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More than Thirty Years of Ultimatum Bargaining Experiments: Motives, Variations, and a Survey of the Recent Literature

Werner Güth
Martin G. Kocher

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Abstract

Take-it or leave-it offers are probably as old as mankind. Our objective here is, first, to provide a, probably subjectively-colored, recollection of the initial ultimatum game experiment, its motivation and the immediate responses. Second, we discuss important extensions of the standard ultimatum bargaining game in a unified framework, and, third, we offer a survey of the experimental ultimatum bargaining literature containing papers published since the turn of the century. The paper argues that the ultimatum game is an extremely versatile tool for research in bargaining and on social preferences. Finally, we provide examples for open research questions and directions for future studies.

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Keywords: ultimatum bargaining, experiment, social preferences.

Werner Güth
Max-Planck-Institute of Economics
Kahlaische Strasse 10
Germany – 07745 Jena
gueth@econ.mpg.de

*Martin G. Kocher**
Department of Economics
University of Munich
Geschwister-Scholl-Platz 1
Germany – 80539 Munich
martin.kocher@lrz.uni-muenchen.de

*corresponding author

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When Güth presented the more recent ultimatum-like experiments, Uri Gneezy suggested writing a survey of more than 30 years of ultimatum bargaining research. We thank him for the nudge and David Bauder as well as Niklas Garnadt for excellent research assistance. We are extremely grateful to the magnificent members of the Economic Science Association Discussion List; many of them – too many to mention each by name – pointed us to scholarly papers that use the ultimatum game. All remaining errors and omissions are of course ours.

1. Introduction

If one searches for "ultimatum bargaining" on scholar.google.com, there are more than 24,000 results. The first result is the original article by Güth et al. (1982) that is cited more than 2,650 times. The ISI Web of Knowledge counts almost 1000 citations for this paper. An entire generation of behavioral and experimental economists as well as psychologists has been influenced by the result that people systematically deviate from the standard prediction of ultimatum bargaining. Thousands of ultimatum game experiments and extensions have been published in the meantime. Thirty years after the publication of the first ultimatum bargaining experiment it is time to take stock.

It seems almost impossible to survey in one paper the entire literature on ultimatum bargaining and on experiments using the ultimatum game. The sheer size of the literature is amazing and forces us to pursue a more moderate approach. Hence, in contrast to a traditional survey, the objective of this paper is threefold. First, it is intended to provide a, probably subjectively-colored, recollection of the initial ultimatum game experiment, its motivation and the immediate responses. Second, we discuss important extensions of the standard ultimatum bargaining game, and, third, we offer a survey of the experimental ultimatum bargaining literature containing papers published since the turn of the century[1], and even that is a task that forces us to be eclectic in what we can cover.

One of the authors (Kocher) vividly remembers a discussion with Amnon Rapoport, probably more than ten years ago, in which Amnon Rapoport claimed that the ultimatum game is one of the most complex games in experimental economics, much more complicated than games with many players, potentially incomplete information, and/or mixed strategy equilibria. It is a claim that becomes clearer only after a second thought: while the game structure is obviously one of the easiest that can be imagined (two players, two stages, complete information, usually small strategy spaces), the motivations behind decisions in the ultimatum game are extremely diverse, and it took years or even decades of research to better understand them.

At the outset of the experimental research on ultimatum bargaining, towards the end of the 1970ies and the beginning of the 1980ies, the source for the interest in the ultimatum game was a bit different. The motivation was to study bargaining and to document limits of the traditional assumptions regarding rationality and material selfishness or opportunism. Whereas social dilemma games such as the prisoners' dilemma and the public goods game

[1] Earlier surveys are Güth and Tietz (1990), Güth (1995), Roth (1995), Camerer (2003), and chapters 46, 47 as well as 50 in Plott and Smith (2008).

explore the efficiency of strategic interaction outcomes, the findings of ultimatum experiments more fundamentally challenge the narrow concept of material opportunism, namely that decision makers maximize their own payoff in each and every situation. Behaving non-optimally in this sense in social dilemma games can be explained by efficiency concerns. However, in ultimatum games where responders reject positive actual offers, i.e., they essentially "burn money", efficiency concerns are also violated. Thus, the results from ultimatum experiments reject the narrow orthodox assumption of material opportunism, but they do not necessarily reject rationality in a broader sense, allowing for all sorts of aversion concepts, intrinsic motivations, other-regarding preferences, and emotions. It becomes apparent immediately why the ultimatum bargaining game had such a profound impact on behavioral and experimental economics and beyond, once it was out there.

Although we still do not understand everything and, especially, cannot predict individual behavior in the ultimatum game, based on observables, the last 30 years have contributed to a better understanding of ultimatum bargaining. Nonetheless, a "ban on ultimatum experiments" (Camerer, 2003) seems at best premature. As will become clear below, beyond its immediate function as a test of bargaining theory, the ultimatum game has become a valuable tool or workhorse for studying a host of different research questions in economics and in other disciplines.

The remainder of the paper is organized as follows. Section 2 traces the first theoretical discussion of ultimatum bargaining (Güth, 1976), before discussing in more detail how this has inspired the first ultimatum experiments, especially by confronting them with earlier experiments of bargaining and negotiations. Section 3 recollects the main findings of Güth et al. (1982) and discusses why they have received much attention and inspired many subsequent studies. Section 4 is devoted to modifications of take-it or leave-it offer bargaining. In section 5, we will mainly focus on scholarly contributions using the ultimatum game after the turn of the century. In section 6, we discuss some possible directions of future research, and section 7 concludes the paper.

2. How it all began

Having studied economics intensified one of the author's (Güth) interest in fairness which he wanted to analyze game theoretically. In spite of the – at that time – still predominant cooperative game theory, he was interested in strategic games generating fair and efficient outcomes (see Güth, 1976, for early attempts). As most game theorists of that time, he was

aware of alternating concession models (Zeuthen, 1930) and how they are related to Nash's (1950) bargaining solution (Harsanyi, 1959) and of alternating offer bargaining models (Ståhl, 1972).

A problem of the latter studies is that they appeal to often observed alternating concessions or agreement offers, although their solutions predict an immediate agreement due to the efficiency loss by delayed conflict resolution. Allowing for just one round of take-it or leave-it offers avoids the problem, but this was no essential reason for being interested in ultimatum bargaining at that time. Undoubtedly, there was an awareness of the active research in characteristic function experiments (see, for example, Sauermann, 1972), which were usually run "face-to-face" and with free from communication. Such protocols obviously allow for all sorts of confounding effects from physical attraction, signaling, beliefs on trustworthiness, to prior acquaintance, which Güth aimed to avoid or at least reduce as much as possible. But, although – thanks to his close relation to Reinhard Selten – he was quite familiar with the experimental method, it needed some "seduction" to make him study "ultimatum bargaining" (see Güth, 1976) experimentally.

To the best of Güth's memory, he mainly wanted to use a strategic model of bargaining and focus, for a start, on the simplest model of take-it or leave-it offers, with the option to later enrich it, e.g. by allowing for more complex choice sets or for more rounds of take-it or leave-it offers by the same party or with both parties alternating. The intuition that this might be an interesting topic for experimental research may have been inspired by the evidence of fair outcomes in the early dictator game or in reward allocation experiments (for example, Mikula, 1973; Shapiro, 1975). Could such fairness be observed also when allowing for the most elementary form of strategic interaction?

What has finally induced Güth to actually plan an experiment which could reveal fairness concerns in spite of its different standard prediction, and thus would question the assumption of material opportunism in case of unfair proposals, similar to findings from reward allocation experiments? In September 1977 (Güth's first month as a professor of economics at the University of Cologne), Wulf Albers and Günther Bamberg organized a workshop bringing together game theorists and social psychologists and trying to promote experimental research. They did so by offering funds for running experiments. In Güth's case, they were successful. He got 1.000 German marks and immediately started preparing the first experiments, the ultimatum bargaining study reported in Güth et al. (1982) as well as an auction experiment described in Güth et al. (1983).

Two students (Rolf Schmittberger and Bernd Schwarze[2]) helped to run the experiments and also typed the many versions of the manuscript before the paper was finally published. This is how it began. Let us now describe what can be learned from it.

3. The first findings

The ultimatum game features a situation in which one party specifies all details of an agreement, and the other party can either accept or reject, where rejections imply that the surplus of the deal is lost.[3] What renders the ultimatum game special, also when compared to principal-agent models, is its constant-pie-assumption. This means that the main concern of the game is how to distribute the rewards and that inefficiency can only be caused by rejection, i.e., by not reaching an agreement.

More formally, let X be the proposer who suggests the shares *x* and *y* for him and the responder Y, respectively, where *x* and *y* are non-negative and add up to the positive pie size *p*. Thus, the sequential process is that, first, X chooses (x, y) with $x, y \geq 0$ and $x + y = p$. Then, after learning the choice of (x, y) by X, responder Y either accepts, $\delta(x, y) = 1$, or rejects, $\delta(x, y) = 0$. This implies the final payoffs $\delta(x, y)\, x$ for X and $\delta(x, y)\, y$ for Y.

Material opportunism requires that a positive actual offer *y* to Y must be accepted by Y, i.e., $\delta(x, y) = 1$ for $y > 0$. On the one hand this, however, does not exclude the existence of a large multiplicity of equilibria, for example, of the form $\left((x, y), \delta(\tilde{x}, \tilde{y}) = 1 \text{ if } \tilde{y} \geq y \text{ and } \delta(\tilde{x}, \tilde{y}) = 0 \text{ otherwise}\right)$ for all y with $0 \leq y \leq p$. In other words, all distributions of *p* are justifiable as equilibrium outcomes. On the other hand, the elimination of weakly dominated strategies implies $\delta(x, y) = 1$ whenever *y* is positive. If this is anticipated, proposer X should offer responder Y at most the smallest positive amount[4]. Thus, repeated elimination of weakly dominated strategies implies that proposer X receives

[2] Bernd Schwarze finally wrote a Ph.D. thesis in experimental economics (Schwarze, 1983; see also Güth and Schwarze, 1983).

[3] Güth (1976) also discussed (von Stackelberg) situations where not all details of the agreement could be specified and some could be chosen by the responder (see Siegel and Fouraker, 1960, for an early experiment of such a situation).

[4] Since both, $\delta(p, 0) = 1$ and $\delta(p, 0) = 0$, are optimal, there is indifference in case of zero offers.

nearly all of p and responder Y at most the smallest positive amount. The same solution is implied by (subgame) perfectness of equilibria (Selten, 1965, 1975).

As a consequence, the empirical finding of the modal offer $y = p/2$ seems less troublesome for game theory (see Aumann, 1974, who propagates coarsening rather than refining the equilibrium concept) than the observation that low offers, for example in the region $y < p/3$, are sufficiently often rejected to render such low offers unattractive for proposers. The rejection of positive offers y clearly questions material opportunism and cannot be explained by noise, mistakes, or confusion.[5]

Importantly, the modal equal split offer is an extremely robust phenomenon. On average, players in the game tend to offer around 40-50% of the pie in the standard version of the game. Such offers are almost always accepted. Responders' acceptance rates decrease with smaller offers, and they approach zero quite quickly for offers below 20%. From an ex post perspective, taking actual rejection rates into account, either the equal split or offers around 40% are payoff maximizing for proposers (see Camerer, 2003). Most responders exhibit monotonic rejection strategies, although one consistently observes a small number of rejections of rare "superfair" offers with $y > p/2$ (Güth et al., 2003).[6]

The evidence from the ultimatum game clearly shows that, first, responders do not only care about their own monetary payoff but compare their payoff with that of the proposer and become frustrated when their share is much lower. Second, proposers are either aware of the responder's willingness to reject unfair offers or guided by own fairness concerns when offering sizable or even fair[7] shares for Y.

In the spirit of the earlier reward allocation experiments it seemed that participants assumed equal "contributions" (since the pie was given to them like "manna from heaven", i.e., as a windfall gain) and therefore wanted to share it equally[8]. Of course, as in almost any

[5] Rationality in making mistakes, for example by assuming that less costly mistakes are more likely (Myerson, 1978), could account for more likely rejection of lower offers but not for the very high rejection rates of substantial, but unfair offers.

[6] Assuming monotonicity allows eliciting responders' behavior by asking them for a minimum acceptable offer (MAO). Methodologically, it might sometimes be helpful to give no information about proposals to responders at all. Eliciting MAOs allows to ask for proposals and responder behavior simultaneously, without having to use the strategy vector method.

[7] We define the equal split (i.e., an offer of $y = p/2$) as fair.

[8] Speaking of "contributions" means to apply equity theory (see, for example, Homans, 1961) in a liberal way in order to make it applicable even if contributions to generate the total reward are minor or if they are only an aspect of belonging to the group of recipients.

experimental game, behavior is very heterogeneous across decision makers. Some of the participants in the experiment engage in backward induction and more often than not fail in reaching an agreement by not figuring out that its result might not be socially acceptable. What is taught in a game theory class or an operations research course may not be behaviorally optimal when fairness matters. Analytic capability is better paired with social intelligence.[9]

There is a second part of the Güth et al. (1982) paper that is hardly ever mentioned or referred to. It allows for a variable pie size by asking X to allocate two stacks of differently colored chips with different monetary chip values in two bundles for the two players. Y can choose the preferred bundle, and X obtains the other bundle. In what is coined the "complicated ultimatum game" in the paper, equality of monetary earnings could be achieved efficiently and inefficiently (see Nydegger and Owen, 1975, for an early experiment using asymmetric chip values). The intention of exploring the complicated ultimatum game was to show how the ultimatum game can be enriched in order to assess additional research questions such as, for example, whether decision makers are mainly interested in equality or in both, equality and efficiency.

Is it just the "manna-from-heaven" pie that triggers such strong fairness concerns? It definitely is responsible for observing $y = p/2$ as the modal offer but not for offering sizable amounts to the responder. Güth and Tietz (1985, 1986) provided entitlements over the endowment (see also Hoffman and Spitzer, 1985) by auctioning the roles of proposers X and responders Y and observed hardly any equal split but splits of pie p in the range of $y = p/3$, in correspondence with the twice as high role prices of proposers X compared to those of responders Y in the auction. Hoffman et al. (1996) allocated roles by assigning participants with a better quiz score to the proposer role and could also confirm an entitlement effect[10],

[9] Social intelligence is something that is accumulated when growing up. The results from ultimatum games played by children and teenagers are somehow mixed, however (see Murnighan and Saxon, 1998; Hoffmann and Tee, 2006; Sutter, 2006; Steinbeis et al., 2012). The general picture from economic experiments with children and adolescents (see also Kocher and Sutter, 2007) tends to support the hypothesis of a development of social intelligence when growing up leading to higher offers and less conflict with increasing age during childhood. When looking at results from experiments with chimpanzees (Jensen et al., 2007), it becomes clear that their behavior is closest to the model of a homo oeconomicus, even though fair sharing behavior has also been repeatedly observed in monkeys (see e.g., Horner et al., 2011).

[10] In the sense that by one's relatively better quiz score one feels entitled to command ultimatum power rather than the other, but not in the sense that ultimatum power corresponds to the difference in "contributions".

weakening equal sharing of *p* and triggering a self-serving bias on the side of the proposer participants (for more recent evidence, see e.g., Gächter and Riedl, 2005).

One important impact of the ultimatum game on research in economics tends to be easily overlooked. The ultimatum game has been extremely relevant as an empirical example and guidance for developing theoretical models of other-regarding preferences. Even if his model only concerns normal-form games, Rabin (1993) mentions the ultimatum game four times in his paper (excluding the reference list).[11] Outcome-based models of other-regarding preferences are, of course, by far more influenced by the results from ultimatum bargaining experiments. Kirchsteiger (1994) mentions the game 29 times, Levine (1998) 37 times, Fehr and Schmidt (1999) mention it 27 times, and Bolton and Ockenfels (2000) 53 times (always excluding the reference list). Not much lower are the numbers for Charness and Rabin (2002) with 17 times, Falk and Fischbacher (2005) with 25 times, and Cox et al. (2007) with 26 times.[12] It seems fair to say that the impact of the ultimatum game results on the theoretical development of behavioral economics was significant.

4. Let the game continue

In the following, we focus on three sets of relevant methodological extensions of the basic ultimatum bargaining game. Section 4.1 discusses alternating-offer bargaining and repeated play of the basic game; section 4.2 provides a selection of modifications of the one-round game, and in section 4.3, we give an overview of ultimatum game extensions that involve more than two players.

4.1 Multiple rounds

An important extension of the basic one-shot ultimatum game was to introduce multiple rounds of – usually alternating – take-it or leave-it offers, especially since the former respective exercises by Ståhl (1972) and Krelle (1962) were by then supplemented by the very elegant studies of Rubinstein (1982, 1985). The first such experiment (Binmore et al., 1985) confirmed the findings of Güth et al. (1982), but mainly discussed the results of a two-round

[11] Dickinson (2000) uses an ultimatum game to test one aspect of the theory, i.e. that people care relatively less about fairness the higher the stakes in the game.

[12] Empirically, the predictive power of models incorporating social preferences has been assessed using the ultimatum game (in conjunction with other games). Examples are Bolton and Ockenfels (2005) and Blanco et al. (2011).

alternating offer game with a second-round pie p_2 at the level $p_2 = p_1 / 4$, with p_1 denoting the first-round pie. In other words, in the design of Binmore et al. (1985) delaying an agreement implied an efficiency loss of 75%. The authors concluded from their findings that, except for the special case of one-round ultimatum offers, game-theoretic backward induction based on standard preference assumptions is a reasonable prediction, especially after allowing for some (minimal) learning. The conclusion inspired a very active experimental tradition of alternating offer games, usually based on "shrinking pies", i.e., delay of an agreement is costly.

One major result of this literature (see the early surveys of Güth and Tietz, 1990, and Roth, 1995) is that backward induction, based on more or less commonly known material opportunism, is hardly ever in line with the experimentally observed behavior. This is most convincingly demonstrated first by using the mouse-lab technique (Johnson et al., 2002) revealing that when submitting earlier offers, participants have not yet retrieved the pie sizes of later rounds. However, proper backward induction requires knowledge of the pie sizes in later rounds.

Güth and Tietz (1985, 1986) questioned backward induction even for the simple case of two rounds, only by imposing either a radically shrinking pie ($p_2 = p_1 / 10$), or an almost not-at-all-shrinking pie ($p_2 = 9p_1 / 10$). The game-theoretic prediction that one party should get only one tenth of the initial pie p_1 was never implemented; especially first-round proposers nearly never accepted that they should receive less (as in case of $p_2 = 9p_1 / 10$, where the first proposer should demand only 1/10 of p_1). Unfair first-round offers were rejected even when it was impossible to earn the offered amount in later rounds (see Ochs and Roth, 1989, and the discussion in Roth, 1995). Learning, for example by allowing to play, first, the last subgame, then, the second-to-last subgame etc. (see Neelin et al., 1998), usually does not lead to behavior consistent with backward induction.

Finally, delaying an agreement must not always be costly. When, for example, later agreements can be conditioned more specifically on environmental aspects, it may be helpful to wait before striking a deal. Güth et al. (1993) explored, first, in(de)creasing, then, de(in)creasing pie sizes in addition to the usual declining "pies" and found that participants usually strive for an agreement in the round when the pie size is maximal. Thus, it seems that decision makers are guided by strong equality as well as efficiency concerns.[13]

[13] Some more subtle aspects of alternating offer experiments are discussed by Roth (1995).

Another question that was of considerable interest in the 1980ies and 1990ies was learning in repeated play of the identical basic game, implemented as a stranger design (changing pairs) in order to rule out reputational concerns among players. Recently, Cooper and Dutcher (2011) provide evidence in a meta-study (see also Lin and Sunder, 2002) that behavior in repeated ultimatum games with stranger interaction seems similar to learning a norm, where offers have to hit some threshold to be accepted. With experience, acceptance rates of low offers even decline. Similarly, a recent learning experiment asking participants to play 100 rounds of standard ultimatum experiments using a random strangers design revealed a very quick convergence to proposers offering and responders demanding an equal share (Avrahami et al., 2010), i.e., behavior did not converge to backward induction play.[14]

Gale et al.'s (1995) learning paper focuses almost exclusively on the ultimatum game, whereas Roth and Erev (1995) provide more general evidence of learning in extensive form games. Nevertheless, the ultimatum game was mentioned more than 60 times in their study (again excluding the reference list). Without looking at the large subsequent literature on learning in games in detail, one sees that the ultimatum game and the experimental studies based on it influenced learning research in economics to a considerable extent.

4.2 Modifying the one-round game

Here we refrain from reviewing the large literature on dictator giving (see Roth, 1995, and Camerer, 2003, for reviews). Mostly, they confirm the findings of the early reward allocation experiments (Mikula, 1973; Shapiro, 1975) that allocator participants are often guided by own intrinsic fairness concerns (Forsythe et al., 1994), but that dictator giving depends on the details of the interaction (Cherry et al., 2002)

It is important to note that many of the dictator game experiments depart quite a bit from the ultimatum game. In the ultimatum game the responder cannot only veto a proposal, but also implicitly voice his disagreement, since the proposer is finally informed about the responder's reaction. Many dictator experiments were run by not only taking away the veto power of the recipient, but also by rendering the recipient voiceless. In our view, when directly comparing the ultimatum game and the dictator game, one should allow recipient participants to accept or reject what is given to them and inform allocator participants about the reaction of their recipient (Bolton and Zwick, 1995, use the term "impunity game"). This procedure avoids that participants are forced to accept every gift that they get.

[14] Learning speed in ultimatum games is discussed in Cooper et al. (2003). Armentier (2006) studies learning in an ultimatum game in which participants receive large and widely unequal initial endowments.

For the following overview of ultimatum game modifications, a more general characterization of the game will be helpful. Consider that the responder's decision $\delta(x,y) \in \{0,1\}$, about which the allocator X should be informed, may imply earnings $\delta(x,y)x + [1-\delta(x,y)]\alpha x$ for proposer X and $\delta(x,y)y + [1-\delta(x,y)]\beta y$ for responder Y, with $\alpha, \beta \in [0,1]$. This apparently features the ultimatum game as a special case of a two-dimensional class of games with $\alpha = \beta = 0$.

Suleiman (1996) explored the subclass of $\alpha = \beta$-games and could show that weaker veto power (i.e., larger $\alpha = \beta$-parameters) suffices to induce fair outcomes.[15] Fellner and Güth (2003) studied the subclass of $\alpha + \beta = 1$-games to investigate different degrees of punishment efficiency and to supplement the earlier studies of corner games (see Bolton and Zwick, 1995, and Güth and Huck, 1997) with $\alpha, \beta \in \{0,1\}$, rather than $\alpha, \beta \in [0,1]$. The general message is that even without punishment power $(\alpha = 1)$, responder recipients can expect some generosity $(y > 0)$, but that punishment efficiency, measured by the ratio of what X and Y lose in case of $\delta(x,y) = 0$, can be crucial. This ratio is partly endogenous and only partly dependent on the exogenously imposed parameters α and β, due to $\alpha x / \beta y$.

Another possibility to view the ultimatum game as a boundary case of a (this time one-dimensional) class of games has been theoretically and experimentally explored by Fischer et al. (2006). The game class is based on the assumption that both parties X and Y independently determine choices x, respectively y, satisfying $0 \le x, y \le p$, and that the implication of Y's demand depends on a chance move, namely whether (i) it serves as an acceptance threshold in the sense that Y gets $p - x$ if $p - x \ge y$ with conflict otherwise or whether (ii) it is a demand meaning that Y earns y if $x + y \le p$ with conflict otherwise.

Such a setup obviously allows to continuously connecting the ultimatum game to the demand game, studied by Nash (1950), via the probability for (i), respectively the complementary probability for (ii). Applying equilibrium selection (Harsanyi and Selten, 1988), all games can be solved uniquely, showing how the solution outcomes vary continuously from full exploitation (y close to 0) to fair outcomes $(y = p/2)$, when the

[15] Güth and Kovács (2001) allow Y participants to buy veto power, in the sense of $\alpha = \beta < 1$ instead of $\alpha = \beta = 1$.

probability for (ii) increases from 0 to 1. Behaviorally, however, equal splitting $(y = p/2)$ is much more persistent, as could have been expected from earlier ultimatum experiments.

More philosophically or methodologically speaking, viewing the ultimatum game as a boundary case of a larger game class allows to compare different games experimentally by using the same verbal instructions and distinguishing treatments only by numerical parameters (α and β, or the probability for (i), respectively (ii) from above). This could help to limit implicit and explicit demand effects and to apply and explore the principle of approximate truth (Brennan et al., 2008) also behaviorally in order to investigate whether discontinuities result when parameters approach the limits.[16]

Focusing again on the standard ultimatum game with $\alpha = \beta = 0$, a dramatic effect on the set of equilibria follows, when not informing Y participants about the offer (x, y) chosen by their X participant. Imposing $p \geq y > 0$ means that Y should always accept $(\delta = 1)$. Consequently, proposer X should only offer the smallest (positive) amount. The first laboratory study of the so-called Yes-No game confirmed the theoretical prediction for Y, however observed offers *y* lower than ultimatum offers but larger than dictator gifts (Gehrig et al., 2007). In contrast, a later study with two possible pie sizes elicited a few $\delta = 0$-reactions (Güth and Kirchkamp, forthcoming). The main reason for choosing $\delta = 0$ seems to be some form of group solidarity in the sense of "as responders, we once in a while should punish to prevent escalating exploitation by proposers", i.e., of responders voluntarily providing a "public good" for all Y participants via rejecting "the pig in the poke".

A more recent variation assumes that proposer X chooses the pie size $p \in \left[\underline{p}, \overline{p}\right]$ from some generic interval with $0 < \underline{p} < \overline{p}$. The choice can be accepted $(\delta(p) = 1)$ or rejected $(\delta(p) = 0)$ by responder Y, and the pie allocation is determined by imposing a positive agreement payoff for one party and featuring the other party as the residual claimant. In case of Y as the residual claimant, proposer X earns the exogenously given amount x and Y earns $y = p - x$ in case of $\delta(p) = 1$, whereas both earn nothing in case of $\delta(p) = 0$, i.e., X gets

[16] Folk theorems for infinitely repeated base games with a unique equilibrium (for example, prisoners' dilemma games) claim such a discontinuity (for finite horizons, there exists one subgame perfect equilibrium, whereas the set of such equilibria explodes when assuming an infinite horizon). Behaviorally, this discontinuity does not exist (except for the so-called endgame effect; participants are cooperating even when the horizon is finite and commonly known; see Selten and Stöcker, 1986).

$\delta(p)x$ and Y earns $\delta(p)(p-x)$. Here, for example in Güth et al. (2012), the parameters satisfy $0 < x < \underline{p} < 2x < \overline{p}$. In case of X as the residual claimant, the payoffs are $\delta(p)(p-y)$ for X and $\delta(p)y$ for Y, where now *y* is exogenously given, and one is naturally interested in the parameterization $0 < y < \underline{p} < 2y < \overline{p}$. If Y is the residual claimant, the game is called "generosity game". In contrast, when X is the residual claimant, the game is termed "envy game".

Both classes of games are especially suited to assess the type and the strength of other-regarding concerns, especially of inequity aversion or equity liking (Homans, 1961; Loewenstein et al., 1989; Bolton, 1991; Bolton and Ockenfels, 1998, 2000; Fehr and Schmidt, 1999), or efficiency seeking. Actually, the two-modal results are $p = 2x$, respectively $p = 2y$, and $p = \overline{p}$, with the latter mode clearly dominating the former one. Thus, when it is possible to grant one party more without own sacrifice, decision makers are guided by efficiency to a greater extent than by equality concerns (Güth et al., 2009, 2012; Bäker et al., 2010).

4.3 Make it three or more players

There are several interesting ways to add players to the standard two-player ultimatum game. In proposer competition, at least two X players make an offer *y* to the single responder Y, who naturally will choose the largest offer, meaning that competition grants almost the entire pie $p(>0)$ to the responder (see Roth et al., 1991). In responder competition at least two Y players set their acceptance threshold determining whether or not they accept the offer *y* of the only X player, where in case of more than one acceptance the Y player with the lowest threshold is selected (see Güth et al., 1998).[17]

In such games, there is no allocation that yields the same earnings to all players. Note that in proposer, respectively responder competition at least one X, respectively Y player is left empty-handed. Such inherent asymmetry apparently reduces the implicit demand of equal earnings for those actively striking a deal (in proposer, respectively responder competition, the only responder, respectively proposer receives considerably more than $p/2$). In a world

[17] One can also have more than two players and allow to endogenously expelling one (see Fischer and Güth, 2012, where proposers can expel one of two responders). Bereby-Meyer and Niederle (2005) use a three-person ultimatum game with different rejection payoffs for the third person that questions some aspects of existing fairness theories. Fischbacher et al. (2009) also study the effects of competition on behavior in bargaining.

in which unequal payoffs are unavoidable, the otherwise strong equality concerns seem to be much weaker.

The latter finding is also revealed by the results of three-person generosity and envy games with exogenously given agreement payoffs x, z of the proposer X and the additional dummy player Z, respectively y, z of responder Y and dummy player Z with $0 < x + z < \underline{p} < \overline{p}$, respectively $0 < y + z < \underline{p} < \overline{p}$. If $\overline{p}$ is large enough, i.e., $\overline{p} > 3(x + y)/2$ respectively $\overline{p} > 3(x + z)/2$ (see Güth et al., 2010, as well as Bäker et al., 2011), and if $x \neq z$, respectively $y \neq z$, the mode of choices is $p = \overline{p}$. Thus, in case of unavoidable inequality, the main concern becomes efficiency. However, when $x = z$, respectively y=z, the main mode is equality, i.e., $p = 3x = 3z$, respectively $p = 3y = 3z$. More generally, if general equality is feasible, it is usually implemented.

Compared to proposer and responder competition, such three-person generosity games and envy games increase the number of players by increasing the variety of player types. In addition to proposer X and responder Y, there is a dummy player Z without any direct influence on the allocation of resources. Three-person ultimatum-like games were inspired by the experiment of Güth and van Damme (1998), who let X allocate a given pie $p(>0)$ by choosing (x, y, z) with $x, y, z \geq 0$ and $x + y + z = p$. They not only elicited the responses $\delta(x, y, z) \in \{0,1\}$ but also the responses $\delta(y) \in \{0,1\}$ and $\delta(z) \in \{0,1\}$ via treatments where responder Y is only incompletely informed about (x, y, z), namely by learning only *y*, respectively *z*. [18] A striking result was that neither proposer X nor responder Y seemed to care much about the dummy player (see Bolton and Ockenfels, 1998, who focus on this observation), although a later newspaper experiment revealed some concerns for the dummy player Z (Güth et al., 2007).

Other variations distinguish an "only proposer" X, an "ambivalent" Y, and an "only responder" Z, meaning that, for example, X demands *x* with $x \in [0, p]$ from a given positive pie *p*. In case of the choice of $\delta(x) = 0$ by Y the game ends with zero payoffs for all, whereas for $\delta(x) = 1$ player Y becomes the proposer for the residual pie $p - x(\geq 0)$. Thus, after

[18] In their experiment they, unfortunately, did not allow the dummy player Z to accept or reject only what is given to him (with the other two players learning the choice of Z). Hence, the setup rendered the dummy Z not only choiceless but also voiceless.

$\delta(x)=1$, player Y demands y from $p-x$, to what Z reacts by choosing $\rho(x,y)\in\{0,1\}$.[19] The payoff of such two-level ultimatum games are $\delta(x)x$ for X, $\delta(x)\rho(x,y)y$ for Y and $\delta(x)\rho(x,y)(p-x-y)$ for Z (Güth et al., 1996). The main novelty here is the ambiguous player Y who, in relation to X, is a responder and, in relation to Z, a proposer. Such a setup allows comparing the acceptance behavior of Y with his or her own proposal making, similar to employing the strategy vector method (see, for example, the newspaper experiment of Güth et al. 2003).[20] Furthermore, what Y chooses in a two-level ultimatum game is strongly influenced by the example x of player X.[21]

Apparently, the ultimatum game provides a good starting point for tackling new research questions by varying its basic design via changing the choice sets, the information conditions, the number of players, and the variety of player types.

5. From the turn of the century until now

Even if we restrict the time horizon to only the 14 years from 2000 until 2013 (less than half of the time since the first publication of an ultimatum bargaining experiment), we end up with almost 200 scholarly articles in journals that are listed in the Social Science Citation Index using the term "ultimatum game" in the title. The number clearly shows that the ultimatum game is still a very important workhorse in behavioral economics and psychology research. In the following we provide a subjectively selected review of the main topics addressed in these papers and the major results of the studies. In the interest of space, it is not possible to summarize all findings in these studies in detail.

[19] One may inform Z only about y rather than about (x,y) so that $\rho(y)\in\{0,1\}$, i.e., Z only learns what is offered to him or her.

[20] What early consistency tests (see the respective discussion in Güth, 1995) and the newspaper experiments reveal are different types of behavior: some participants would not accept their own offer, others accept nothing less than what they offer, and finally some offer more than what they minimally demand for themselves.

[21] Having groups decide in the role of proposers and responders, rather than individuals, has fueled team research in economics (Bornstein and Yaniv, 1998; Elbittar et al., 2011; a survey is provided by Kugler et al., 2012). For reasons of succinctness, we do not discuss those studies in detail.

5.1 Fairness perceptions and emotions

Although the ultimatum game is asymmetric by nature, one can further increase or decrease asymmetry by introducing asymmetry in conflict payoffs, outside options to be chosen or waved before playing the game, and asymmetries in information and communication possibilities (Güth et al., 2001; Falk et al., 2003; Schmitt, 2004; Wichardt et al., 2009; Conrads and Irlenbusch, 2013). Naturally, such asymmetries favor those who are advantaged and disfavor the players in the disadvantaged role. In Conrads and Irlenbusch (2013), the proposer can remain ignorant about the payoff of the responder. Indeed, the proposers benefit from such ignorance because responders accept almost every offer.

Norm and fairness perceptions trigger emotional arousal, when responders are confronted with an unfair offer. Grimm and Mengel (2011) use an ultimatum game to show that an exogenously imposed cooling-off period before deciding about acceptance or rejection has an effect on behavior. Such delay in decision making indeed reduces the proportion of rejected unfair offers. However, Tang et al. (2009), who let the delay be determined endogenously by the responders, observe that a self-inflicted delay, i.e., exerting self-control over one's immediate emotions, is rarely chosen voluntarily. The opposite, decision making under time pressure in the ultimatum game, has been studied by Sutter et al. (2003), with rejection rates of responders becoming significantly higher under a tight than under a very weak time constraint. However, the effect vanishes with repetition. Cappelletti et al. (2011) show that time pressure leads to an increase in offers, whereas inducing cognitive load on decision makers does not have a significant effect on behavior compared to the standard ultimatum game.

Other studies elicit fairness perceptions by additional independent tests or questionnaires (Carpenter, 2003; van Dijk et al., 2004), partly by differentiating which emotions and perceptions are actually activated when playing the game (Nelissen et al., 2009, 2010; Srivastava et al., 2009; van Dijke and de Cremer, 2011). Finally, the ultimatum game has been used to study fairness behavior after inducing incidental (i.e., unrelated) emotions before play (Harle and Sanfey, 2007; Bonini et al., 2011), after depleting the ego ressources of the decision makers (Halali et al., forthcoming), and even after sleep deprivation (Anderson and Dickinson, 2010).

5.2 Social comparisons and information on previous play

Social comparison has been studied in a wide range of games and paradigms in economic experiments. By providing and varying population feedback (Bohnet and Zeckhauser, 2004)

social comparison and its impact have been assessed in the context of the ultimatum game. Some studies add further players to the game (Alewell and Nicklisch, 2009) or introduce an uncertain pie size (Moran and Schweitzer, 2008); others go beyond interpersonal comparisons and focus on intrapersonal comparisons (Handgraaf et al., 2003) and even intergenerational naïve advice and learning (Schotter and Sopher, 2007). The general finding of most papers in this area is that social comparison matters in the sense that it influences decision making in the ultimatum game significantly. Additionally, Schotter and Sopher (2007) provide evidence that advice, and also knowledge of the history of the play of the game by others, sharpen up expectations, leading to a tighter distribution of offers.

5.3 Socio-demographic and individual determinants of play

While, on the one hand, it is not surprising that economists are keen on documenting socio-economic determinants of decision making in standard experimental games, it is nevertheless a bit surprising, on the other hand, that the issue of what are robust socio-economic determinants of behavior is far from being settled. Results with regard to age, gender, income and education effects are often inconclusive (recent contributions are, for instance, Saad and Gill, 2001; Eckel and Grossman, 2001; Solnick, 2001; Carpenter et al., 2005; Garcia-Gallego et al., 2012), especially if one takes a look at the overall picture over the last 30 years. Methodologically speaking, however, these results tend to become more and more reliable, with a steadily growing number of independent observations in single economic experiments, and especially with new methods such as newspaper experiments (Güth et al., 2003), incorporating experiments into large-scale or representative surveys (Bellemare et al., 2008; Exadaktylos et al., 2013), and internet experiments. Obviously, increasing numbers of observations within one consistent study are key for robustly assessing the impact of socio-demographics on economic behavior in the experimental laboratory.

Personal features of proposer and responder participants (such as names or other cues that modify social distance) also influence behavior in the ultimatum game in the predicted direction (Charness and Gneezy, 2008; Marchetti et al., 2011), and high-testosterone men reject low ultimatum offers (Burnham, 2007), as expected. Zak et al. (2009) administer testosterone and observe a significantly negative effect on offers. Emanuele et al. (2008) provide evidence for the relevance of serotonin: low platelet serotonin levels make people more likely to reject unfair ultimatum offers.

The issue of cultural influences on behavior in the ultimatum game has always been a hot research topic, but comparisons have been quite unsystematic, so far. Again large-scale

studies with an international component could be helpful in answering open questions. Another way forward is conducting meta studies. Oosterbeek et al. (2004) provide results based on 37 papers with 75 results from ultimatum game experiments. However, potential differences in behavior cannot really be explained along the lines of well-known cultural classifications. Chen and Tang (2009) compare ultimatum bargaining behavior of Tibetans and ethnic Han Chinese and find that Tibetans are more likely to accept offers than their Han Chinese counterparts. Ferraro and Cummings (2007) run ultimatum game experiments with Hispanics and Navajo subjects in the US and find differences in behavior. Even though the percentage of equal split offers is remarkable among Spanish gypsies (above 90%) in a study by Brañas-Garza (2006), responders are willing to accept low offers very often in their strategy vector ultimatum game.

The usefulness of the ultimatum game as a tool for understanding the economic behavior of small-scale societies has been demonstrated by Henrich (2000) and Henrich et al. (2001). It is used quite frequently in anthropology nowadays (e.g., Paciotti and Hadley, 2003; Bahry and Wilson, 2006).

Bargaining among members of different cultures is another aspect that can readily be studied in the context of the ultimatum bargaining game. For instance, Chuah et al. (2007, 2009) let Malaysian Chinese and UK subjects meet opponents of their own as well as of the other culture in an ultimatum game. Similarly, Boarini et al. (2009) let Indian and French subjects interact in an ultimatum game.

5.4 Stakes and entitlements

While stake size effects on proposer and responder behavior are generally small (for a complete overview of the early literature, see Camerer, 2003), Andersen et al. (2011), show that rejections go down with an increasing stake size.

Introducing bargaining over another “currency”, i.e., over waiting time, reinforces previous results from standard ultimatum bargaining experiments (Berger et al., 2012), and creating stronger entitlements over the money by introducing a real-effort task shapes behavior in the predicted ways (Garcia-Gallego et al., 2008), as already mentioned above (section 3).

5.5 Variation of the choice format

Much of the discussion concerning “hot play” versus “cold play” – methodologically speaking, the difference between the direct response method and the strategy (vector) method

in economic experiments (see also Brandts and Charness, 2011) – relied on evidence from the ultimatum game (Brosig et al., 2003; McLeish and Oxoby, 2004). The results are mixed, however, with a tendency of increasing rejection rates of unfair offers under the direct response method. Obviously, this is in line with explanations that take emotions into account. Comparing deliberate play and random moves, Bolton et al. (2005) use specific versions of a mini-ultimatum game to study the impact of procedural fairness versus allocation fairness.

An interesting and still not fully understood regularity in experiments using the strategy vector method are non-monotone acceptance thresholds. Interestingly, the phenomenon that advantageous offers above the equal split are rejected is very robust (see also section 3), although it is usually only a minority that exhibits such a behavior (Güth et al., 2003; Bahry and Wilson, 2006; Bellemare et al., 2008; Hennig-Schmidt et al., 2008). In order to be able to infer preferences from decisions in a more suitable way Andreoni et al. (2003) convexify the decisions in an ultimatum game. Their findings are in the ballpark of previous studies: Half of the subjects can be classified as money maximizers, half reveal a preference for fairness. Experimentally separating fairness concerns and failure to play the subgame perfect equilibrium – by comparing a tournament bargaining structure with control treatments in an ultimatum game setup – Andreoni and Blanchard (2006) find that fairness and imperfect learning are about equally important in shaping behavior.

Hoffman et al. (2000) use treatments that emphasize the interactive aspect of the game in the instructions for the proposers. Interestingly, there is a significant increase in proposals following the emphasis and not a decline as implied by the subgame perfect equilibrium of the game. Self-selection of interaction partners in the laboratory is rare. In the context of the ultimatum game, Holm and Engseld (2005) give proposers the chance to select their bargaining partners based on income and gender. Low-income responders and female responders are much more popular than high-income participants and males.

Finally, Bühren et al. (2012) introduce a competitive framing in mini-ultimatum games utilizing chess puzzles, and they use chess players as their participants. While offers do not respond to the treatment variation (competitive versus neutral), accepting low offers is more prevalent in the competitive framing.

5.6 (Pre-play) communication and messages

Similar to the use of the ultimatum game as a workhorse for studying social comparison, the game has also been used extensively in order to explore varying forms of communication and their impact on behavior rather systematically. Both “cheap talk” (Xiao and Houser, 2005;

Zultan, 2012) and potential deception over private information aspects in the game (Boles et al., 2000; Croson et al., 2003; Lusk and Hudson, 2004; Koning et al., 2011) have been analyzed. Examples for the first form are persuasion and non-binding requests (Rankin, 2003; Andersson et al., 2010).

Kriss et al. (forthcoming) compare explicit deception (lies about the pie size) and implicit deception (through actions) in an ultimatum game with asymmetric information on the pie size. Deception is very common in their study, and it is more prevalent when only explicit deception is available than when information is communicated implicitly.

5.7 Brain imaging data, genetics, and evolution

To our knowledge, Sanfey et al. (2003) were the first in scanning brain activity while showing the participants fair and unfair offers in the ultimatum game. Unfair offers led to activity in brain areas related to both emotional responses (anterior insula) and cognition (dorsolateral prefrontal cortex). A heightened activity in the anterior insula for rejected unfair offers seems to reinforce questionnaire results that stress the important role of emotions in the ultimatum game.[22]

Results from Wallace et al. (2007), based on a twin study, sparked the debate on the impact of nature and nurture on economic behavior. They find that more than 40% of the variation in subjects' rejection behavior in the ultimatum game can be explained by additive genetic effects. A somewhat similar general conclusion – i.e. that social preferences in the ultimatum game and related games are shaped by both prenatal and current biological factors – is provided in a study by Buser (2012), who uses digit ratios (2D:4D) and information on the menstrual cycle.[23]

Rand et al. (2003) employ stochastic evolutionary game theory, where agents make mistakes when judging the payoffs and strategies of others, to show that natural selection favors fairness. An experiment provides empirical support for their theoretical findings

6. What comes next?

What to expect in the future? Exploring take-it or leave-it offer bargaining by multi-dimensional proposals, as already attempted by the complex games in the original Güth et al.

[22] See also Boksem and De Cremer (2010).

[23] Further results on sex-hormone genes as well as a dopamine receptor gene and their association with bargaining in the ultimatum game are provided by Chew et al. (2013) and Zhong et al. (2010).

(1982) study, could be worthwhile when trying to disentangle how participants cognitively perceive such games and generate their decision behavior. Mostly, experimental researchers subscribe to the revealed preferences – more generally: motives – approach, meaning that they try to infer motives only from observed choice data. Doing so could be easier when the choice data are multi-dimensional.[24]

Social embedding of an ultimatum game matters. In the two-round alternating offer experiment of Güth and Tietz (1985, 1986), behavior in the second-period ultimatum (sub)game, reached after rejecting the first-round offer, was very different when this implied a 90%- (due to $p_2 = p_1/10$) or only a 10%-efficiency loss (due to $p_2 = 9p_1/10$). In the former case, participants were just trying to harm each other, whereas they behaved very similar as in usual (non-embedded) ultimatum experiments when the efficiency loss was minor. Similarly, the ultimatum game may be embedded socially, for example, by distinguishing an in-group and an out-group, varying the constellation of group origin. More specifically, both (proposers and responders) can come from the same group or both can come from different groups (see Zizzo, 2011, for a related study). Furthermore, being observed by an in-group or an out-group member while making a decision could be an interesting aspect for a study. Of course, it can be investigated with other games as well, although norm-guidedness renders such attempts especially interesting in the context of the ultimatum game.

Ultimatum bargaining with incomplete information could experience a revival. Whereas so far, asymmetric information was mainly assumed by letting only the proposer know the pie size (see Mitzkewitz and Nagel, 1993), it is also conceivable that the responder is better informed.[25] As in the theoretical analysis of Güth et al. (2004), one could, for instance, assume a sequential decision process in which, first, proposer X chooses x, i.e., what he demands for himself, and then the pie size $p \in \left[\underline{p}, \overline{p}\right]$ with $0 \le \underline{p} < \overline{p}$ is randomly chosen according to some positive density with carrier $\left[\underline{p}, \overline{p}\right]$, before, finally, Y learns about both, X's demand x and the pie size p. In the end, Y decides between $\delta(x, p) = 0$ and $\delta(x, p) = 1$, leading to payoffs $\delta(x, p)x$ for X and $\delta(x, p)(p - x)$ for Y.

[24] The data of principal-agent experiments allowing the principal to propose a multi-dimensional contract or to discriminate between heterogeneous agents who can react by (non-)acceptance or high and low effort levels may be seen as a continuation of such attempts.

[25] The „acquiring-a-company" game of Bazerman and Samuelson (1983) is a game in this class. The "buyer" does not know the value of the firm when proposing a price that the "seller", knowing the value of the firm, can accept or reject (see the related experiment of Dittrich et al., 2012).

When $x > \underline{p}$ is possible, one may be especially interested in cases $x > p$, for example, with $p - x$ negative and p rather large: will responder Y accept the minor loss $p - x$ to give the large amount x to X? The results of generosity game and envy game experiments suggest such responder generosity, especially when x does not exceed half of the expected pie size. On the other hand, suffering a monetary loss for the other's sake seems unlikely. Choosing a take-it or leave-it offer not knowing yet how much is available and what the other, i.e., the responder, will accept should render ultimatum bargaining not only more realistic but also more exciting.

As indicated above, the ultimatum game is just a special point, namely $(\alpha, \beta) = (0,0)$, in the unit square of α, β-bargaining games with payoffs $\delta(x,y)x + \alpha\left[1 - \delta(x,y)\right]x$ for X and $\delta(x,y)y + \beta\left[1 - \delta(x,y)\right]y$ for Y. Exploring the whole class $(\alpha, \beta) \in [0,1]x[0,1]$ rather systematically seems futile, although varying only α or only β for some (generic) value of the other parameter or of both like in Suleiman (1996) and Fellner and Güth (2003) can be interesting and might promote an awareness of how special the ultimatum game is. In experimental research, we rely often on special paradigms, for example symmetric games, rather than on generic ones which could approximate the degenerate paradigms when they are seen as especially interesting.

There are lots of conceivable methodological innovations that could advance our knowledge of bargaining based on the ultimatum game. We have already mentioned the potential advantage of large-scale studies. An internet experiment on the ultimatum game with thousands of participants would allow to address the impact of socio-demographic and socio-economic determinants of play. We are also not aware of studies that link laboratory bargaining behavior with field bargaining behavior. In general, field experiments on bargaining are very rare. Obviously, there is ample room for research.

It is also interesting to emphasize the interdisciplinary path that the ultimatum game has taken. We have only superficially sampled the literature outside of economics and psychology. It is noteworthy that at least an equal share of the scholarly contributions that use the ultimatum game as a workhorse in the last 14 years comes from non-economics journals. Many different disciplines and sub-disciplines have adopted the game as an important tool to

study fairness in bargaining. Its simplicity when implementing it makes it useful for a very versatile deployment in experimental research.[26]

7. Conclusion

In view of the already existing summary chapters in handbooks (for example, Roth, 1995) and textbooks on experimental economics (for example Camerer, 2003, Chaudhuri, 2009) and even meta-analyses of ultimatum studies (for example, Cooper and Dutcher, 2001), the focus of this paper has been the architecture of social interaction that can be captured by the ultimatum game and its modifications. We have also tried to provide a selective overview of research based on the ultimatum game that has been conducted after the turn of the century.

When performing the first ultimatum bargaining experiments, there was already a very active group of experimental researchers. Ultimatum bargaining has added to their existing research rather than starting from scratch. As being revealed by Güth (1976), ultimatum bargaining has been in the air even before actually being experimentally explored.

As far as we are concerned, observing that human decision makers are not only and mainly interested in own material success was not a big surprise but something that had to be expected. What could not easily be anticipated is how socially, motivationally, and emotionally rich already the very simple ultimatum game turned out to be. As a consequence, we still do not fully understand when and why we submit certain take-it or leave-it offers and how we react to them. In view of this, it has to be expected that the already impressive tradition of ultimatum bargaining research will continue in the future.

[26] We have provided a list of examples that is by far not exhaustive (for instance we did not discuss the power-to-take game experiments; see Bosman and van Winden, 2002; Bosman et al. 2005; Ben-Shakhar et al., 2007; Sutter et al., 2009; Reuben and van Winden, 2010; or stronger deviations from the standard setup such as the ultimatum reciprocity measure in Nicklisch and Wolff, 2012). Many more extensions are possible and have been implemented.

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