IN SMALL DECISIONS IT IS RATIONAL TO ACT LIKE BOPUNDED RATIONAL – AN ANSWER FOR RABIN AND BEHAIORAL ECONOMISTS

Uri Weiss*

In a state of the world in which there is computation cost, like in real life, in small enough decisions it is rational not to compute and act like bounded rational. Economic theorists do not take it into account and it may provide the answer for many propositions of Behavioral Economics, including this of Rabin. Rabin structures the situation, such that there is no computation cost, and then it is true that a rational agent, who rejects a lottery of [11, -10], will reject also a lottery of [∞, -100]. However, if we structure the situation of real life correctly and take into account computation cost, then a rational agent may not compute in the small lottery and hence may reject it. This behavior will be consistent with the Expected Utility Theory. Another conclusion from the above proposition is that the assumption of rationality of an agent could not be refuted by showing that in real life she sometimes makes mistakes in small enough decisions. Actually, if there is computation cost and in addition an agent will take the right decisions in probability 1 iff she computes, but there is no computation cost of the question: to compute or not to compute, the

* This working paper is written under the supervision of Prof. Robert J. Aumann, to whom my gratitude is dedicated for his help and support, gudience, encouragement, and advices that improved sginificantely every part of this paper. Special thank is dadcited to Itai Arieli. I also wish to thank Oren Bar Gil, Elchanan Ben Porat, Sergiu Hart, Michael Maschler, Inon Nir and Omri Yadlin for our conversations about and to the participants at the BGU and UCLA, Affect, Motivation and Decision Making Conference 2006. Of course, the responsibility for errors is mine.

assumption of her rationality may be refuted by showing that she always takes the right decisions.

1. Introduction

Aumann (2005) claims that a significant shortcoming of economic theory is that it fails to take the cost of calculation into account. In knowledge theory there is fundemental axiom of logical omniscience, which means that agents know everything that follow logically from anything that they know. I wish to follow up this proposition of Aumann and to think about the dynamic dimension of it. When do rational people compute? If we assume knowledge of the cost and benefit of the computation and that there is no computation cost of the question how much to compute, they will compute iff the benefit of the computation is bigger than the cost of it[1]. Thus, if the cost of computation is constant and the benefit is positively correlated with the size of the decision, rational people will behave differently in small decisions and in big decisions. In small enough decisions they will avoid from computing and act like bounded rational people, however in big enough decisions they will compute and act like rational people that have no computation cost. Thus, I think that the shortcoming that Aumann points out is very problematic in real life decision theory of small decisions, but much less problematic (and sometimes even not problematic) in real life decision theory of big decisions. In small enough decisions, models that fail to take into account computation cost will provide us different predictions from models that take computation cost into account. However, in big enough decision models that do not take computation cost into account will provide us same predictions as models that take it into account do, if we have binary

[1] I assume that there is a binary choice: to compute or not to compute.

choice between to compute or not to compute. It may challenge the productivity of experimental economics studies, including behavioral economics, to big enough decisions. It is so since experimental and behavioral economics usually study the conduct of human beings from experiments in small cash-money or in hypothetical questions, however in big decision people may behave differently than in small decisions, which means that in small enough decisions even rational agent will behave like bounded rational ones, whereas in big enough decision they will behave like rational ones. In addition, the proposition that in small enough decisions it is rational not to compute, but to act like bounded rational challenges the common understanding that we can refute the assumption that an agent is rational, by showing that she sometime makes errors, .i.e. takes wrong decisions. If those are small enough decisions, like the case in the lab experiments, we can explain her wrong decisions by saying that it is rational for her not to compute and then makes errors sometimes. It does not mean that the assumption that someone is rational becomes irrefutable assumption. I wish to claim that, surprisingly, if there is computation cost and in addition an agent will take the right decisions in probability 1 iff she computes, but there is no computation cost for the question: to compute or not to compute, the assumption of her rationality may be refuted by showing that she always takes the right decisions. It contradicts the current understanding of economist theorist; however it is consistent with the daily life experience. If someone never makes mistakes in small decision, such as her clothes are always absolute clean without any stain or wrinkle; we will not call him rational person, but obsessive one.

2. Motivation

Rabin (2000) has shown that a rational agent, who behaves according to Expected Utility Theory assumptions and rejects a lottery of 0.5*11+0.5*(-10) will also reject a lottery of 0.5*∞+0.5*(-100). Rabin (2000) claims that his theorem shows that expected utility theory is an utterly implausible explanation for appreciable risk aversion over modest stakes. In addition, Rabin and Thaler (2002) claim that because most people are *not* risk neutral over modest stakes, expected utility theory should be rejected by economists as a *descriptive* theory of decision making.

One answer for Rabin and Thaler is that Rabin has not examined empirically if people really reject those small lotteries. It is the way of Leroy (2003) to overcome this critic. Leroy claimed that it is not true that in real life people reject such small lotteries with positive expected value.

However, Ariel Rubinstein (2001) claims that Rabin's calibration relies on mental experiment and rings true without the need to be verified. Let us skip on this discussion and assume that it is true that in real life a significant number of people really reject small lotteries like [11, -10], and accept lotteries like [∞, -100]. If we accept this assumption, Rabin's proposition may challenge the applicability of the expected utility theory to real life.

In this paper I want to claim that in real life, in which there is computation cost, a rational agent, who acts according to the assumptions of the expected utility theory, may reject the small lottery of [11, 10], however takes the big lottery. That's so because of the computation cost. When an agent is proposed to take a lottery of [11, 10], it will be rational for her to avoid from bearing the computation cost, and then rejecting the lottery.

In addition, I wish to challenge the productivity of the conclusion of behavioral economics experiments in small money or hypothetical questions to big enough decisions and to challenge the belief that those studies may refute the proposition that human beings are rational by showing that the participants in the experiments in small money sometimes make mistake. I wish to provide a new answer for the question how the assumption of rationality may be refuted.

3. The Model

Computation – Co

The set of alternatives of the agent is [Co, ~Co]X[A, ~A]. The agent needs to choose first between [Co, ~Co], and then between [A, ~A].

The computation cost is c.

The agent has a utility function $U=f(c) + u(x)$: x {A, ~A}

U: R_+X{~A, A}

$U(Co) = \max\{u(A), u(\sim A)\} - f(c)$

$U(\sim Co) = (1-P)\max\{u(A), u(\sim A)\} + P*\min\{u(A), u(\sim A)\}$

$S = \max\{u(A), u(\sim A)\} - \min\{u(A), u(\sim A)\}$

A is the right decision regarding [A, ~A] iff $u(A)>u(\sim A)$. ~A is the right decision regarding [A, ~A] iff $u(\sim A)>u(A)$. A decision which is not the right decision (r) regarding [A, ~A] is a wrong decision (w) regarding [A, ~A].

Co implies right decision regarding [A, ~A].

~Co implies a probability of P to make the wrong decision regarding [A, ~A] and a probability of (1-P) to make the right decision.

u(r) - u(w) = S. (It is the size of the decision)

The agent knows the game. (and there is no computation cost of the question how to compute).

This means that

Hence,

The agent will choose Co and not ~Co iff U(Co)>U(~Co).

max{u(A), u(~A)} – f(c) > (1-P)max{u(A), u(~A)} + P*min{u(A), u(~A)}

- f(c) > - P* max{u(A), u(~A)} + P*min{u(A), u(~A)}

max{u(A), u(~A)} - min{u(A), u(~A)} > f(c)\P

S > f(c)\P.

Hence, the agent will compute, iff **S > f(c) /P**

The conclusion is that if we assume that P and c are uncorrelated with S, in this simple model there is a critical point **f(c)/P**, that if the decision is bigger than that (big enough decision) the agent will compute and if the decision is smaller than that (small enough decision), she will avoid from computing.

4. Discussion and Explanation

A rational agent will not bear the computation cost when the cost of the computation is bigger than the benefit of it. We have shown that the question if a rational agent will compute is a function of the size of the decision. When the size of the decision is also not negatively correlated with the probability to make the wrong decision in a case of absent of computation, and in addition the size is not positively correlated with the computation cost, the decision maker will compute (In our model there are only two options: to compute or to not compute) iff the decision is big enough.

I think that the insight that the computation is a function of the size of the decision provides also the answer for the paradox of Rabin and explains why agents behave differently in small decisions than in big decisions. The explanation for Rabin's paradox is the computation cost. In the paper of Rabin there is an assumption that there is no computation cost and in this state of the world the theorem of Rabin is absolutely true, however in real life there is computation cost. Hence, even if it is true that in real life people reject small lotteries with positive expected value, it does not implies the absurd results Rabin spoke about. This means, it is not true that in a state of the world in which there is computation cost, which is the case also in real life, a rejection of lottery of [11, -10] by a rational person implies a rejection of a lottery of [+∞, -100] by her. It is so since in small enough decisions it will be rational for a person not to compute and, for example, to act according to her finger rule of rejecting proposed lotteries. However, when the decision is big enough, the benefit of computation becomes much bigger, so it is rational for her to compute, what implies right decision, i.e. a decision which is consistent with her utility function.

The conclusion is that Rabin does not challenges the proposition that in a state of the world in which there is computation cost, like in real life, the expected utility theory is still a useful theory both as a descriptive theory and as a normative theory, if we structure the situation correctly. To structure the situation correctly means to take into account the computation cost. However, if we do not structure the situation correctly, which means that we do not take the computation cost into account (or alternatively if we think that the assumption of computation cost contradicts the classic expected utility theory), then regarding small decision, Rabin's proposition that the expected utility is not an applicable theory to real life is true and also clear. However, I say that it will be also a wrong normative theory, since it will lead to inefficient results. It will lead the agent to take the right decision regarding [A, ~A] in a probability 1, although it will not maximize her utility because of the computation cost.

However, what is the case regarding big enough decisions, if we do not structure the situation correctly, which means we do not take into account the computation cost? We have shown that in our model, which is a very simple and binary model, if the decision is big enough, which means if **S > f(c)/P**, then the agent will compute and always arrives to the right decision regarding [~A, A]. This means that even if we do not take into account the computation cost, the expected utility theory will be right both as descriptive and normative decision theory regarding the choice between [A, ~A].

Rabin just says that "the expected utility theory is manifestly not close to right explanation of risk attitudes over modest stake decision". However, Rabin does not tell us how much big the decision needs to be in order that the expected utility theory will be a good enough decision theory. He gives us a clue when he says: "Expected Utility Theory may well be a useful model of the taste for very-large-scale insurance". We may get the impression that he thinks that the expected utility theory is a good descriptive theory for only this size of decision. However, first, my model provides us the critical point in which the expected utility theory is a good descriptive theory even when we ignore the computation cost. It is when **S >f(c)/P**.

Second, I think that the conclusion of this formula is that even when the expected utility theory does not take into account the computation cost, it is still a good normative and descriptive theory in much smaller decisions than very-large-scale insurance, which means it describes many more situations of real life than Rabin thinks.

In addition, Rabin thinks that the right explanation for risk aversion in small decision is the loss aversion. However, I think that alternative explanation may be the computation cost - in small enough decisions it is inefficient to compute, and the avoiding from computing may lead to wrong decision regarding [A, ~A]. .I.e. in small enough decision in a state of the world in which there is computation cost, it is rational not to compute, which means to take a decision that a bounded rational agent does in a state of the world in which there is no computation cost.

In addition, it is important to emphasize that in my model the agent still maximizes expected utility and in addition may be sensitive to her the initial wealth, what is consistent with the common understanding of expected utility theory.

Furthermore, the behavioral economics points out some systematic cognitive failures that may lead to wrong decisions. However, even according to Kahneman one can handle with them by reformulating the question in some alternative ways. We can study from the proposition - that in small enough decisions it is rational not to compute and to behave like bounded rational one - that when the decision is small enough, it is irrational to bear the cost of reformulation, however when it is big enough it is rational to do it. The conclusion is that the Behavioral economics is much more attractive in describing small decision making than in describing big decision making.

In addition, the proposition that the choice: "to compute or not to compute" is a function of the size of the decision challenges the productivity of many studies of experimental economics, including behavioral economics. If it is an experiment in small cash money, we cannot conclude from it about the behavior of people in big decisions. Furthermore, Even models of Rational Choice, that take into account the computation cost, will lead to conclusion that agents will act like bounded rational regarding small enough decision, however not regarding big enough decisions. Hence, the applicability of a Rational Choice model to big enough real life decisions cannot be refuted by experiments in small cash money. Hence, I also think that the studies of Kanhman and Tverski have not refuted the Rational Choice or the "real life" expected utility theory, which means expected utility theory that takes into account computation cost, as descriptive theory. Actually, if we assume that in real life there is computation cost , but there is no computation cost of the question: to compute or not to compute (or alternatively that the it is irrational to have a rule of computing regarding such decisions) and that agents will make right decisions in probability 1 iff they compute; then the proposition that a person is rational, will not refuted by showing that she sometimes takes wrong decisions\ make mistakes in small enough decisions, but by showing that she never takes wrong decisions in small enough decisions. It is so since it shows that she always computes, even when it is inefficient to compute. It is also consistent with our daily life experience. When someone never makes mistakes in small decisions, such that his clothes are always perfect arranged, clean and ironed, or if he never forgets locking his door, we are not tend to call him rational one, but obsessed one.

Furthermore, the studies of experimental economics in small cash money or hypothetic questions, including behavioral economics, that contradicts the common Rational Choice models may be explained by the failing of those Rational Choice models to take into account the computation cost. They do not structure the situation of real life correctly. However, from the fact that those models, that fail to take into account the computation cost provide wrong predictions regarding small decision, we cannot conclude that those models will provide wrong predictions regarding big decisions. It is so since we have shown that the shortcoming of economic theory to fail to take into account computation cost is much more acute in structuring the situation of small decisions than in structuring the situation of big decisions. Actually, in our model in which there is an assumption of binary choice between to compute or not to compute, the shortcoming of failing to take into account the computation cost will not lead to wrong predictions on the choice of the agent between [A, ~A] in big enough decisions, .i.e. when **S > f(c)/P.**

However this shortcoming will lead to wrong predictions on the choice of the agent regarding [A, ~A], when the decision is small enough, .i.e. when **S <f(c)/P**

Another interesting counter-intuitive conclusion from the model is that it is not true that the bigger the probability to make mistake without computation is, the bigger probability to make mistake is. It is so since if P>c\S the risk neutral agent will compute what implies right decision, whereas if P<c\S the risk neutral agent will avoid form computation, what implies a probability of p to make mistake. This means that if the probability to make a mistake is small enough, the benefit of computation is such small that it is inefficient to compute, what increases the probability to make mistake. It is consistent with our experience: a person with good memory may avoid

from writing his appointments and forget them more than a person who has a bad memory and hence writes his appointments.

5. Conclusion

When there is knowledge of the computation cost and there is no computation cost of the question if to compute, a rational agent will compute iff the benefit of the computation is bigger than the cost of the computation. When the benefit of the computation is positive correlated with the size of the decision and uncorrelated with the cost of computation, the computation is positively correlated with the size of the decision. It means, that then in small enough decision it is rational not to compute, but to act like bounded rational. It is also the answer for Rabin: in a state of the world in which there is computation cost, it is not true anymore to say that a rejection of a lottery of [11, -10] by a rational agent who behaves according to expected utility theory assumptions, implies a rejection of a lottery of [∞, -100] by her. Hence, if we structure the situation of real life well, which means if we take into account the computation cost, then Rabin does not challenge the expected utility theory as a descriptive theory. In addition, we may explain the results of behavioral economics experiments, which have been done in small cash money by the proposition that in small enough decision it is rational to act like bounded rational one. Furthermore, it challenges the current understanding that we can refute the assumption that an agent is rational by showing that she sometimes takes wrong decisions. In small enough decisions a rational agent sometimes takes wrong decisions. Surprisingly, if there is computation cost and in addition an agent will take the right decisions in probability 1 iff she computes, but there is no computation cost of the question: to compute or not to compute, we can refute the assumption that an agent is rational by showing that she never takes the wrong decisions.

6. References

Aumann, Musings on Information and Knowledge," *Econ Journal Watch* (2005), pp. 88-96.

Kahneman and Tverski Choices, Values, and Frames. American Psychologist 39/4 (1984): 341-350.

Stephan Leroy, "Expected Utility: a Defense", *Economics Bulletin* vol 7, no. 7 pp. 1-3

Rabin, "Risk Aversion and Expected-Utility Theory: A Calibration Theorem," *Econometrica* 68(5), 1281-1292, September 2000

Rabin and Thaler, "anomalies, risk aversion" *journal of economics prespective* 15 (1), 2001, 219-232

Rabin and Thaler "'Defending Expected Utility Theory' -Response", *Journal of Economic Perspective*s, Spring 2002, 229-230

Rubinstein, "Comments on the Risk and Time Preferences in Economics." (2001)