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Current Emotion Research in Economics

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Current emotion research in economics

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Positive and negative feelings were central to the development of economics, especially in utility theory in classical economics. While neoclassical utility theory ignored feelings, behavioral economics more recently reintroduced feelings in utility theory. Beyond feelings, economic theorists use full-fledged specific emotions to explain behavior that otherwise could not be understood or they study emotions out of interest for the emotion itself. While some analyses display a strong overlap between psychological thinking and economic modelling, in most cases there is still a large gap between economic and psychological approaches to emotion research. Ways how to reduce this gap are discussed.

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Pleasure and pain are undoubtedly the
ultimate objects of the Calculus of Economics

W. Stanley Jevons (1871, 1957, p. 37)

Why would emotion researchers from other disciplines (e.g., psychology, philosophy, sociology) be interested in the way in which emotions are understood and studied in economics? What is there to be learned? To start with, it might be interesting to see that economists draw and learn a lot from psychology. What is characteristic to economic analysis, however, is the use of formal mathematical tools. In the process of formalizing psychological ideas about determinants of emotions, the contents of these ideas get shaped, become more precise, and/or are elaborated further. This yields new insights in these determinants, which may also be of interest to other disciplines than economics. Going one step further, almost any theoretical economic analysis comprises a description of the process of decision making. When these analyses are extended to allow for emotions, they also offer insights into the influence of emotions on the outcome of decision making – in addition to several other determinants of decisions.

We present an overview of emotion theories and research in economics, organized in three sections.[1] The first section addresses the role that feelings play in utility theories from classical economics, neoclassical economics, and behavioral economics. This historical digression allows us to better understand some of the current discussions in economic emotion research. The second section addresses the role that specific full-blown emotions, rather than mere feelings, play in economic analyses.[2] Finally, Section 3 focuses on the questions what economists can learn from emotion psychology, and what psychology and other disciplines can learn from emotional economics – the analysis of emotions in economics.

The Place of Feelings in Economics

The natural place to look for emotions in economic thinking is ‘utility theory'. Utility theory gives an account of the process of decision making, which requires a comparison of values of different objects. Walking through the history of utility theories in economics, we see that feelings sometimes have been ignored and sometimes incorporated: In classical economics, utility was clearly perceived as a measure of an individual's feelings. Neoclassical economics, by contrast, provides a framework that allows predicting human behavior without any reference to feelings. Behavioral economics, which can be considered as a renaissance of classical economics with more sophisticated research tools, provides interpretations of utility that again allow for the role of feelings.

[1] We restrict our survey to theoretical analyses in core journals of economics. The reader is referred to Wälde (2016) for a more comprehensive version, which also comprises references to psychological surveys of the role of emotions in decision making and for a more extensive treatment of the formal background.

[2] We follow psychology in considering feelings as one among several other components of emotions or emotional episodes (next to information processing, action tendencies, and expressive behavior).

Classical economics

The term utility was introduced into economics in 1776 by Adam Smith in his path-breaking book "The Wealth of Nations" (Stigler, 1950a, p. 307). It is defined as the "value in use" of a certain good, for example, the value of using a piece of furniture. This differs from the "value in exchange", which would be the price of the piece of furniture. It was left to Bentham (1789, 1970), however, to make utility a popular concept. He made the famous statement that "Nature has placed mankind under the governance of two sovereign masters, pain and pleasure" (p. 11). His analysis then continued with a discussion of various types of pleasures (e.g., from wealth, skill, power, expectation, and relief) and pains (e.g., of desire, disappointment, regret, and expectation). The importance of understanding feelings was expressed even more forcefully by Jevons (1871, 1957). He used the term utility "to denote the abstract quality whereby an object serves our purposes". This object is then said to "afford pleasure or ward off pain" to its user (both quotes from p. 38). Like Bentham, he considered pleasure and pain to be "the ultimate objects of the Calculus of Economics" (p. 37). This interpretation of utility as a feeling was shared by Edgeworth (1881, 1967, p. 67), who understood utility as a form of pleasure and the maximization of social welfare as achieving the "greatest possible happiness" (p.67).

Neoclassical economics

The introduction of the concept of utility into economics was accompanied by a discussion of how utility could be measured and whether it could be compared across individuals. Jevons (1871, 1957) strongly denied that utility could be measured, stating that "we can hardly form the conception of a unit of pleasure or pain" and that the idea of "quantities of feelings" is out of the question (Stigler, 1950a, p. 317). As a reaction to this difficulty, neoclassical economics developed theories of decision making that are free of any explicit discussion of feelings. We illustrate this by discussing three variants of neoclassical economic theories: the preference-based approach, the choice-based approach, and expected utility theory.

The preference-based approach

In the preference-based approach, human beings are described in terms of 'preference relationships', which expresses their tastes. Such a relationship could state for a certain individual that a consumption bundle x (e.g., 5 loafs of bread and 3 bowls of ice-cream) is "*at least as good*" as a consumption bundle y (e.g., 4 loafs of bread and 4 bowls of ice-cream). Symbolically, this is represented by $x \gtrsim y$. Any real-world individual would then be described by one preference relationship on a very large (if not infinite) number of consumption bundles. Under fairly general conditions, this preference relationship can be represented by the formula $u(x) \geq u(y)$, which states that utility from x is at least as large as utility from y. Based on the assumption that individuals want to maximize utility, predictions about human decision making are possible if we endow the individual with a certain amount of resources (labour income, capital income, wealth, valuable goods) and inform him/her about prices of the goods.

The standard interpretation of this approach does not allow any room for feelings. As Varian (1992) put it: "A utility function is often a very convenient way to describe preferences, but it should not be given any psychological interpretation" (p. 95). Yet, our intuitive understanding of "preferences", "tastes", and "at least as good as" do suggest that

feelings are involved. If I prefer ice cream to bread, this means that I have a more positive hedonic experience when eating the ice cream than when eating bread. Therefore, the preference approach is not in itself incompatible with an interpretation of preferences as involving feelings. Feelings could provide the psychological micro-foundation of economic preference relationships.

The choice-based approach

The choice-based approach (going back to Samuelson, 1947) puts forward the notion of "revealed preference relationships", with an emphasis on "revealed". The relationships for an individual would then state that a certain consumption bundle x is "revealed preferred" to a consumption bundle y (symbolically, this is often expressed as $x \succsim^* y$). The big difference with the preference-based approach is that the revealed preference relationship $\succsim^*$ is defined with respect to observables and not with respect to tastes of an individual: A consumption bundle x is "revealed preferred" to y if an individual chooses x and if both x and y are affordable by the individual. As Mas-Colell, Winston, and Green (1995) put it, a "theory of individual decision making need not be based on a process of introspection but can be given an entirely behavioral foundation". Some authors (Brandstätter, Güth, & Kliemt, 2007) argue that the choice-based approach to individual decision making in economics is the incarnation of positivism in the philosophy of science as is behaviorism in psychology, and that economics is now currently undergoing a cognitive revolution.

Expected utility theory

The models of decision making discussed so far are based on the assumption that we live in a deterministic world, as they do not refer to any potential source of uncertainty or risk. This limitation is overcome by expected utility theory, which can be considered as the standard economic decision model under risk today.[3] According to this version of utility theory, the "expected utility" of an action option equals the sum of the values of the possible outcomes of the action times the subjective likelihoods that the action will indeed lead to these outcomes. An individual faced with the decision between two action options calculates the expected utilities of both action options and chooses the action with the highest expected utility. Take an individual who has to decide between spending the next weekend outdoors or indoors, without having certainty about what the weather will be like, and hence whether his/her choice will lead to the desired outcome. This individual has to rely on the values of indoor and outdoor activities given each weather condition combined with the probabilities of these weather conditions.

Similar to the deterministic (preference-based and choice-based) utility models discussed above, the expected utility model as originally designed does not leave room for feelings. This neoclassical, feeling-free view of utility is the most widely held in economics, whether implicitly or explicitly. As Kahneman, Wakker, and Sarin (1997, p. 375) put it, "Utility is inferred from observed choices and is in turn used to explain these choices." There is no need to think about whether utility is a feeling, leave alone what type of feeling it is. It is a construct, which is not and even does not need to be observed.

[3] In economic decision theory, a distinction is drawn between *risk* (objective probabilities) and *uncertainty* (subjective probabilities; see Gilboa, 2009; Knight, 1921).

Behavioral economics

The neoclassical approach discussed in the previous section equates utility with overt choice, thus ignoring the distinction between what makes individuals truly happy and what they choose. As Gul and Pesendorfer (2008) put it, in "the standard approach, the term utility maximization and choice are synonymous". In other words, what an individual is observed to do is, by assumption, what maximizes his/her utility. This feature of the neoclassical approach has spurred alternative proposals, which go by the name of behavioral economics, to return to an interpretation of utility in terms of feelings. For instance, Loomes and Sudgen (1982, 1986) took utility to mean "experienced utility", thereby putting themselves in the tradition of classical economics again. For them, the utility function measures "the psychological experience of pleasure that is associated with the satisfaction of desire" (Loomes & Sugden, 1982, p. 807). From now on, we use the term experienced utility to refer to the type of utility that does not only depend on observable choices but also on subjective feelings and/or values. Note that the analyses in the section "Emotions in economics" all adopt an experienced utility view.

Kahneman et al. (1997) took the proposal of Loomes and Sudgen (1986) one step further by splitting utility into decision utility and experienced utility and by arguing that both types usually fall apart in reality and must therefore be treated as different objects in theory. Decision utility is inferred from the overt choices that people make. Experienced utility is itself again split into three subtypes: (a) instant utility, which results from the outcome of a decision (e.g., consumption, health, and social status), (b) remembered utility, which an individual recalls (potentially in a biased way) from past outcomes, and (c) predicted instant utility, which is anticipated by the individual.

One important challenge to the neoclassical utility theory by behavioral approaches is the use of non-choice data. While the use of self-report and physiological data to measure subjective well-being is standard in psychology, this is traditionally not so in economics. However, in one area of behavioral economics, namely happiness research, the measurement of subjective well-being (in the spirit of Clark, Diener, Yannis, & Lucas, 2008; Diener, Suh, Lucas, & Smith 1999) is common. Economists working in this field asked whether average happiness in society rises over time, and found that it does not, even when countries become richer (Easterlin, 1974, 2001; Stevenson & Wolfers, 2008). This was dubbed the Easterlin paradox. Economists also asked whether unemployed workers are more or less happy than employed workers. Choice-based approaches reasoned that given that unemployed people choose not to work, they must attach a higher utility to not working than to working. Yet there is abundant evidence that unemployed workers report lower happiness values than employed workers, even when the differences in income and other socio-economic factors are taken into account (Clark and Oswald, 1994, Di Tella, MacCulloch, and Oswald, 2001, Ohtake, 2012). This suggests that unemployed workers would rather like to work and that at least a part of their current status is due to factors outside of their choice.

One final extension in behavioral economics worth mentioning is that utility can be construed as not only depending on one's own consumption but also on the consumption of others. This extension allows an explanation of altruism and envy within a utility framework (see Becker, 1976; Rabin, 1993; Fehr & Schmidt, 1999). If we denote utility of individual A by u^A, then her utility would be given by $u^A=u(c^A,c^B)$, where c^A is consumption of A and c^B is consumption of an individual B (which could also stand for a large group of individuals). The utility function u(.) would rise in both arguments such that one could meaningfully talk about altruism of individual A with respect to individual B. If utility rises in c^A but falls in c^B, one could talk about envy of individual A with respect to individual B. More elaborate versions of

this idea can be found in Rabin's (1993) and Fehr and Schmidt's (1999) treatments of fairness. These economic analyses of altruism and fairness are not in the first place about trying to understand the underlying feelings but more about the effects of altruism and fairness on behavior. The same seems to be true for the literature on reciprocity (Sobel, 2005). Reciprocal behavior could have an intrinsically high value (the individual likes reciprocal behavior per se) or it could be instrumental (the individual behaves reciprocal as he/she expects a return).

Emotions in Economics

We now look at the role of full-blown specific emotions in economic analyses. This section distinguishes between (a) ex-ante or anticipatory emotions, which occur at the moment of the decision making and *before* the outcome is revealed (e.g., fear of a negative outcome, desire or hope of a positive outcome) and (b) ex-post emotions, which occur *after* the decision is taken and when the outcome is revealed. If future ex-post emotions are anticipated at the moment of the decision making, they are called anticip*ated* emotions. In addition to studying the quality of emotions, some economic researchers also study the intensity of emotions, and the evolution of this intensity over time.

Economic emotion models deliver two types of knowledge. First, they provide an account of the origins or determinants of specific emotions, borrowing frequently from psychological insights. The formal analysis that is typically undertaken in economic analysis, however, further details and shapes these insights. Second, economic models provide an account of how specific emotions influence utility and hence the outcome of the decision making process. In other words, they take emotions as one among several determinants of decisions. Both types of knowledge will be illustrated in the treatment of ex-ante and ex-post emotions and in the research on the dynamics of emotions.

Ex-ante emotions

Ex-ante emotions or anticipatory emotions occur at the moment of decision making and are caused by the current anticipation of an uncertain event that will take place at a future point in time. Illustrations include an individual who needs to go to a doctor for a diagnosis, an investor considering the acquisition of a large stock of risky assets, or a child looking forward to her birthday. We consider models that have analysed the ex-ante emotions of anxiety and craving vs. disgust. In the economic literature, some models are static while others use an explicit dynamic framework (i.e., which includes different time points). Our discussion of anxiety is dynamic, whereas our illustration of craving vs. disgust neglects dynamic aspects.

Anxiety

An explicit model of ex-ante emotions, in particular anxiety, was developed by Caplin and Leahy (2001).[4] Think of an investor who, for simplicity, lives for two time periods only, t and t+1. He makes an investment at time t and, at time t+1, he receives an interest rate or return, denoted by r_{t+1}. This return is uncertain at time t. The return can take any value and a simple example would be values of -1% in the bad case and +1% in the good case. The investor owns a certain amount of wealth w_t in t (say 1000 EUR) which he can split between consumption c_t and the investment i_t. In period t+1, his consumption level amounts to the

[4] For earlier work on 'savouring' and 'dread' in a world without uncertainty, see Loewenstein (1987). To see how much more theoretical work is needed to account for empirical findings, see Harris (2010).

original investment plus the interest payments on it, $c_{t+1} = i_t + r_{t+1}\, i_t$. Imagine his optimal decision implies investment of 300 EUR (and therefore consumption c_t of 700 EUR in the first period). Then his/her consumption level c_{t+1} in t+1 equals 300+3 EUR in the good case when the interest rate is +1% or 300-3 EUR in the bad case when the interest rate is -1%.

To understand the decision process of the investor, we need to describe his preferences. The investor values consumption and experiences anticipatory emotions. Instantaneous utility in the first period t is a function u(.) of consumption c_t and the emotion a_t. Instantaneous utility in t is therefore written as $u(c_t,a_t)$. In period t+1, the investor has the same utility function u(.) but there is nothing to be anticipated (as life is over at the end of t+1). Instantaneous utility in t+1 is therefore $u(c_{t+1},0)$. Anticipatory emotions arise as the interest rate r_{t+1} is uncertain. Caplin and Leahy (2001) specify the anticipatory emotion as anxiety. Anxiety is assumed to rise in the variance of the interest rate and to fall in its mean: The more there is uncertainty, the more the investor is "anxious" that the interest rate may differ from its expected value. At the same time, however, when the expected value of the interest rate rises, anxiety falls. Imagine that the variance is constant but some marvelous mechanism can increase the average interest rate. It seems plausible that this would make an investor less anxious about the outcome of the investment. If the average interest rate is large enough, (negative) anxiety could turn into (positive) suspense.

When we specify a certain functional form for the utility function and anxiety, we can compute optimal investment levels i_t. Optimal investment is a function of the following determinants: preference and personality parameters, the expected interest rate, its variance, and – the new feature of this setup – anxiety. Such a framework predicts (at least) two relationships: (1) The more an individual is worried about the variance of the return and the less this worry reduces in the average return, the less the individual will invest. Why? Worrying a lot about the outcomes of an investment creates a lot of negative feelings with respect to investments. The optimal reaction is therefore to reduce investments. (2) The predictions become richer when we consider the degree to which anxiety matters to an individual relative to the utility he/she can gain from consumption. We predict that an emotional individual (for whom anxiety matters more) will save less only if he/she worries enough. In other words, there is a dependency of the emotion effect on the worry effect: An emotional individual could save more if he/she worries less.

Craving vs disgust

Laibson (2001) proposed an analysis of consumption behavior that is driven by habits, which in turn are developed through cues and subsequent rewards. As an example, think of an individual walking through the streets and the many advertisements he/she encounters for drugs such as cigarettes. These cues can induce strong desires for consuming this drug. Craving for a drug can then simply be understood as high marginal utility from the drug.

To see this most clearly, consider an individual who in principle enjoys drugs and food. Following Laibson (2001), the essential aspect of the decision problem can be described by a utility function that reads $u=(c^{drug}-x)^{\alpha}\,(c^{food})^{1-\alpha}$. Consumption of drugs is denoted by c^{drug}, consumption of food by c^{food}, and both variables are assumed to take on a positive value. The parameter x denotes a cue (an advertisement for cigarettes), which is positive but not as large as the consumption itself (c^{drug}). The individual's preference for the drug is captured by a preference parameter α which satisfies $0<\alpha<1$. When the individual can use a certain amount of money to buy drugs and food, s/he would consume an optimal amount of both drugs and food of which the exact quantity depends on the preference parameter α, the cue x and the prices of drugs and food.

Now imagine the cue becomes more positive, that is, x rises (but still remains below c^{drug}). Then, marginal utility from consuming drugs rises, meaning that the increase in utility resulting from an increase in drug consumption rises. This can be seen as a formal translation of strong desire or craving. The more intense the cue, the higher the increase in utility from drugs. As a consequence, drug consumption rises. In an extreme case, the individual will stop consuming any food and use all of his/ her money for drug consumption.

By simply reversing the valence of the cue x in the same utility function u, one can use this framework to also understand disgust or horror (i.e., the opposite of craving). Suppose that the cue encountered by the person would be a warning message on tobacco packaging instead of an advertisement praising the good. Given the same utility function as above, when the cue x is sufficiently *negative* (the warning message is sufficiently explicit), an individual might actually choose not to consume drugs at all. If cues are negative enough, marginal utility from drugs becomes very small (the more x approaches minus infinity, the closer marginal utility from cigarettes lies to zero). This very small increase in utility from an additional unit of consumption could be called disgust or even horror. One and the same structure (the utility function u) can therefore illustrate the link between emotion concepts of opposite meaning by simply varying the sign of the cue x.

Ex-post emotions

Ex-post emotions occur after the decision has been taken and the outcome of the decision is revealed. Illustrations include the outcome of a medical exam, of getting married, or of accepting a new job. We consider models that have analysed the ex-post emotions of regret vs. rejoicing, and disappointment vs. elation.

Regret vs. rejoicing

In Loomes and Sugden (1982), experienced utility of the individual resulting from a choice does not only include utility from the choice per se (as standard neoclassical economics would have it) but also regret or rejoicing relative to the alternative. Imagine an individual who can spend holidays in Italy (option 1) or in France (option 2). If she decides to go to Italy but, once she arrives, there is more sun in France (which is the alternative), she would regret the choice. If there is more sun in Italy than in France, she would rejoice. To formulate this idea a bit more precisely, assume the weather in Italy and France can be rainy, cloudy, or sunny. The world can therefore be in 3x3=9 states j (see Figure 1).

Italy\France	Rainy	Cloudy	Sunny
Rainy	1	2	3
Cloudy	4	5	6
Sunny	7	8	9

Figure 1: The states j of the world with Italian weathers in the rows and French weathers in the columns

When we simplify Loomes and Sugden's (1982) approach as much as possible without losing the essential points, we denote utility for the individual that chose option 1 and the state of the world being j by $u(c_{1j},c_{2j})=c_{1j}+R(c_{1j}-c_{2j})$. Utility from the choice of option 1 in state j is represented by c_{1j}, utility from the choice of the alternative option 2 in state j is c_{2j}, and $R(c_{1j}-c_{2j})$ measures regret or rejoicing. It would make sense to assume that (a) there is neither regret nor rejoicing ($R(c_{1j}-c_{2j})=0$) for states 1, 5, and 9, (b) rejoicing ($R(c_{1j}-c_{2j})>0$) for states 4, 7, and 8, and (c) regret ($R(c_{1j}-c_{2j})<0$) for states 2, 3, and 6.

When the individual makes a choice about where to go on holiday, the state j of the world is unknown. She therefore has to base her decision on the expected utility from both options. The expected utility $U_{1,2}$ from option 1 is given by the sum of the utilities in a given state of the world weighted by the probability p_j that this state will actually realize,

$$U_{1,2} = \sum_{j=1}^{9} p_j u(c_{1j}, c_{2j}).$$

The expected utility $U_{2,1}$ from option 2 is then expressed in perfect analogy. When considering going to France, the alternative is Italy (option 1). Utility in state j of the world when having chosen option 2 is $u(c_{2j},c_{1j})=c_{2j}+R(c_{2j}-c_{1j})$. Here, there would be regret (for states 4, 7, and 8) or rejoicing (in states 2, 3, and 6) in exactly the opposite way as described above for the choice of Italy. The expected utility is then given by

$$U_{2,1} = \sum_{j=1}^{9} p_j u(c_{2j}, c_{1j}).$$

It is interesting to note that even though individuals are assumed to maximize expected utility, this is *not* an example of expected utility theory as defined previously. Utility here depends not only on the utility c_{ij} from the actual choice but also on the hypothetical utility that the alternative choice would have provided.

When the individual makes a decision where to spend holidays, this decision is based on both expected utilities. An individual will go to Italy (i.e., prefers option 1 over option 2), whenever the expected utility from Italy is larger than the expected utility from France (i.e., whenever $U_{1,2}>U_{2,1}$).

The setup implies that standard, non-emotional decision making is a special case of this setup. When one assumes that $R(c_{1j}-c_{2j})=R(c_{2j}-c_{1j})=0$ for all states, a person's holiday choices only depend on utility c_{1j} and c_{2j} from option 1 and 2 in state j. Individuals would not compare after the decision is taken and would just experience a certain utility level from the current weather conditions wherever they ended up spending their holidays. One can easily imagine that allowing for emotions via the function R has a strong impact on predictions about choices.

Disappointment vs. elation

In their study on disappointment and elation, Loomes and Sugden (1986) again focus on ex-post emotions that result from the match or mismatch between the outcome of a choice and some reference point. While the reference point in the cases of regret and rejoicing was the hypothetical utility of an alternative option (e.g., going to Italy), here the reference point is the expected utility from the option chosen (e.g., going to France). An individual is disappointed if the actual utility is lower than the expected utility (e.g., when it rains) and elated when the actual utility is higher than the expected utility (e.g., when there is sun).

An alternative approach to disappointment is proposed by Gul (1991). Like Loomes and Sugden (1986), Gul (1991) also defines elation relative to some reference point. But while the reference point for Loomen and Sugden (1986) was expected utility of c_1 and c_2, for

Gul (1991) it is the so-called "certainty equivalent" of the uncertain choice.[5] Take again the holiday choice between Italy and France under uncertainty discussed above. If the outcome (weather condition) is better than the certainty equivalent, the individual is elated; if not, the individual is disappointed. While Loomes and Sugden (1986) write down a convincing and intuitively plausible form, Gul (1991) derives the utility function from various axioms that remain as close as possible to axioms of expected utility theory.

The dynamics of emotions

Emotions in economics traditionally have been modelled as something instantaneous. When there is an uncertain event in the future, there is an emotion of anxiety or suspense. When the event in the future is taken away (e.g., the exam is canceled), the emotion is gone. When the individual experiences a negative outcome (e.g., a bad mark on an exam), there is disappointment, but when the negative outcome is taken away (e.g., the mark is corrected), disappointment is gone. There is a lot of evidence, however, that emotions sometimes only gradually build up while at other times they build up very quickly (see Heylen et al., 2015, for the case of anger).

In a recent model of the dynamics of stress, Wälde (2015) studied the pattern of a slow increase and a slow decline of emotions. In the presence of a stressor, stress gradually builds up. When the stressor is taken away, subjectively felt stress only gradually falls. Sometimes it takes an entire weekend to recover from a stressful week at work—or an entire week to recover from a stressful weekend. This explicit dynamic structure offers a formal background for understanding cross-over of emotions from work to the private domain and also spill-over processes of emotions onto partners (Bakker & Demerouti, 2012).[6]

Why Emotional Economics is Useful

For economics

Economic theory advances by taking emotions into account. Including emotions (or the mechanisms leading to them) as additional determinants of decision making can improve the predictive power of existing economic decision models. Kahneman and Tversky (1979) forcefully argued that observed choice behavior presents many violations to fundamental axioms of expected utility theory. To accommodate these violations, Loomes and Sugden (1982) developed a theory of decision making that is descriptively more successful in explaining observed human behavior than standard expected utility models. The motivation for Gul (1991) was similar: Behavior observed in experiments departed in a systematic way (giving rise to the so-called Allais paradox) from central axioms of expected utility theory (the independence axiom). Gul posed the question of how this axiom could be relaxed to account for this violation and how to make predicted behavior consistent with the Allais paradox.

[5] The certainty equivalent c of a random outcome x yields the same utility u(.) as expected utility from the random outcome, u(c)=Eu(x). As an example, imagine you have to choose between a certain amount of money (e.g., 30 EUR) and a lottery ticket (e.g., 60% chance of winning 100 EUR and 40% chance of winning 20 EUR). If you are indifferent between the certain amount of 30 EUR and the lottery ticket, then the 30 EUR is the certainty equivalent of the lottery ticket.

[6] There is a large field of emotion research based on "psychological game theory" (Geanakoplos, Pearce, & Stacchetti, 1989). It studies emotions depending on other people's presumed emotions and beliefs, such as feeling guilty when disappointing a person that trusts in one's behavior. Immediate emotions and visceral factors are analysed by Loewenstein (2000). See Wälde (2016) for a more extensive treatment of these issues.

For psychology

Is emotional economics useful for advancing psychological understanding of emotions? We think formal mathematical analyses in economics can further refine and elaborate ideas from psychology. In doing so, emotional economics also points out further determinants of emotions. Finally, economic theories provide detailed hypotheses about how emotions and other determinants influence decision making and behavior in general. These hypotheses can be taken as a source of inspiration for psychologists interested in how appraisal or information processing more broadly understood translates into action tendencies and actions.

Determinants of emotions

The first objective of economic theorists who included emotions as one type of determinant of decision making was not to understand specific emotions per se but to understand the effects of emotions on decision making. This brought them to a decision theory that is descriptively more successful in explaining observed human behavior than standard expected utility models. Whether these authors also had an intention to come up with a model that describes emotions or whether a formal analysis eventually revealed a structure that could be given an intuitive interpretation by using emotion concepts can only be answered by the authors. Whatever the intention, the outcome of these analyses is a fascinatingly simple and elegant characterization of emotion concepts: In the models of Loomes and Sugden (1986) and Gul (1991), regret, rejoicing, elation, and disappointment are all characterized in terms of some reference point. In the model of Caplin and Leahy (2001), anxiety is characterized by properties of uncertain consumption (its mean and the variance), which in turn result from uncertain investment. As consumption also depends on an individual's other income sources (apart from this specific investment), broader personal considerations beyond personality measures (like, for example, wage income, wealth or family status) could be taken into account as determinants of anticipatory emotions.

From determinants to behavior

Economic models are also very precise on the type of influence that determinants have on behavior. Is there a linear relationship or is it non-linear or even non-monotonic? Do changes in determinants have an immediate impact or does it take some time before the impact on behavior is observable? Do determinants reinforce or dampen each other? These and other properties of determinants should also provide new testable theoretical predictions interesting for psychologists.

Economic theory has a tendency to reformulate any type of behavior as the outcome of a decision process (or the solution to a decision problem). This idea can also be applied to emotion regulation. In Wälde's (2015) stress model, for example, the stressed individual follows a precise decision rule that makes her choose coping strategies in a systematic way. Gross (2008, p. 505) wrote: "one intriguing puzzle is why people use one emotion regulation strategy rather than another". The answer would be that personal costs and benefits induce an individual to decide in one way or another. Such a framework allows to understand, for instance, why some people predominantly use a problem-focused and others use an emotion-focused strategy to cope with stress (Lazarus, 1991), or why some people choose to assimilate (continue goal striving) whereas others choose to accommodate (goal adjustment; Brandstädter & Rothermund, 2002).

But the idea that any type of behavior can be reformulated as the result of a decision process can also be applied to initial emotional action tendencies and actions (see Bushman & Anderson, 2001; Eder & Rothermund, 2013; Moors, Boddez, & De Houwer, 2016). For instance, the tendency to flee characteristic of fear can be considered as the result of a decision between fight and flight.

Mathematical analysis

As mentioned earlier, the advances that economics can bring to other disciplines reside within the fact that it relies heavily on mathematical analysis. Looking at disciplines other than economics, one of the leading proponents of behavioral economic theory argues that theories developed in most social sciences are what could be called "imprecise theories" (all quotes in this paragraph are from Rabin, 2013). Undertaking emotion research following a formal approach would therefore follow "a desire to expose how <existing views> are wrong" or, to put it a bit more positively, to work out what existing views actually mean. As long as models of emotion lack mathematical rigor and precision, it is "just harder to identify flaws". Translating standard psychological views into an otherwise mainstream economic model allows us to "see their limits that can guide us in further improvements".

As an illustration, emotional economics could provide a formal analysis of Bechara and Damasio's (2005) somatic marker hypothesis. An emotion according to their definition is "a collection of changes in body and brain states" (p. 339). Once a cue is perceived, the body reacts accordingly: There are "changes in internal milieu and viscera" or "changes in the musculoskeletal system" (p. 339). When x (and potentially further variables) in the utility function $u=(c^{sweets}-x)^{\alpha}(c^{fruit})^{1-\alpha}$ from above represents the state of the body (and changes in this variable then change the state of the body), such a theory would provide an immediate and very precise link between body states and observable behavior.

Conclusion

Economists have always been interested in emotions. This is true for the early times of economics when utility was taken to describe feelings of individuals about pleasure and pain. This is true for current research in behavioral economics that uses empirical measures of happiness based on questionnaires or on diary methods to quantify utility as used in theoretical analyses. And it is also true for various detailed studies of emotions (e.g., regret, rejoicing, craving, stress, anxiety, suspense, trust, and guilt) and their effect on decision making.

From the articles surveyed here, it seems true that psychological emotion research has a strong impact on economic analyses of emotions. Many researchers cite psychological evidence to motivate their formal modelling. Economics gains a lot from this transfer of knowledge as certain behavioral regularities that could not be explained by standard economic models can be understood when emotions are taken into account. This economic research on emotions is also potentially valuable for psychologists. An economic analysis is called theoretical only when it is based on a mathematical model. Economic theory therefore is very stringent in making predictions and the underlying assumptions. This precision should bring a lot of potential for refining psychological theory. Hopefully this will be the case in the future.

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