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Time and the analysis of economic decision making[1]

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Abstract
Economics is concerned, to a considerable extent, with explaining real economic behavior. And real economic behavior is generated by the making of real economic decisions. Both real economic behavior and real economic decision making occur in real time. How real time is represented, indeed if it appears explicitly at all, reflects significantly on the realism and relevance of the explanation produced by an analysis. This paper explores the role of real time in the analysis of economic decision making through its impact on the knowledge and ignorance that is present when decisions are made.

Introduction

Economics is concerned, to a considerable extent, with explaining real economic behavior. And real economic behavior is generated by the making of real economic decisions. Both real economic behavior and real economic decision making occur in real, or what is often referred to as historic time. Real time, then, is implicit if not explicit in all economic analysis. How real time is represented, indeed if it appears explicitly at all, reflects significantly on the realism and relevance of the explanation produced by an analysis.

The concept of time, in and of itself and apart from the meaning and implications of time in economic analysis, economic policy proposals, and economic conduct, has puzzled philosophers as to its ontological status and the epistemological challenges implicit in it. Sir Thomas Browne, while admitting to the inability of solving the riddle of time, nevertheless observed in his *Hydriotaphia*: "Time which antiquates antiquities . . . hath an art to make dust of all things".[2] Time passes. History occurs. And its deposits too frequently falsify our expectations. Browne's failure to solve the riddle of time, though he was apparently aware of its often unforgiving imperatives, echoes both subsequent and prior philosophic investigations. Eric Rosenfield has observed to similar effect:

> "In 1917, Albert Einstein completed work on the *General Theory of Relativity*, one of the rules of which states that time is fundamentally bound to matter and gravity. Oddly, this concept was presaged almost 1,300 years before when Augustine (in Book 11 of his *Confessions*) put forth the idea that when God created the Heaven and the earth he created time as well." [3]

Human beings experience real time as a series of durations – not as a sequence of isolated points lined up along a continuum.[4] Durations do not have a well-defined length. They do not follow each other as separable and discretely identifiable intervals with a precise beginning and a precise end; each overlaps is predecessor and successor. Moreover durations are frequently perceived with respect to the events they contain. That is, time is often felt in a vague sort of way as events come into view, evolve, and pass into history. With this in mind, it

[1] The author would like to thank Douglas Vickers for his considerable help.
[2] Browne (2012, Ch. V).
[3] Rosenfield (2015, p. 7).
[4] Georgescu-Roegen, (1971, p. 70).

suffices here to take account of the ontological status of time as an entity in itself that moves and rolls as a stream and alters human consciousness between yesterday, today, and tomorrow. From such a perspective, time presents the challenge of knowing, with significance for human action, what it contained yesterday, what it means for action and behavior today, and what it might encompass tomorrow. And this, in turn, implies that the ontological status of time throws up profoundly significant, perhaps insoluble epistemological questions. Its significance for economic argument and conduct protrudes on several levels that have to do with the interdependent realizations of knowledge and ignorance. Three such issues immediately raise their demands.

First, it was Mill (1874, Sect 3, p. 237) who wrote that the cause of any event is the entire "… set of antecedents which determine it, and but for which it would not have happened." In the present context, that statement points to the following question: to what extent is it possible to know enough of what has occurred in the past and the causes of those occurrences in order to determine adequately the possibilities of human action in the present? That in itself, as will become clear as present argument proceeds, is not simply a statistical problem. For involved in it are matters of human epistemic potential, including in that the nature of presuppositions that influence one's look into the past, and what it is that determined those presuppositions. The limits of epistemic finitude exert their sway. We face the problem of how do we know, what are the origins and processes of knowledge, and what are the validity criteria that vindicate our grasp of what we conclude occurred in the past. That nexus of inquiry takes up also one's realization of the inter-determining forces and relationships that cause the past to be what we suppose it to have been. For example, is one to take a severely deterministic view of the past, is it to be understood, as some contemporary postmodern arguments suppose, to be the depository of chance events and outcomes, or is the past capable of bequeathing distinctly cognizable lines of explanation?

Knowledge of the past emerges, of course, from experience over time – that is, observing, reading, and interacting in other ways with individuals, groups, and the environment. Combining those activities with thought processes about what, with varying degrees of certitude, is already known produces new interpretations and possible bases for action in the future. All of this is stored in memory and added to knowledge. But there are pitfalls: We are unable to observe and read everything; nor can we know everything from the past. Thus there are necessarily big gaps in our knowledge. Our interpretations and understandings of observations, readings, and interactions may not be accurate. And as time passes, memories dim. We forget some things, we often change our understandings or meanings of others, and we add some that were never present. Time, therefore, alters knowledge by making it, at the same time, both more and less reflective of the world in which we live and of our assumed history of that world.

Second, what, as result, is it possible to understand as accessible grounds of responsible decisions for action in the present? That is only partly dependent on what might have been resolved by the discussion of issues raised in the preceding. For now there comes into play certain highly significant matters regarding the manner in which a marriage might be effected between two considerations raised by answers to the previous questions; first, what is now to be understood to be the history that precedes human action; and second, what can be discerned as the predilections, preferences, and predispositions that interact to determine what is seen as contemplated and desired results of present decisions. The latter, of course, is the goal-oriented grounds of action or criteria on the basis on which the decision choice is made. Indeed, what shall be suggested as possible decision criteria will take heavily into

account a number of such epistemic considerations. In any case, it is the union of these two considerations that produces the foundation for the decision.

Apart from knowledge in time that goes into the making of decisions, the cultural and social backgrounds of the decision maker are also highly significant.[5] That is because decisions emerge from more or less ordered and articulated thought processes. Thought processes, in turn, are mental acts that rely heavily on the symbols and their interpretations that individuals import across time as part of their intellectual maturation and subsequent development. Motivations are included in those imports. The source of the imports is the cultural and social environment in which the individual lives, acts, and grows. Thought processes that result in decisions involve, in light of motivations, the manipulation of the imported symbols in culturally and socially determined ways. It follows that since cultural and social values and imperatives evolve over time, the thought processes of the individual move in (possibly lagged) parallel fashion. The passage of time, then, may lead to variation in decision-making thought processes and the consequent alteration in decision outcomes from what might otherwise have been.

Third, in its reluctance to confide to us a full understanding of what occurred in its past, and in our incomplete comprehension of the meaning of the present, unarguable as that is, time hides from us completely what it will disclose in the future. For the epistemic reality we face is not simply that the future is unknown. It is unknowable. It would be an epistemic trap that leads to a blind alley to imagine that it is possible to know a part, even if in humility we say only a part, of what the future will disclose. The realities with which the inexorable passing of time has to be cognized are that as we look from our present posture to the future we are ignorant of what it will contain.[6] It might be imagined that on the basis of what we have constructed as the events of the past, we can entertain certain expectations or hunches of what the future may bring. Part of what will be observed below as decision criteria and ways of corralling the unknown and unknowable future, have been based on some such notions. But it must be acknowledged that all we have is our 'construction' of the past, never, as referred to above, a true, in the sense of accuracy and completeness, knowledge of the past. But therein lies a significant part of the problem that confronts the economic analyst or forecaster or decision maker. And for that reason the epistemological questions raised here will influence the decision processes and criteria that will be subsequently examined.

The argument that follows will look, in intentionally brief and incomplete terms, at the ways in which the already-addressed issues emerging from the acknowledgment of real time are relevant to the analysis of decision-making in economics. It is concerned, then, with first, the inability to know the past completely and comprehensively; second, the possible relation between that imperfect knowledge and the particular preferences, predilections, and presuppositions that influence the criteria of the decision maker's action; and third, the ignorance that confronts the decision maker as he looks into the unknowable future. The future, it needs to be grasped, is not there to be observed in advance. Decisions made in the present create the future that emerges.

Economic analysis, in its historically long development has, of course, been conscious that the realities of time and its passing need to be taken into account. As economics as an

[5] See Katzner (2008, pp. 5, 6 and Essay 3).
[6] As will be argued below, we cannot even know the probabilities of future events. The economic world is decidedly non-Bayesian.

intellectual discipline matured, something of an antagonism existed between opposing views of the manner in which this was to be accomplished.[7] Adam Smith, in his insightful inquiry into the nature and causes of the wealth of nations, looked essentially at the ways in which, in actual time, the relations inherent in market activity did, in fact, work out to the mutual advantage of participants. But real time as such was not explicit as a determining factor or variable in his analysis. In the classical economics that followed Smith, and notably at the hands of David Ricardo, the problem of real time was essentially solved by assuming it away. Ricardo's approach was based on the supposition that if left to itself the market system would automatically lead to a full employment of economic resources and, as a result, to maximum attainable economic welfare. The classical economists, in eliding the problem of, and the possible disturbances resulting from, the passing of real time, imagined that the economic system was shot through with automatic harmonies.

But so far as the explicit recognition of time was concerned, all that changed as the nineteenth century progressed and gave rise to what became referred to as neoclassical economics which, in turn, projected its analytical content into the twentieth and twenty-first centuries. Now the question of time was, in a special sense, recognized and taken into account. On more levels of analytical sophistication than can be addressed in the present space, distinctions were contemplated between the short run and the long run in economic affairs and outcomes, as they depended on individuals' decisions. But the time-scale differences did not address what we are now referring to as real historic time. Analytical focus remained on what is often referred to as logical time.[8] Decisions now took place in that time, and the imagined length of time over which resulting outcomes were contemplated was accorded a very important place in the analysis. Indeed, on such a logical level, progress was made in the dynamic view of things and time-paths over which the economy may develop, with convergent or explosive results and corresponding equilibrium or disequilibrium postures extensively examined. But nevertheless, time was in all that conceived of as a logical variable. Underlying that development in analysis were assumptions imported from the preceding classical economics that in the long run the market system would, in the general case, automatically lead to full employment of economic resources and again to maximum attainable economic welfare. At the base of the analysis were assumptions that the market system was characterized by perfect competition between small firms in various markets, producing identical products, under conditions of perfect knowledge, automatic and perfectly rapid market adjustment mechanisms, and assumptions of freedom of entry to, and exit from, markets. All that was subject to modification as time moved on, of course, and consideration was given to forms of imperfect competition such as duopoly and monopoly, and assumptions of decision makers' alternative actions were introduced.

The point that argues for attention, however, is that throughout that analytical evolution, important significance attaches to the fact that time was taken as simply a logical variable in the analysis. When, in such ways, time is simply a logical variable, the differences between yesterday, today, and tomorrow can be introduced into the analysis without any recognition that the real passing of time can, and does in fact, cause changes in the various variables inherent in the analysis of the scheme of things. At that juncture, if the question of real time is

[7] See Vickers (1994).
[8] When time is viewed as logical, pairwise comparisons of events are made in such a way that any one event, regardless of whether it occurred in the past, occurs in the present, or is thought to possibly occur in the future, is only said to take place before, simultaneously with, or after another. All that is important is the sequencing of events. The specific and distinguishing qualities of being in the past, present, or future are irrelevant and ignored.

to be taken adequately into account, there is a fly in the ointment. The awareness of it is at this point critically important when we are dealing with analytical economics and the relevance of actual decisions within it, and not merely with descriptive economics. For in systems of logical time analysis there do not really exist any choices that a decision maker in real time would face in contemplating the movement of the economic system from one time point to another, from the present to the future. A subtlety exists to spoil the argument. For when real time is taken into account, it is difficult to agree, as has generally been stated, that economics is concerned with nothing more than choices between achievable ends by the allocation of present (scarce) resources. Rather, if the general assumptions of neoclassical economics as have previously been indicated are present in the analysis, the outcome is automatically determined by the assumption content of the thought-system that is in place, and no real choice or actual decisions exist. The analytical structure of the system determines its own outcome. On the contrary, genuine choice in real time exists only when real uncertainty is present. That is so because in that case judgments have to be made, real decisions and real decision responsibilities exist, and the entire compass of unknowable possible outcomes have to be contemplated.

Real time, then, ignorance, and responsible judgment provide a context for the analysis of economic decision making that propels thought in significantly different directions from what economics has, in the past, substantially supposed. What needs to be considered now, therefore, is a brief recognition of the ways in which economic analysis has, with possible degrees of reality and pretense, taken real time into account.

To begin that argument it is necessary to recognize an essential difference between two very different methods of proceeding. First, by the use of certain analytical tools and assumptions, most usually the introduction of the probability calculus, the future with its ignorance and residual uncertainty can be and is, in effect, assumed away. Future-dated variables, subjected to estimation so as to be describable by the first and second (and possibly higher) moments of assumed probability distributions, may be reduced to present values by appropriate discounting procedures. The assumption of complete contracts – that the parties involved are able to specify commitments in every possible future state – follows a similar path. Such ways of incorporating the significance of real time into the analysis have to be seen as essentially attempts to transform ignorance into knowledge, opening serious argument as to the epistemic grounds on which, with the future unknowable in real time, the underlying probabilities inherent in the analysis are capable of specification. More will be said of this below.

It is, of course, possible that history might give the appearance of ‘repeating’ itself. That is, given our limited knowledge of past and present, it may seem that the occurrences of one day were identical to those of the previous day. But such repetition can only be observed after both days have passed in time. Moreover, in the context of decision making under the supposition of repetition in which all conditions of the decision problem were assumed to remain fixed, no account could be taken of the fact that real time passes between the making of the decision and the realization of the outcome of the decision, and hence that the world is in fact changing as the decision outcome is generated. The actual outcome of the decision, then, could be quite different from what might have been anticipated. Even with historic repetition, there is still no epistemic basis for the assumption that the same conditions will be repeated again tomorrow. History, as has been said, is created from moment to moment. Only time can reveal the mysteries of what is to come.

In the second approach to the making of economic decisions, the force and significance of real time is present throughout. Specifically, time enters the analysis by "… taking note of the manner in which the actual flow of it, and the unknowable expanse of it spread out ahead of us, impinge on real-world choices …. [T]ime is significant because our imaginative perceptions of the possibilities inherent in it determine what we do in our choice-decision moments, and because the passing of time qualifies our stance at the decision points we confront".[9] An explanatory model of decision making which to a considerable extent accounts for time in this way was proposed by Shackle (1969) and modified by Vickers (1987, Ch.12). The remainder of the present paper is concerned with the appearance and role of real historic time in that model. The discussion that follows is heavily dependent on the present author's expanded discussion in his *Time, Ignorance, and Uncertainty in Economic Models* (Katzner, 1998) of the analysis of decision making under the Shackle-Vickers assumptions of real time and ignorance of the future.[10]

It is natural to begin with the objects among which a decision or choice is to be made. In the concrete example presented below, those objects are alternative investment capital outlays. More generally, the objects of choice are known to the decision maker with the accuracy and completeness that the acquisition of knowledge over time as previously described permits. That is not to say that, at some future date, it might not become clear that other choice objects, unknown to the decision maker at the decision point, might actually have been available. However, the possibility of making adjustments to the decision as the future unfolds will not be considered here.

Upon making a decision, the selected object of choice or the elements of the choice decision interact with future states of the world that they meet as time passes to produce the outcome of the decision that was made. Because those states arise after the decision is made, perhaps both while and after it is being carried out, they are unknowable at the decision point. But the states of the world that greet the decision have a considerable impact on its outcome, and whether the decision made may, in retrospect, be regarded as a success or failure. The uncertainty of future states created by the veil of time should somehow be recognized in the decision-making process.

Expanding on what has earlier been said, many economists account for this uncertainty in terms of probability, that is, by assigning probabilities to states of the world. Probability arises in two forms: Aleatory probability is associated with the outcome of chance mechanisms and the relative frequencies they produce upon repeated trials in unchanging environments; epistemological probability is concerned with measures of degrees of belief, as warranted by evidence or reasonably informed judgment, that outcomes will obtain.[11] But both forms of probability leave something to be desired in their encounters with the difficulties of real time in the context of economic decision making. On the one hand, aleatory probability fails on two grounds. First, to calculate frequencies of states of the world requires, in part, knowledge of all possible state outcomes that can be produced by whatever chance mechanism is thought to generate them. But since the future is unknowable, it is not possible to be cognizant of all future states even if one allowed for the possibility of accurate knowledge of all states that have come before. In addition, each moment as time passes is unique in the sense that it has a unique history of actions and happenings, and unique collections of individuals and

[9] Vickers (1994, pp. 194-195).
[10] See Katzner (1998, Sect. 4.3).
[11] Hacking (1975, Chs. 1, 2).

institutions. The latter have unique preferences, attitudes, values, etc. that have evolved in the past and will modify in the future. Such uniqueness precludes the repetitive trials in unchanging environments that would generate frequencies of appearances of states of the world. On the other hand, calculating the epistemological probability of future states of the world also leaves something to be desired because the knowledge necessary as evidence relating to futures states or to make the reasonably informed judgments about them cannot, because the future is unknowable, be present.

An alternative way of assessing the uncertainty of futures states of the world is in terms of degrees of surprise that might be held regarding them. Surprise is based on imperfect knowledge of the past and on current psychological structures as they relate to such elements as attitudes and predilections. It does not require a leap across time into speculations regarding the actions, happenings, and nature of individuals and institutions of the unknowable future. And it is applied only to what are considered to be possible future states, recognizing that other states, currently unknown, may well appear as the future unfolds. The specific notion as originally proposed by Shackle (1969, pp. 68-70) was called potential surprise. It is defined as follows: The potential surprise of a possible future state of the world is the surprise the individual imagines now that he would experience in the future if that state were actually to come to pass. This notion captures to a sufficient extent the uncertainty in the economic decision problem and requires no unknowable knowledge of future states of the world.

A given choice object will be connected in the decision maker's mind to a range of possible outcomes, and to each such outcome he will attribute a potential surprise value. That, then, provides a set of pairs consisting of possible outcomes and the degrees of potential surprise with which they are contemplated. Outcomes could be expressed, perhaps, in terms of utility or profit. In either case, some outcomes, say those identified with higher utility or profit, would be seen as more favorable than others. Now for the given choice object, looking on the more favorable side, the decision maker's attention is pulled towards one particular combination of a more favorable outcome and a potential surprise value associated with it. That is, given the decision maker's psychological make-up at this moment of time, he is in some way drawn or attracted to that combination. Note that this combination of a more favorable outcome and a potential surprise value is one member of the previously described set of possible outcomes and the potential surprise values to which they relate. The analytical details concerning the manner in which the decision maker comes to focus on this particular combination will be outlined in the illustration below.

Similarly, on the less favorable side, a different combination stands out in the decision maker's thoughts or attracts his attention. These two combinations may be used to fully characterize his view of the choice object in question. Thus the entire decision problem is reduced to the selection from a collection of choice objects, each represented by two combinations that have grabbed the decision-maker's attention (consisting of a more favorable outcome and a less favorable outcome with their associated potential surprise values), according to a specific criterion in the decision maker's mind. It is assumed that that criterion is to select a choice object whose representation by the two combinations is the highest on what may be referred to as a decision index.[12]

[12] See Vickers (1987, pp. 222-235).

The explanatory model of decision making just outlined (i.e., that of Shackle and Vickers) has a more complex structure than those based on the frequently-employed assumption that future possible outcomes can be specified probabilistically, often making use in such a process of the statistical moments of relevant probability distributions. But its focus on potential surprise, attractiveness, and the decision criterion is intended to follow the possible thought process of the decision maker making his decision. In that regard, the known objects of choice are first captured in terms of the surprise they may call forth and their attractiveness to the decision maker. To reach a decision, the decision criterion is then applied to the manifestation of these characteristics in each choice object. The process does not rely on a construct, namely probability, that requires knowledge never available to the decision maker.

It will be useful to conclude with a concrete example of a decision-making situation as that might be conceived of in terms of the potential surprise approach. First, let it be imagined that an entrepreneur faces the possible wisdom of investing distinct designated sums of capital in an expansion of an industrial plant. That is, there are different possible expansion projects, each requiring a unique investment or quantity of funds. In terms of the proposed decision procedure, for each project or possible investment the entrepreneur would contemplate a range of possible profit outcomes (or present capitalized values of those outcomes), and to each such outcome he would assign a potential surprise magnitude. That is, to recall, he would identify the degrees of surprise that he thinks now he would realize at a designated future date if particular possible results were, in fact, to occur. In connection with each imagined investment project, then, he would have recognized in his thinking a set of pairs of (i) possible outcomes and (ii) the potential surprise magnitudes associated with them. For each such project, the elements of that set can be understood to describe a potential surprise function defined over the domain of possible profit outcomes from the contemplated investment. It should be borne in mind that the domain of such a function would include the range of negative or loss (less favorable), as well as positive or gain (more favorable) outcomes. That is to say, possible financial losses as well as possible financial gains will occur to the decision maker as conceivable.

Second, and independently of any of the investment projects, the decision maker will, in his estimation of things, conceivably be prepared to compare combinations consisting of the various possible profit outcomes and their corresponding potential surprise values according to their attractiveness to him. The set of relations between such contemplated profit and surprise combinations, then, can be interpreted to mean that the decision maker holds in mind what might be called an 'attractiveness function,' defined over the Cartesian product of combined negative and positive ranges of possible outcomes and the range of potential surprise values. Such a function indicates the combinations of profit outcomes and potential surprise values which he would consider equally attractive. What is in view at that stage is akin to the well-known utility function in, for example, the neoclassical theory of consumer commodity choice. In the same way as with the familiar utility function, equally attractive pairs (of profit outcomes and potential surprise values) would be taken to describe iso-attractiveness contours in the profit-potential surprise space. Clearly, the realities of entrepreneurial investment require it to be realized by the decision maker that such iso-attractiveness contours will be described in the negative or loss quadrant, as well as in the positive or gain quadrant.[13] The contours in the two quadrants are independent of each other. When the iso-attractiveness contours and the potential surprise function from a specific

[13] The loss quadrant is defined as the Cartesian product of the range of loss outcomes and the range of potential surprise values. The gain quadrant is defined in similar fashion.

investment project are brought together, it will emerge that the respective functions osculate at a unique pair in the positive or gain quadrant, and similarly at a unique pair in the negative or loss quadrant. At those points of osculation (given appropriate assumptions of functional forms) the potential surprise function will touch in each case the highest achievable contour of the attractiveness function. It is to these unique pairs the decision-maker's attention is drawn. Then the desirability of the capital investment outlay that is in view can be located on a decision index constructed by taking account of both attention-grabbing positive and negative pairs. A point on the decision index can be observed at a magnitude determined by assigning values to the combination of those gain and loss pairs, conceivably assigning a negative value to potential unfavorable outcomes, and a positive value to potential favorable outcomes.

What has just been described as a procedure to assess the desirability of the investment project referred to at the beginning may be repeated with respect to every other possible investment project facing the decision maker. In that way, when all possible alternative investment project outlays that are available and competing for the entrepreneur's capital funds are brought to comparison on the same decision index, the entrepreneur can choose between various projects and construct his economic organization according to that which registers the highest or most prominent.

It should be clear that all of the structural components of this decision process are relevant only at the decision moment. As time moves on and the future comes into view, the emerging state of the world and the outcome of the decision take their place in history. And at the next decision point, the presumption is that the structural components are all different and work their way through the decision process to a different decision outcome.

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