



HAL
open science

From Normative Rationality to Cognitive Consistency

Louis Lévy-Garboua, Serge Blondel

► **To cite this version:**

Louis Lévy-Garboua, Serge Blondel. From Normative Rationality to Cognitive Consistency. 2000. halshs-03774097

HAL Id: halshs-03774097

<https://shs.hal.science/halshs-03774097v1>

Submitted on 12 Oct 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License



C
a
h
i
e
r
s

de
la

M
S
E

From Normative Rationality to Cognitive Consistency

Louis LÉVY-GARBOUA

Serge BLONDEL

2000.67



**From Normative Rationality
to Cognitive Consistency**

Louis Lévy-Garboua¹, TEAM
Serge Blondel², TEAM and INH

01 September 2000

¹ TEAM (CNRS et Université Paris 1)
106-112, bd. de l'Hôpital F75647 Paris Cedex 13 - France
Tel. (33) 1 44 07 82 45 llg@univ-paris1.fr

² Institut National d'Horticulture
2, rue Le Nôtre F49045 Angers Cedex - France
Tel. (33) 2 41 22 55 00 sblondel@angers.inra.fr

Abstract

Cognitive dissonance or cognitive consistency theory, as we understand it, does not presume irrational behavior although it is inconsistent with normative rationality. Previous discussions have overlooked that cognitive dissonance implied dynamic uncertainty. Once this dimension of choice is restored, it becomes obvious why normative rationality does not properly describe fully rational behavior. Aiming at cognitive consistency is then the optimal way to behave.

Résumé

La dissonance cognitive ou la théorie de la cohérence cognitive, telles que nous les voyons, ne supposent pas qu'un comportement est irrationnel, même s'il s'avère incohérent avec la rationalité normative. Les travaux précédents ont ignoré que la dissonance cognitive impliquait une incertitude dynamique. Une fois cette dimension du choix restaurée, il apparaît clairement que la rationalité normative ne décrit pas correctement un comportement complètement rationnel. Rechercher la cohérence cognitive devient alors le comportement optimal.

JEL Classification: C91, D81

Keywords: Cognitive dissonance, Dynamic uncertainty, Rationality

Mots-clés: Dissonance cognitive, Incertitude dynamique, rationalité

1. Introduction: rationality in economics and cognitive psychology

Modern economics describes rational behavior by a small set of axioms which ensure the logical consistency of choices. Von Neumann and Morgenstern (1947) pioneered this approach for choices under risk, with objective probabilities, and Savage (1954) extended it to choices under uncertainty, with subjective probabilities. The main achievement of the axiomatic approach is to allow the derivation, for each individual, of a unique ordered set of preferences, the expected utility (EU), which can be defined prior to knowing each particular choice set. Consequently, the decision-making process is seen by economists as irrelevant for determining rational choices.

By contrast, cognitive psychology has focused on decision-making procedures, information processing and the limitations of human mind. The definition of cognitive consistency which is most often mentioned is that an individual suffers from holding two opposite cognitions and will thus seek ways of reducing his cognitive dissonance. For instance, Festinger (1957)'s famous theory of cognitive dissonance states that a person confronted to a bad experience after having made a choice will be looking for justifications of his past decision and tend to ignore the dissonant information.

One consequence of economics and cognitive psychology having taken divergent paths is that, while these approaches have been opposed many times (see, for instance, Hogarth and Reder 1986, Smith 1991), few serious attempts have been made to bring them together into a common framework. In light of the greater mathematical rigor of economic analysis, the emerging consensus among researchers from various fields has been that normative rationality defines an ideal goal for rational behavior that will sometimes be beyond human reach for a number of benign reasons summarized by the concept of bounded rationality (small decision costs, use of approximate heuristics). Perhaps the most impenetrable line between economics and psychology lies in the economic postulate of given and known preferences to which psychology does not adhere. This has to do with what Simon (1976) labeled procedural rationality. We reformulate cognitive dissonance theory in this paper and show that it is inconsistent with normative rationality and implies dynamic uncertainty for the decision-maker. Because this dynamic uncertainty is invisible to the normative eye, it is wrongly inferred that cognitive dissonance implies irrational behavior. Instead, we argue that cognitive consistency is the adequate rationality concept under dynamic uncertainty because, with an appropriate definition of cognition, it reduces to the use of all available information. If we are prepared to

take these steps, it is possible to bring economics and cognitive psychology into a common framework for the purpose of decision theory.

Normative rationality and cognitive dissonance are first presented in sections 2 and 3. The theoretical implications of cognitive dissonance for rational behavior are then analyzed in section 4.

2. Normative rationality

The most comprehensive view of rationality is probably that a choice is rational if it is justified by a consistent set of reasons. At first sight, this broad definition of rationality is alien to the mathematical precision required by modern economics. But it turns out to be a surprisingly fertile exercise, because axioms of logical consistency obviously form a consistent set of reasons for justifying one's choice. A long time ago, Ramsey (1926) justified the transitivity of preferences by the immunization that it provides against the money pump danger. More recently, Sugden (1991) has provided a nice interpretation for the completeness of preferences, by saying that it ensures that no choice will be made without having reasons for it. For choices under uncertainty, the reduction of probabilities axiom, the independence axiom, or the sure thing principle may be viewed as elementary expressions of description and procedure invariance. The latter property is obviously a consistent reason for justifying one's choice without prior knowledge of the choice set. Under the veil of ignorance, rational individuals should consider the context of their future decisions and the presentation of their future objects of choice as irrelevant, by the principle of insufficient reason. We believe that this is what makes the EU axioms of Von Neumann-Morgenstern (1947) and Savage (1954) so intuitive and appealing.

But our analysis also demonstrates that the axioms defining description and procedure invariance essentially identify an individual's prior preference, i.e. the preference judgment which can be made by him prior to being aware of the particular problems and alternatives that he will face. Abstraction from the singularity of each decision characterizes the normative perspective, whether it applies to individual or to social choices. It is thus more accurate to speak of the individual preferences deriving from a set of axioms as normative preferences, and Savage (1954) himself recognized the normative character of his theory after his controversy with Allais (1953).

As a descriptive theory, the economic theory of choice maintains that the preferences revealed by observed choices and judgments always coincide with (or are closely approximated by) the normative preference. But, having described axioms of logical consistency as context or choice set-independent reasons for justifying one's choices, it becomes clear that axioms cannot describe all the potential reasons that can be invoked to justify any single decision ¹. Therefore, it is far from obvious that rational choices always coincide with normative preferences. One good reason for complying with one's normative preference is that the latter constitutes an individual norm, in the sense of being a prescription of behavior, which is given to the individual because all the information needed is gathered prior to the choice, and known to him because it is merely his own preference in a specific state of information. Although individual norms cannot be accompanied by social sanctions, their consistency requirement acts as a built-in sanction that a rational agent wishes to impose on himself. This was exactly Ramsey (1926)'s plea for transitivity. However, this is not a full-proof argument in favor of the normative preference in the presence of uncertainty because the consistency requirement is then constrained by a strong additional informational requirement. There are cases where it may be better to use more information (drawn from the context or the choice set) and give away logical consistency.

By postulating that the rational choice always coincide with the normative preference, normative rationality implies that the normative preference summarizes all available information, not only before proceeding to the choice, but also at the very time of choosing and revealing one's preference. Recent advances in the cognitive sciences (e.g. Dennett 1991) make it clear that this is in fact a strong assumption which overlooks the sequence of information in the brain and how individuals reason and treat such information.

3. Cognitive Dissonance

Cognitive dissonance theory is a theory of attitude change or, to speak like an economist, of preference change. The mere fact of being committed to one decision seems to trigger off a positive reevaluation of the chosen object and a negative reevaluation of unchosen objects. To get a flavor of the theory, let us borrow a nice example of this phenomenon from an early experiment of Jack Brehm (1956), reported by Aronson (1991: 186):

«Brehm showed each of several women eight different appliances (a toaster, an electric coffee maker, a sandwich grill, and the like) and asked that she rate them in terms of how attractive each appliance was to her. As a reward, each woman was told she could have one of the appliances as a gift and she was given a

choice between two of the products she had rated as being equally attractive. After she chose one, it was wrapped up and given to her. Several minutes later, she was asked to rate the products again. It was found that after receiving the product of her choice, each woman rated the attractiveness of that appliance somewhat higher and decreased the rating of the appliance she had a chance to own but rejected.»

Immediately after reporting this experiment, Aronson (1991: 186) provides the following explanation:

«Again, making a decision produces dissonance: Cognitions about any negative aspects of the preferred object are dissonant with having chosen it, and cognitions about the positive aspect of the unchosen object are dissonant with *not* having chosen it. To reduce dissonance, people cognitively spread apart the alternatives. That is, *after the decision*, the women in Brehm's study emphasized the positive attributes of the appliance they decided to own, while de-emphasizing its negative attributes; for the appliance they decided *not* to own, they emphasized its negative attributes and de-emphasized its positive attributes.»

From this account, we see that the psychologists who adopt cognitive dissonance theory tell a wholly different story about decision making than economists do. Economists like to describe decisions as originating from a stable normative preference

normative preference → decision

while psychologists stress the influence of decision making, including one's past decision of a similar kind, on revealed preference (attitude)

decision → revealed preference

The psychological view essentially recognizes that individual preferences may change over a very short time span. Since the preference changes which have been observed experimentally normally took place shortly after a decision was made, as for the Brehm's study, or even immediately after in some experiments, it is natural to think that, in the limit, we are just observing the revealed preference at the time of decision. What cognitive dissonance theory then implies is that decision-makers may shift from their prior preference to a different revealed preference at the time of decision. If we take the normative preference as the individual's prior preference, we come up with a simple interpretation of the psychological view: individuals may deviate from their normative preference by the end of the decision process after feeling cognitive dissonance, in an attempt to reduce such unpleasant feeling.

This is plainly inconsistent with the economic view since no changing revealed preference can maximize any one stable normative preference function. However, as pointed out by Akerlof and Dickens (1982), it cannot be simply dismissed by the economic profession because it is based on a lot of careful evidence. Furthermore, the revelation of many paradoxes to the conventional economic wisdom about rational behavior under uncertainty (Machina 1987) and

in seemingly riskless situations (Tversky and Kahneman 1991, Lévy-Garboua and Montmarquette 1996) brings a proof, or at least a very strong presumption, that normative rationality fails to provide a fair account of all observed behavior. In the sequel of this paper, we propose to take the evidence about cognitive dissonance seriously but to have a closer look at the theoretical implications of this phenomenon for rational behavior.

4. Cognitive Dissonance and Rational Behavior

We hope that our brief account of cognitive dissonance theory will convince economists that the latter brings an original contribution to the analysis of decision; but we are conscious that it first needs to be exposed in words that any economist will understand. This effort will turn out to be rewarding as it yields a radically new vision of cognitive dissonance and decision theory which is implied, not by normative rationality, but by a more general form of rationality, cognitive consistency or informational efficiency.

Let us begin this task by mentioning that psychology describes people, either making a new decision or considering to repeat a past decision, as capable of holding two cognitions, like two preferences or two probabilistic beliefs, that contradict each other. In this last sentence, the three words needing an explanation have been underlined. Cognitions are information states about the determinants of choice (prices, wealth, preferences, beliefs) which can best be summarized, for the need of exposition, by the individual's choices given this information. For instance, the normative preference is a potential cognition because it relates to an information state which is perfectly conceivable prior to the decision. The evidence mentally represented by one cognition may either take the form of a sure outcome (pure cognition) or a lottery (mixed cognition); and it may either take the form of simple evidence (e.g. one particular outcome has just been observed) or complex evidence which needs to be aggregated. It is further contended that several different cognitions can be held during the decision process. People who feel cognitive dissonance go at least through two information states and perceive two preferences, conditional on different informational states, which contradict each other. Although these two cognitions are supposed to be simultaneous in standard accounts of the theory, it is certainly more realistic to describe them sequentially as in search theory, with both perceptions probably following one another by milliseconds. This provides a natural method for aggregating all the evidence accumulated in the past into one prior cognition. So we are led to the view that decision-makers comparing two objects **A** and **B** generally perceive one preference first, say

for **A**, then perceive whatever objections they may find to their prior preference and in favor of **B**. But it is impossible that the first cognition «I choose **A**» and the second cognition «I reject **A**» both describe the true preference, if the latter is assumed to exist. Cognitive dissonance theory must imply that individuals in general do not know their true preferences and may change their decision or judgment over time after being exposed to dissonant cognitions. They must feel that they behave under dynamic uncertainty, with each simple cognition representing a random draw from one stable distribution. Consequently, they will be very sensitive to what they perceived, and will consistently weigh contradictory evidence in order to update their beliefs and resulting choices. They will have unambiguous temporary preferences at any time but will never know their true preferences with certainty (an early assessment of this view can be found in Lévy-Garboua 1979).

In trying to derive the theoretical implications of cognitive dissonance theory, we have come up with the sketch of an alternative to the normative theory of choice. The only assumption added by us reflects the emerging consensus within the cognitive sciences that people do not make one grand decision at some fixed place in the brain, but keep reassessing their immediate environment and their temporary preferences in search for valuable information which keeps arriving at various points in the brain (see Dennett 1991, and Damasio 1999, among others). This is a sequential and uninterrupted process. For the purpose of decision theory, situations of cognitive dissonance are especially interesting because they are necessary for causing preference reversals. If the two dissonant cognitions were perceived simultaneously, decision would appear to be a case of conflict resolution between two selves having systematically opposite preferences, like a good self and a bad self (Aronson 1991). Instead, when cognitions arrive sequentially in the brain, decision becomes the output of learning and information acquisition by one single self. In this new framework, cognitive dissonance will be reduced essentially by the sequential use of all available information.

One claim of this paper is that, when properly interpreted, cognitive dissonance theory is, or should be extended into, a descriptive theory of decision. But this was not originally the case. Festinger's (1957) seminal work was concerned with the reactions of one person confronted to a bad experience after having made a choice. Aronson's account of the theory (quoted in section 3) kept the same track. Both argued that cognitive dissonance was aroused by the contradiction between having made a choice – which ought to be good – and experiencing a bad outcome, and that it was typically resolved by ignoring the dissonant information and adjusting one's preference to one's past decision. In order to examine the welfare implications

of cognitive dissonance-reducing behavior, Akerlof and Dickens (1982) incorporated this psychological theory into the standard economic model. They assumed that individuals had the power to control their beliefs and choose the «best» one. Workers employed in dangerous jobs, for instance, were relieved from fear by underestimating the risk of accident. With a sufficiently low estimate for the latter (below the true risk anyway), they would both reduce the unpleasantness of cognitive dissonance («fear») and save the cost of purchasing safety equipment over and above the expected cost of making more mistakes through their intended departure from rational behavior. Can our personal account of cognitive dissonance also explain the influence of past decisions on currently revealed preferences? The answer is yes for a basic reason overlooked by previous models: Dynamic uncertainty. If preferences are drawn from a given stable stochastic process, the latter naturally relates current preferences with past preferences which summarize prior information. The greater is the precision of the prior relative to the news received after the choice was made, the more likely is the individual to stick to his past decision. It takes him a sufficiently bad surprise to reverse his prior decision (for a formal treatment of preference reversal in this framework, see Lévy-Garboua and Montmarquette 1996). In addition to providing a rational explanation for the cognitive dissonance phenomenon studied by Festinger (1957) and others, dynamic uncertainty radically alters its welfare implications. If individuals are bayesians, the inefficiency related to cognitive dissonance does not stem from the inertia of beliefs and preferences but from the inevitable presence of a background uncertainty.

The sequence of two opposite cognitions is clearly visible in some applications, like the bad surprise experienced after one choice. Unfortunately, it is less clear in many other examples found in the psychological literature, including the Brehm's experiment quoted in section 3. We shall attempt to make it clear in the canonical context of a comparison between two uncertain objects of choice. A neat example is provided by the comparison between two risky actions sharing common states of the world, each of which occurs with a given probability, because the two dissonant cognitions can then be characterized objectively. The simplest case, inspired by a well-known problem of Kahneman and Tversky (1979), compares one sure money gain S (e.g. win \$3000) with a bet like R (win \$4000 with probability .80, and nothing with probability .20). The payoff matrix is shown below.

State	1	2
Probability	.80	.20
S_1	\$3000	\$3000
R_1	\$4000	\$0

Consider this problem. According to the «certainty effect» (Kahneman and Tversky 1979) which has received a lot of experimental support, a large majority of subjects would choose the sure outcome , although the risky bet has a greater expected value (\$3200) than (\$3000). This behavior is inconsistent with the expected value criterion but it can be described by EU theory, taking risk aversion into account. According to EU rule, will be chosen if the utility of winning \$3000 is greater than 80% of the utility of winning \$4000 (the utility of winning nothing is always set to 0). Otherwise, will be chosen. Since cognitive dissonance should be able to explain why the choice deviates from the normative preference according to our interpretation, let us suppose that the utility is linear: a gain of \$X has a utility X. In this case, which makes computations easy, EU is equal to 3000 for and to 3200 for . The risky bet is selected by the normative preference. How can cognitive dissonance arise and possibly reverse the choice in favor of the sure outcome?

The answer is that having a normative preference does not suppress the risk of decision here because no option dominates the other. Consequently, the decision-maker is seeking more information. He wishes that some genie could tell him the gamble's outcome a few seconds before playing so that he always be able to choose the winning option. If he really had this opportunity, his expected gain would be $.80(4000) + .20(3000) = 3800$ instead of 3200. Therefore, he would be ready to pay the compensating variation $3800 - 3200 = 600$ to the genie, if the latter ever existed. This sum ² represents the value of perfect information and, equivalently (see Raiffa 1968, for instance), the expected opportunity loss of choosing according to the normative preference : $.20(3000 - 0) = 600$. The latter is obviously related to cognitive dissonance: it describes the dissonant cognition that, if one chooses , one faces the risk (with probability .20) of winning nothing and losing the opportunity to win 3000. In everyday language, a dissonant cognition aroused before the choice is made is called an objection to the prior preference. Doubt is the feeling of an objection to one's prior judgment, and it is unpleasant because it manifests a latent demand for information. It is experienced each

time no option dominates the other. Thus, after perceiving his own normative preference, the decision-maker in doubt will be looking for information and, in the process, automatically perceive the objection to the former. The objection is treated by the brain as an available message, which is obviously context or choice set-dependent so that the normative observer and the decision-maker are in a state of asymmetric information: the former cannot perceive what the latter does. What matters to a descriptive theory of choice is the decision maker's perspective. The individual doubting his normative preference reduces doubt (cognitive dissonance) by making use of all available information and legitimately treats the perceived objection as information. Whenever he finds this information valuable, he will make a choice that deviates from his normative preference; otherwise, he will discard the information and confirm the latter. A formal theory of cognitive consistency under risk and uncertainty explaining many well-known paradoxes and anomalies of EU theory can be found in Lévy-Garboua (1999) and it will not be pursued here.

The above discussion has suggested how a risk-neutral agent might prefer, in order to reduce cognitive dissonance, a sure gain to a great possibility of winning more money offering a higher expected gain. Kahneman and Tversky (1979) have shown that, while many persons were attracted by the certainty of a gain, quite as many were attracted by a great possibility of losing more money, offering a greater expected loss but a small chance to escape as well. For example, consider most people would prefer the bet (lose \$4000 with probability .80, and nothing with probability .20) to the sure loss (lose \$3000). These two options were obtained by mere «reflection» of and , converting gains into losses of an equal amount with the same probabilities. It is interesting to see how a risk-neutral agent attracted by a sure gain out of cognitive dissonance might as well wish to avoid a sure loss for the same reason. By reflection, the normative preference for converts into one for which minimizes the expected loss. However, doubt drives the individual, in his quest for information, to perceive the dissonant cognition that, if he chose , he would bear the risk (with probability .20) of losing \$3000 and missing the opportunity to lose nothing. With cognitive consistency theory, risk-neutral agents exhibiting the «certainty effect» would always exhibit the «reflection effect» as well ³. We believe that cognitive dissonance is a powerful tool for explaining anomalous behavior of this kind with simple and well-behaved utility functions (e.g. Blondel 1997).

It is time to explain the finding of Brehm's experiment quoted in section 3. Here again, the women were in a state of dynamic uncertainty because they were exposed to surprises in the course of the experiment. After she was asked to rate several appliances, each woman was

given a choice between two equally rated appliances as a reward to her participation and received the appliance she had chosen as a gift. As a matter of fact, when she was asked again, a few minutes later, to rate the two appliances among which she had to choose, she had been exposed sequentially to two cognitions: the prior rating (before knowing that she would receive her preferred appliance as a gift), and the later cognition that she had previously chosen or rejected the option. These two cognitions were consonant in the case of the chosen appliance, but they were dissonant in the case of the unchosen one since the two appliances initially had an equal rating. Since the final rating is a consistent estimate based on a sample of two observations (cognitions), the chosen appliance logically ended up with a higher value and the rejected appliance with a lower value. It is worth noting that this outcome is somewhat similar to the «endowment effect» exhibited by Thaler (1980) and others, the difference being that the gift received by subjects is exogenous in one case and endogenous in the other (Lévy-Garboua and Montmarquette (1996) explain the endowment effect in the same spirit).

The comparison of Brehm's experiment with the choice among two risky actions examined before brings two important lessons. First, it shows how dynamic uncertainty lies, invisibly to the normative eye, both behind a host of «riskless» situations (hence, we prefer to call them «seemingly riskless») and all situations of «static» risk without dominance. Second, we have found a case of cognitive consonance in Brehm's experiment, so that cognitive dissonance is too restrictive as a theory of decision and we are aiming at a more general theory of cognitive consistency rather than just cognitive dissonance.

5. Conclusion

Cognitive dissonance or cognitive consistency theory, as we understand it, does not presume irrational behavior although it is inconsistent with normative rationality. Previous discussions have overlooked that cognitive dissonance implied dynamic uncertainty. Once this dimension of choice is restored, it becomes obvious why normative rationality does not properly describe fully rational behavior. Aiming at cognitive consistency is then the optimal way to behave.

References

- Akerlof, George A., and Williams T. Dickens (1982), «The Economic Consequences of Cognitive Dissonance», *American Economic Review* 72: 307-319.
- Allais, Maurice (1953), «Le comportement de l'Homme rationnel devant le risque : critique des Postulats de l'École Américaine», *Econometrica* 21: 503-546.
- Aronson, Elliot (1991), *The Social Animal*, Stanford Cal., 6th ed., New York: W.H. Freeman & Company.
- Blondel, Serge (1997), «Testing Theories of Choice under Risk: From Normative Rationality to Cognitive Rationality», unpublished PD dissertation, University Paris 1 Panthéon-Sorbonne.
- Damasio, Antonio R. (1999), *The Feeling of What Happens. Body and Emotion in the Making of Consciousness*, New York: Harcourt Brace & Company.
- Dennett, Daniel C. (1991), *Consciousness Explained*, Boston: Little, Brown & Company.
- Festinger, Leon (1957), *A Theory of Cognitive Dissonance*, Stanford Cal., Stanford University Press.
- Hogarth Robin M., and Melvin W. Reder (1986), *Rational Choice: The Contrast Between Economics and Psychology*, Chicago: The University of Chicago Press.
- Kahneman, Daniel, and Amos Tversky (1979), «Prospect Theory: An Analysis of Decisions under Risk», *Econometrica* 47: 263-291.
- Lévy-Garboua, Louis (1979), «Perception and the Formation of Choice», in Lévy-Garboua L. (ed.), *Sociological Economics*: 97-121.
- Lévy-Garboua, Louis (1999), «Expected Utility and Cognitive Consistency», TEAM Working Paper 1999.104, University Paris 1 Panthéon-Sorbonne. The paper is available on <http://www.univ-paris1.fr/MSE/CahiersMSE>
- Lévy-Garboua, Louis, and Claude Montmarquette (1996), «Cognition in Seemingly Riskless Choices and Judgments», *Rationality and Society* 8: 167-185.
- Machina, Mark J. (1987), «Choice under Uncertainty: Problems Solved and Unsolved», *Economic perspectives* 1: 121-154.
- Raiffa, Howard (1968), *Decision Analysis*, Reading, Mass.: Addison-Wesley Pub. Co.
- Ramsey, Frank (1926), «Truth and Probability», in *The Foundations of Mathematics and Other Logical Essays*, Braithwaite R.B. (ed.), New York: Humanities Press, 1950 ; 1st ed.
- Savage, Leonard J. (1954), *The Foundations of Statistics*, New-York: Wiley.

- Shafir, Eldar, Simonson, Itamar, and Amos Tversky (1993), «Reason-based Choice», *Cognition* 49: 11-36.
- Simon, Herbert A. (1976), «From Substantive to Procedural rationality», in Spiro J.L. (ed.), *Method and Appraisal in Economics*, Cambridge: Cambridge University Press: 129-148.
- Smith, Vernon (1991), «Rational Choice: The Contrast Between Economics and Psychology», *Journal of Political Economy* 99: 877-897.
- Sugden, Robert (1991), «Rational Choice: A Survey of Contributions from Economics and Philosophy», *The Economic Journal* 101: 751-785.
- Thaler, Richard H. (1980), «Toward a Positive Theory of Consumer Choice», *Journal of Economic Behavior and Organization* 1: 39-60.
- Tversky, Amos, and Daniel Kahneman (1991), «Loss aversion in riskless choice: a reference-dependent model», *Quarterly Journal of Economics* 95: 1039-1061.
- Von Neumann, John, and Oskar Morgenstern (1947), *Theory of Games and Economic Behavior*, Princeton University Press, 2nd ed.

Notes

¹ Shafir et al. (1993: 34) have made a similar remark by suggesting that «the axioms of rational choice act as compelling arguments, or reasons, for making decision when their applicability has been detected, not as universal laws that constrain people's choices».

² The value of perfect information is directly expressed in money terms thanks to the assumption of risk neutrality.

³ Lévy-Garboua (1999) obtains perfect reflection under the risk-neutrality assumption. Non-linearity of the utility function would mitigate the «reflection effect».