the optimum, given the complexity and uncertainty of their task (Engel 1994). Most relevant, however, is the already mentioned Dahlem conference. Most contributions have tested the power of the heuristics concept for both interpreting and developing legal institutions (Gigerenzer and Engel 2006).

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IV. Research Programme: Focus of Partners

Within the framework of the programme outlined above, each partner institution has a different focus. This section presents the foci.

1. Psychology

Behaviour in a Fundamentally Uncertain World

The Initiation and the Coping with Social Change: Jena Dept. Psychology

The focus of the department of social psychology in Jena is on psychological processes leading to the initiation and underlying the coping with social change. Examples are the relations and behaviour between members of host and immigrant cultures or social groups participating in social and organisational merger. The specific goals are as follows: (1) to combine research on uncertainty and research in the domain of mergers and migration that make up two separate fields in intergroup research up to now (2) to apply knowledge from social and cognitive psychology to get a better understanding of the precondition for the success of economic innovations.

The Power of Simple Heuristics in Uncertain Environments: MPI Berlin

The Center for Adaptive Behavior and Cognition is an interdisciplinary research group, spanning the fields of psychology, computer science, economics, and biology; and using a variety of methods to analyze the building blocks of simple heuristics and the way people manage uncertainty. The interdisciplinary character of the center provides a productive environment for graduate students of a potential International Max Planck Research School.

The main focus of the Center is the development and the test of heuristics describing the underlying cognitive process of decisions and inferences under risk and uncertainty. Research projects, which could be approached by graduates of the research school, include the development and test of models of bounded rationality by examining their performance, simplicity and accuracy in predicting people's decisions. This includes the development of tools and heuristics that can help people to deal with uncertainty and risk, for instance, examining different numerical or verbal representations of uncertainties. Finally it includes the test of how good heuristics are in comparison to other models of human behaviour to predict people's behaviour either in experimental settings or in field studies.

Foraging Decisions in an Uncertain Environment of Strategic Interaction: Bloomington Psychology

People and other animals facing resources distributed in patches are required not only to make decisions on where to forage, but also on how long they should forage in a particular patch. When these resources are informational in nature, as in memory or on the Web, how do people make these decisions, and how well do they do? One approach to answering this question comes from biology: The Marginal Value Theorem states that the optimal strategy is to leave a patch when the instantaneous rate of return from the current patch falls below the long-term mean return rate. The MVT has been successful in predicting animal behaviour in

searching for food and human behaviour in searching for information on the Web, but it is an "as-if" model, describing how individuals behave but not the processes by which they make their decisions. Simple decision mechanisms to model animal patch departure have been proposed, along with specification of the kinds of environments in which each works well. In previous work, we have tested whether the heuristic rules evolved to direct animals when to leave a food patch also underlie human decision making in the same context, and whether humans in an internal-search task (e.g. information in memory) use the same rules as in a external-search task (e.g. physical objects). We did this by setting up two experiments, which differed in whether search is external or internal, but whose environmental parameters were matched. In the first experiment, our fishing task, participants were presented with a virtual landscape on a computer screen allowing them to "forage" at a pond. If they stayed they caught fish at stochastic intervals depending on the number of fish left in that pond; if they chose to leave, then it took them time to walk to the next pond. All ponds appeared equal, but the number of fish in each varied according to three different resource distributions. In the second experiment, foraging for fish was replaced by searching for solutions to a word puzzle. In a modified anagram search task, people generated meaningful words out of random letter sequences. This latter experiment showed that information search could be governed by the same kinds of simple search rules that are applied to food search. Our continuing research in this area focuses on how people search for information externally, e.g. on the Web rather than in memory, and on how social aspects of the environment and task can affect the search mechanisms used, as for instance when people can search for information held by others, or when groups are cooperating or competing on information-search tasks.

2. Economics

Strategic Interaction in a Fundamentally Uncertain World
Jena Department of Economics, MPI Jena, Jerusalem Center

The economists within this program focus their work on the development of a general theory of bounded rationality (the Strategic Interaction Group of the MPI Jena and the Rationality Center in Jerusalem) as well as on the economics of change (the faculty of economics and the other two groups of the MPI Jena). The theory of bounded rationality must be capable to describe the behaviour of human decision makers under fundamental uncertainty. Moreover, this theory has to explain the formation and adaptation of aspiration levels. In this respect also the problem of how agents form expectations are of interest. If a decision maker can not be certain about the future, what can be said about the decision maker´s expectations? Can we model expectations as a forward looking process, as in neoclassical rational expectations, or is a model of backward looking adaptive expectations more appropriate? Are expectations for consumer good prices formed following the same process as, e.g. expectations for share prices, inflation, or taxation? Extending this line of research one may ask under which conditions does a decision maker wants to reduce uncertainty with the help of a contract. From contract theory we know how incentives are influenced in a contractual relationship. Can we extend this analysis also to not-perfectly rational decision makers? Will human decision makers write the same or different contracts as perfectly rational decision makers, and how do these contracts affect the incentive problem?

The economists will apply such a theory on decision makers in strategic interactions. Particularly, one has to ask which factors trigger innovative activities although inventors have almost no knowledge about the expected benefits of their activities. Is there a strategic choice between different factors in the decision process? And how do economic agents learn to

innovate? How important is failing on one task for following innovation decisions? What can be learned from the failure of competitors? To what degree require agents cooperation partners in order to overcome information and competence gaps?

Innovation also matters at the demand side. When are consumers willing to be the first to use an innovation? How does this decision impact on the diffusion of the product innovation? How do preferences change due to innovations offered? How do consumers interact with innovators in generating innovations?

Due to these features, the dynamics of the innovation process on the supply as well as on the demand side are characterised by nonlinearities. In order to gain a proper understanding of these dynamics, not only complicated dynamical features such as oscillatory behaviour, chaos, and catastrophes have to be taken into account. New insights are to be gained by introducing rough behavioural rules like 'rules of thumb'. The modellers from the Jena Department of Economics apply cellular automata, multi-agent systems and other, related discrete, non-analytic mechanisms to investigate the dynamic behaviour of such processes.

3. Institutional Analysis and Design

Institutions Moderating Behaviour in a Fundamentally Uncertain World: MPI Bonn

Institutions are moderating behaviour in a fundamentally uncertain world in multiple ways. The researchers working at the Bonn MPI contribute to the programme of the school by either analysing existing institutions from this perspective, or by designing new ones for the purpose.

Some institutions reduce the degree of (relevant) uncertainty by making the environment safer. An example is a rule that bans some form of potentially detrimental human behaviour, like buyers or sellers exposing consumers to the risk of options trading. Court rulings frequently have a related effect. They artificially construct certainty in that the validity of the decision makes the underlying real world uncertainty irrelevant for the parties. Other institutions immunise their addressees against the effects of uncertainty. An example is the rule that judges are not personally liable if, ex post, their decisions turn out to be materially wrong. Further institutions reallocate uncertainty to a superior bearer. This is what a standard employment contract does. Typically, workers do only have their human capital for gaining them a living. To that end, it must be combined with other human and financial capital, which is done in a firm. The firm's profit responds to market opportunities. The employment contract insulates workers from this uncertainty by shifting the residual risk to the employer. The employment contract thus has an insurance element. It is backed up by restrictions on giving workers notice. Yet other institutions, conversely, aim at safeguarding socially beneficial uncertainty. A classic is antitrust, which prevents competitors from reducing uncertainty by a cartel.

All the foregoing interventions make a material difference for its addressees. Other institutions are confined to changing risk perception. Producers are obliged to state on cigarette packets: "Smoking is a deadly risk". This is meant to accentuate uncertainty. Conversely, when the avian flu breaks out, public authorities routinely inform the public that the risk of humans being affected is small. Not so rarely, it is rational to react to the way how others perceive a risk. A classic is a bank run. No bank has enough capital to pay all its creditors at once. It is individually rational to come first. Individual rationality, however,

generates a vicious cycle. Bank supervisory authorities have powers to interrupt payments should the risk materialise.

Many institutions respond to uncertainty in an indirect way. They make it easier for their addressees to trust. Trust is risky by definition. But trust is not blind. People trust since they judge their counterparts to be trustworthy. Or they exhibit generalised trust since they believe that a situation has sufficiently predictable and manageable features. Institutions may push the uncontained risk below the threshold of trustworthiness. For instance, criminal law makes it less likely that one be attacked by a stranger on the street. Other institutions generate reliable information so that trustors may decide on a richer factual basis. The land register provides an illustration. If the seller is listed in the register, the buyer need no longer worry whether the seller is indeed the owner.

Foraging Decisions Leading to a Social Dilemma in Harvesting Natural Resources: Bloomington Workshop in Political Theory and Political Analysis

Elinor Ostrom is currently working with Robert Goldstone in Cognitive Science and Fil Menczer in Information Science at Indiana University on the study of human foraging experiments. We present subjects with a virtual renewable resource and enable them to harvest without any rules (open access), with a private property system, with the option to vote for a private property system, or with open communication to share information about potential joint strategies. A working paper on "Rule Choice in a Real-Time Sptailly-Explicit Renewable Resource Experiment" in final draft that explore the effect of learning about this uncertain environmental over time as well as the diversity of rules used. This project has a natural intellectual linkage to all three MPI centers – given the focus on uncertainty, learning, complexity, institutional analysis, and experiments.

V. Fields of Research to be covered by the School

The school spans three disciplines in an innovative way. The following paragraph describes our research focus: decision making under fundamental uncertainty.

Decision Making in a (Sufficiently) Certain World

How should one make a decision? The answer seems obvious: figure out what you want, check your options and choose the option that comes closest to your desires. Neoclassical economics has developed this programme to near perfection. It is the programme of optimisation under constraints (Feldman 1980). From this starting point, it is natural to see uncertainty as a problem of information. If more information is available, rational decision makers use it. If full information is not to be had, rational actors replace it by the best available proxy. In the most comfortable case, the set of possible events is finite and known. Both the range and the distribution of each possible event within the range of possible realizations may be estimated. There is, for instance, reason to believe that the unknown event is taken from a well-defined class of events, and that there is data from a representative sample. If so, the present value of the option may be calculated (Neumann and Morgenstern 1947). If there is no hard data, decision makers may still be able to come up with educated guesses. The rational choice programme still works if they rely on merely subjective probabilities, and on a merely subjective definition of the action space (Savage 1954).

The programme takes into account information cost. If the acquisition of additional information is costly, decision makers make an investment decision (Stigler 1961). They estimate the expected value of improving decision quality, and compare it to the cost. If, ex ante, it is uncertain whether costly search leads to success, the benefit is multiplied by the (if necessary only subjective) probability of success. By the same token, the solution space for the meta-decision about search may be extended. First, the decision maker constructs the space of potential outcomes of search. Each outcome is the product of two factors: the probability of being found, and its value. Summing up over all weighed outcomes gives the expected value of engaging in search (Helstrom 1960).

The same way, one may introduce decision cost. This is easiest to see if the decision maker relies on the services of an intermediary. The cost of entrusting the actual decision making to an outsider is justified in either of two cases. In the first case, the decision maker could have made the decision herself. But decision-making effort saved on this task may be invested in other, more profitable tasks. In the second case, bringing in the third party is a way to overcome limitations of the decision maker. Either meta-decision rests on comparing expected benefit to cost.

In this (neoclassical) programme, decision-making under certainty is the conceptual starting point. Decision cost, complexity and uncertainty are added as complications. By the steps sketched above, these complications become tractable, provided computational capacity is not bounded. Once the necessary estimations have been made, the actual decision is a mere matter of calculus. Given the right estimates, the right decision is unquestionable. If outsiders accept the estimates, one may prove that one has taken the correct decision.

These features of the neoclassical programme have made it attractive to psychologists and lawyers as well. In psychology, the anomalies and biases programme has turned into norms

what is a mere analytic tool in economics (Kahneman, Slovic et al. 1982; Kahneman and Tversky 2000). In experiments, subjects have been tested against the predictions of rational choice theory. Systematic deviations have been dubbed as biases. Indeed, long lists of such biases have been found (see the series of articles by Thaler 1988-2006, Dawes and Thaler 1988; Kahneman and Thaler 2006). Legal scholars have bought into this programme from two angles. In law and economics, legal institutions are reconstructed from the perspective of actors who follow the rational choice programme (Posner 2003). In most of behavioural law and economics, legal institutions are reconstructed as decision aids, helping individuals overcome the empirical deviations from rational choice norms, i.e. biases (Sunstein 2000).

Decision-Making in a Fundamentally Uncertain World

There is a radically different way of construing decision-making. It starts from the assumption that the problem is either ill-defined, or complexity transcends decision-making abilities (Gigerenzer, Todd et al. 1999; Gigerenzer and Selten 2001). Of course, not all problems fall into one of these categories. Actually, one of the main purposes of institutions is narrowing down problems such that they become tractable in rational choice terms. Take decision-making in Parliament. At the outset, the factors potentially relevant for making political decisions are overwhelmingly rich. But all that is needed to make a decision on behalf of the entire country is sufficient votes in Parliament. But this institutional intervention is already a response to the fact that complexity had been extensive in the first place.

The domain of the alternative approach is extended by the fact that not all decision makers dispose of perfect cognitive abilities. Yet nonetheless they have to take decisions. Others have to divide their limited cognitive resources among multiple tasks, or to decide in limited time. Yet others cannot afford training or the help of decision-making intermediaries with larger cognitive resources. For all of these reasons, decision makers might want to content themselves with a more parsimonious method of decision-making under uncertainty, provided the expected results are at least satisfactory (Oaksford and Chater 2001).

Once one introduces human interaction into the definition of the situation, further reasons for fundamental uncertainty become visible. People possess the power of creativity. They can use it for mere technical or institutional innovation (von Hayek 1945). But they may also creatively circumvent what would be a restriction for a mere utility maximiser (Wegner 1996).

Finally, if the situation is not exceptionally simple, actors must engage in sense making (Weick 1995; Turner 2001). To that end, they construct mental models (Johnson-Laird 1983). Uncertainty can also be said to be fundamental if actors lose confidence in their mental models (Siegenthaler 1993; Siegenthaler 1997).

If uncertainty is fundamental for one of these reasons, decision-making is no longer a matter of calculus. Search must be stopped at one point, and often early on (Gigerenzer, Todd et al. 1999). The decision maker must take on personal responsibility. It is clear at the outset that the decision may turn out to be suboptimal, after the fact. It does not make sense to strive for the perfect decision. A good illustration is the so-called secretary problem, i.e. a search problem where former options are foregone (Lee and Zwick 1999). Here one may learn after the fact that a former option would have been preferable. But one has no chance to revert on one's earlier decision not to seize the opportunity. In such situations, the normative goal shifts to coming up with an appropriate move, given the limited abilities of the decision maker (Simon 1979). Depending on the situation, avoiding bad mistakes (e.g. hiring the worst

secretary) may be more important than missing theoretical opportunities (e.g. hiring the theoretically optimal secretary). In other situations, taking the risk of small mistakes may be conducive to gradually improving decision quality, and to prepare for situations where decision quality matters more. In the same vein, it may be preferable to split an important decision into small steps, thereby gaining an opportunity for redirecting one's course in light of intermediate experiences. It always pays to remain open for surprise. Making good use of feedback becomes paramount.

The hallmark of rational choice theorising is strategic interaction. Many real life problems fall into this category, the two main exceptions being the direct interaction between man and nature, and behaviour in markets if competition is workable. The tool for analysing problems of strategic interaction is game theory (e.g. Fudenberg and Tirole 1991). If some actors have a chance to design rules for future interaction, game theory takes the form of principle-agent theory and of mechanism design (Bolton and Dewatripont 2005). If the uncertainty is fundamental, this does not make the strategic element and anticipation disappear. Yet if neither actor optimises, strategic interaction takes on a different flavour. Generating predictability is a precondition to gains from cooperation. Complex cascades of mutual anticipation become unlikely. Simple interaction heuristics are more likely to be employed by one's interaction partner. On the other hand, too much predictability is dangerous when “predators” are on the loose. In such situations, a decision-rule must help the individual choose between the prospect for gains from cooperation and the ensuing risk of being exploited.

The best machinery for implementing the traditional rational choice programme is formal logic. Logic has its role in the alternative programme. But it must be supplemented by different cognitive and motivational tools. On the cognitive side, the decision maker must be able to comparatively assess the desirability of options on a thin factual basis. Most likely, there is not one all-purpose tool for this. In some contexts, simply repeating past success and avoiding past failure may be enough (cf. Camerer and Ho 1999). In other contexts, it may be more promising to build a rough mental model of the situation, and to rank the options that come to mind along simple criteria (cf. Bandura 1986). In yet other contexts, tracing patterns and matching their probabilities may be best policy (Shanks, Tunney et al. 2002), and so forth. On the motivational side, two elements are crucial. Decision makers must be willing to take risks; otherwise they would be immobilised in the face of patent uncertainty. Conversely, decision makers must feel pressed to change a course of action if there are sufficiently strong signals that they got it wrong. The relatively high willingness to trust others (Buchan, Croson et al. forthcoming), coupled with fairly strong punishing sentiments (Fehr and Gächter 2002; Price, Cosmides et al. 2002), fit this picture well.

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