

The Dynamic Temporal Sequence and Reflexive Adjustment Behavior: Foundations for a Behavioral Alternative to Optimization Theory

John B. Davis

Marquette University and University of Amsterdam

Abstract

This article discusses the difference between mainstream and heterodox economics in terms of philosophy's distinction between two types of temporal sequences governing events: the static, truth-tenseless before-after sequence and the dynamic, truth-tensed past-present-future sequence. Mainstream theory and optimization analysis employs the first. However, Aristotle showed long ago this implies fatalism. Heterodox explanations employ the second, which I argue implies people reflexively adjust their choices over time in a combined backward-looking and forward-looking way that rules out optimization. Central to this explanation of behavior is how uncertainty about the future is connected to uncertainty about the past. I show this can be explained in terms of how people engage in counterfactual thinking whereby their uncertainty about the future is investigated through how they re-examine their uncertainty about the past. This behavioral explanation affects how we interpret two different sets of temporal phenomena heterodoxy emphasizes: (i) irreversibility and path-dependence and (ii) emergence and cumulative causation. I argue this demonstrates the need for the open economic thinking heterodoxy employs, not the closed economic thinking the mainstream employs.

Keywords: temporal sequences, fatalism, reflexive adjustment, future-past uncertainty, open economic thinking

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Mainstream economics makes assumptions about the nature of time that determine how it explains the economy. Heterodox economists have been critical of those assumptions and have produced different explanations of the economy. One way this difference has been understood is in terms of a distinction between logical time and historical time (Robinson, 1980; Shackle, 1958; Georgescu-Roegen, 1994). This paper discusses the difference between mainstream and heterodox economics from the perspective of a related distinction in thinking about time, one debated by philosophers since Aristotle but largely overlooked by economists. This is the distinction between two types of temporal sequences governing events: the before-after sequence, regarded as a static conception, and the past-present-future sequence, regarded as a dynamic conception. In addition to the advantage focusing on this distinction has for connecting existing thinking in economics about time with a long history of thinking about it in philosophy, an important advantage of this focus is that it directly raises the issue of how people act and behave according to which sequence one employs – a matter central to economics.

Mainstream economics, then, employs the static, before-after sequence, and this is foundational to its explanation of behavior as optimization. Most heterodox economists employ the dynamic, past-present-future sequence, but they are not united and generally not clear about just how this produces a theory of behavior alternative to optimization theory. They refer to such phenomena as (i) irreversibility and path-dependence and (ii) emergence and cumulative causation, which presuppose the past-present-future sequence, and defend a number of important ideas about behavior based on it, but on my reading do not advance an alternative theory of behavior comparable in generality and applicability to optimization theory. Until such a theory comes forward, I believe, mainstream theory and optimization analysis will continue to dominate economics. What is missing, I argue, is an explanation of how people reflexively adjust their choices over time in a combined backward-looking and forward-looking way that rules out optimization and relies on seeing the world in past-present-future terms, not before-after terms.¹

¹ This paper draws on arguments previously made in Davis (2017, 2021, 2023, 2024).

This paper's first section explains the difference between the static, before-after sequence and dynamic, past-present-future temporal sequences as the difference between tenseless and tensed truth statements, and shows how the mainstream's reliance on the before-after sequence underlies its explanations of behavior as optimization and change as sequences of equilibrium states.

The second section reviews Aristotle's famous 'sea battle' problem to show a long-held result in philosophy that using the before-after temporal sequence to explain human behavior entails fatalism, and then argues that why the mainstream has taken this path lies in it providing a rationale for its mythologizing about the automaticity of the market system.

The third section uses the distinction from philosophy of science between state descriptions and process descriptions to further differentiate between static and dynamic conceptions of the world, and argues that process descriptions are needed in economics to account for how economic agents continuously and reflexively adjust their behavior under conditions of uncertainty.

The fourth section outlines a simple dynamic model of reflexive adjustment behavior in which agents are uncertain about not only the future but also the past, and rely on a combination of backward-looking and forward-looking thinking in making choices – a behavioral adjustment decision-making approach employed complexity theory agent-based modelling.

To explain this type of decision-making, the fifth section shows how this combination of backward-looking and forward-looking reflexive adjustment behavior employs counterfactual 'what if' thinking, as investigated and understood in psychology, whereby individuals address their uncertainty about the future by re-examining their uncertainty about the past.

The sixth section comments on how this understanding of reflexive adjustment behavior accommodates but also requires modifying how heterodoxy interprets (i) irreversibility and path-dependence and (ii) emergence and cumulative causation, and how this implies a need for an open economic thinking rather than closed economic thinking.

1. Two Conceptions of Temporal Sequence and Mainstream Optimization Analysis

The distinction between the two conceptions of temporal sequences can be explained in terms of how they differ regarding making true statements (Emery, Markosian, and Sullivan, 2020; Morgan, 2023b). Thus, the past-present-future sequence and the before-after sequence –sometimes termed the A-series and B-series (McTaggart, 1908; cf. Dummet, 1960; Gale, 1967)– differ according to whether the truth of truth statements depends on when they are made or is independent of when they are made. Both types exist in human thinking. The issue is when which is appropriate according to the kinds of explanations we are making. Roughly, the difference is between historical explanations and logical explanations.

When, then, we frame time in terms of the past-present-future sequence, what is true at one point in time may not be at a later point in time. For example, one can say it is true that 'unemployment in country *a* is *x*' at that point in time when it is, but can no longer say it is at a later point in time when it no longer is. Truth statements in this case are 'tensed' statements, where their truth depends on their position in time. This is also known as a dynamic temporal idea. In contrast, when we frame time in terms of the before-after sequence, what is true is always true. For example, if it is true that 'unemployment in country *a* is *x* on June 1, 1970' that statement is always true. Truth statements in this case are 'tenseless' statements in that their truth holds irrespective of when they are expressed. This is also known as a static temporal idea.

Note, then, that optimization analysis employs before-after, tenseless, static temporal thinking. If it is true that individuals maximize utility at any point in time, it must be true at a later point in time that they maximized utility at that earlier point in time. Otherwise, one would have to say that when they maximized utility it was not necessarily true that they did. One might reasonably argue instead that people attempt to maximize utility at a point in time but it can turn out later that they did not, particularly because their beliefs and/or expectations about the future were mistaken. But this view is ruled out in mainstream economics via a principle of 'averages' or the claim that people on average are not systematically mistaken in these ways. Indeed, to say that they could be systematically mistaken is to question rationality at its core. If people can be systematically mistaken in various ways, then they cannot be said to be inherently rational.²

Rationality, however, is the Archimedean point on which mainstream equilibrium theory rests, not just as a principle in itself but also because it underlies the mainstream's whole theory of markets as an

² This is of course the challenge that heuristics and biases behavioral economics has made to mainstream theory in challenging whether behavior is rational.

equilibrium process. That theory assumes that economies always tend to settle to new equilibria when disturbed by 'external' shocks that create temporary 'out of equilibrium' or disequilibrium conditions. Economic agents were in individual equilibria before such shocks but are then in disequilibria after they occur. They thus make new choices that both restore them to individual equilibria and drive economies to new equilibria. Comparative statics is the method of analysis for this type of explanation (see Morgan, 2023a).

It needs to be emphasized, then, that on this view when they make new choices this does not imply their old choices were mistaken. Since by definition 'external shocks' are unpredictable, they do not imply those earlier choices were in error. Agents old choices thus truly maximized utility when they were made and this remains true at later points in time. Or, their old choices were rational before these 'shocks' and remain so after. That is, statements that they rationally maximized utility at any given time are tenselessly true.

Many critics of mainstream economics see mainstream rationality as improbable and heroic. This is certainly reasonable, but the larger picture is that rationality is also instrumental to the mainstream view that the market process is a relatively benign set of activities involving many agents that always tends to equilibrium, and when disturbed, usually in modest ways, is certain to tend back again to an equilibrium state of affairs. Arguments exist regarding whether shocks are supply or demand-driven, but those arguments still share the view that their impending result will again be an equilibrium state of affairs.

Since the mainstream rationality-equilibrium view assumes that when agents optimize their old choices can never be mistaken (otherwise they would not have optimized), it employs the before-after temporal sequence view of truth statements. For brief comparison, consider what assuming the past-present-future sequence implies. When truth statements are seen as tensed, what is true at one time might not be true at a later time. Individuals could then 'optimize' at one point in time but later find that they did not, say, because they were systematically mistaken in various ways, or not rational. In this case, there is no obvious reason to suppose an economy seeming to be in equilibrium, then disturbed in some way, will move to a new equilibrium-like state of affairs, or that the economy is a succession of equilibria, punctuated by shocks. Indeed, the whole idea of 'external shocks' becomes questionable once one says agents may not ever 'optimize' and thus that when the economy undergoes change, and even a relative settling at times, this produces a succession of equilibrium states. Rather the economy would be better described as some sort of process undergoing trends without automatic means of correction. Then, when people then say intervention in the market process is called for, equilibrium-like states of affairs might emerge if policies are well-chosen, but nothing is guaranteed. In section three, I lay out ideas for what non-standard explanations of economic behavior employing the past-present-future sequence involve, but in the next section first discuss the problems using the before-after sequence creates for explanations of economic behavior.

2. Implications of the Mainstream's Commitment to the Before-After Temporal Sequence

Aristotle points to the greatest problem associated with using the before-after temporal sequence to explain human behavior in his famous 'sea battle tomorrow' thought experiment – also known as the problem of future contingents (Aristotle, 1984).³ Imagine, he said, that at some date a sea battle that seemed imminent could be avoided. If we think in terms of the tenseless, before-after temporal sequence, then if it is true today that battle can be avoided, it would also be true in the future that it could be avoided, since for tenseless before-after sequences what is true at one time is always true. Yet it is possible that, though it is true today something such as a future sea battle could be avoided, it might not be true in the future that it could be avoided. To assume that was true yesterday is true tomorrow, is to say that the future is predetermined, implying fatalism in human affairs and that what people do in the present does not affect how the future plays out. That it is true today that the sea battle could be avoided does not guarantee it can be avoided tomorrow. Though it is possible it could be avoided, people could fail to do what makes this happen, which might particularly happen should they believe that because it could be avoided it must be avoided.

³ Future contingents are statements about future states of affairs contingent upon what later happens that cannot be determined to be true or false in the present. The philosophical literature on Aristotle's 'sea battle' argument is extensive and mostly concerned with his doubts about the law of the excluded middle in the case of future events and his understanding of the concept of necessity. It would be a distraction from the argument here to review that literature. My focus is on the implication the difference between tensed and tenseless statements makes for economics.

To us it seems that reasoning about things in this way in tenseless before-after terms makes little sense. We ascribe freedom to human beings, and recognize that true statements often depend on when they are expressed. However, many Greeks in Aristotle's time were under the spell of the view that the course of human events was divinely determined, as many of the famous plays of Sophocles and others depicted. What was true could not be changed – thus their sense of tragedy.⁴

Aristotle criticized this thinking by distinguishing two types of temporal sequence, and by arguing that the dynamic past-present-future sequence describes the historically evolving human world, and the static, before-after sequence does not. When it came to momentous events such as possible sea battles, it was crucial that people believed that what they did influenced what happened, and not think that an expected future based on past truths, however likely, had to come about.

From this vantage point, mainstream economics' adoption of the before-after temporal sequence produces a low-grade fatalism, not one that tells us what specific events will occur but one that assures us that whatever people do economies will move back to equilibrium states of affairs. The rationality principle that people are not on average systematically mistaken thus offers the same assurance as the idea that if a sea battle can be avoided today, it will be avoided tomorrow.

This kind of fatalism leads us to a second problem associated with the mainstream relying on the before-after temporal sequence. As those who have taught microeconomics well know, down-sloping demand curves, which market equilibria depend upon, are derived from a number of essentially logical assumptions about the concept of preference. We can accordingly distinguish between two motives for why those assumptions have been adopted. One is their instrumentality for showing markets tend toward equilibria. Without down-sloping demand curves the whole supply-and-demand equilibrium analysis breaks down.

A second, deeper motive is a mythologizing mainstream economists arguably engage in about markets (going back to their happy interpretations of Adam Smith's invisible hand). The myth is that fortuitously, as if divinely, human beings live in a world that generally benefits people – despite the evidence that markets under capitalism often produce suffering and exploitation. The form this myth takes involves saying that no matter what people do markets continually work to achieve settled states of affairs 'scientifically' characterized as equilibria. A mythology, like in religious systems, is an imagined world order that must be believed but cannot be explained – an eternal mystery that ultimately determines what counts as fact. In contrast, a genuinely scientific approach to the market process builds its view of how markets work and affect people from a continual evaluation of theoretical hypotheses about markets in light of what they do and do not tell us given the evidence bearing on them. Thus, a second problem associated with the mainstream commitment to the before-after temporal sequence is that it closes off economic thinking to an open investigation of its subject matter.

3. Explanations of Economic Behavior Employing the Past-Present-Future Sequence

Corresponding to the distinction between the two types of temporal sequence there also exists a distinction between two types of descriptions of the world used in science: state descriptions and process descriptions. State descriptions explain the world in terms of sequences of distinct states of affairs occurring at successive points in time. They correspond to the before-after temporal sequence, because the before-after idea simply refers to an ordering of states. Process descriptions explain the world in terms the passage of time. They correspond to the past-present-future, dynamic temporal sequence, because past, present, and future refer implicitly to one another as a connected relationship.

Herbert Simon held that both types of explanations have roles in science, but argued that modern science had increasingly come to interpret state descriptions as embedded in process descriptions. In effect, a given state came after another, not just because of the before-after idea, but also because the earlier state led to the later one. Process, that is, explains succession. This was apparent in his view of living things where agency, the ability to bring things about, is involved. Thus, he argued:

'substituting a process description for a state description of nature has played a central role in the development of modern science [...] [and] the correlation between [them] is basic to the functioning of any adaptive organism, to its capacity for acting purposefully upon its environment' (Simon, 1962, 481).

⁴ Modern tragedy is based on an array of causes, personal flaws, social relationships, historical surprises, etc. but the gods have dropped out of the picture or at most been demoted to 'fate.' See Carabelli (2021) where tragedy arises from the need to take decisions in spite of uncertainty about the consequences.

However, post-1950 mainstream economics largely gave up process explanations. The rise of general equilibrium theory with its vision of markets always tending to a perfect balance went hand-in-hand with increased use of mathematics, producing a new emphasis on what historian of economics Mark Blaug termed 'end-state' solutions (Blaug, 1997). State descriptions in mathematical terms are compiled out of sequences of 'end-state' solutions. How one moved from one to another, the adjustment process, was stripped of explanations of how agents behaved with the assumption that their rationality delivered them to new optimal states. What was consequently pushed out the field was an earlier emphasis going back to Adam Smith and after on competition as a process and more complex explanations of how agents adjust to change. This earlier literature emphasized process descriptions and explained competition as a continuous adjustment process in which agents 'rationally' assessed their past positions in determining their future positions.

Simon, as an early behavioral economist, was critical of neoclassical rationality thinking, and advanced an alternative 'satisficing' conception of agent behavior that substituted process descriptions for state descriptions (Simon, 1955). In contrast to the 'end-state' general equilibrium theory conception of equilibrium, 'equilibria' were at best relatively settled, transient states of affairs that left open what agents might choose to do later. Thus, 'satisficing' agents were not be optimizers who ignored possible future choices. In terms of the past-present-future dynamic temporal sequence, 'satisficing' agents' reflected on their past actions and aimed toward future ones, always leaving possibilities open for how they might act at later dates.

The difference between using state descriptions and process descriptions lies in whether one thinks of the world agents occupy in closed or open systems terms. If one is a Bayesian, the world is probabilistically closed. Mainstream rationality, in keeping with its myth of an ever beneficent market system, makes optimizing agents Bayesians and closes off the future. However, if one is a Keynesian/Knightian, markets are continually changing and agents are continually adjusting, because the world always presents an open, uncertain future. How, then, might we explain their behavior?

4. A Simple Dynamic Model of Reflexive Adjustment Behavior

Heterodox theories of agent behavior incorporating Keynesian/Knightian uncertainty emphasize future uncertainty, not only is the future is uncertain, but so is the past, though in different ways. It is true that future uncertainty reflects a future that has yet to occur whereas the past has occurred. This difference may incline many to think uncertainty does not apply to the past. However, as debates among historians continually show, there is much that is uncertain about the past as well. At the same time, while the future has yet to occur, much about it will follow the past and is predictable and thus not particularly uncertain, so the difference between past uncertainty and future uncertainty is less pronounced than many believe. A more reasonable view, I suggest, is that both the future and past are uncertain and our understanding of how each is differs in important ways.

One might then suppose that the way to proceed is to first compare these two forms of uncertainty in order to weigh their respective roles in explaining adjustment behavior. A complication in doing this is that how people address the future depends on what they believe about the past, so future uncertainty and past uncertainty interact. Below I will discuss one way this interaction works in how uncertainty about the future stimulates people to investigate their uncertainty about the past through recourse to counterfactual reasoning or 'what if' thinking. Counterfactual thinking probes past uncertainty by examining what might have been misunderstood about the past. Uncertainty about what to do in the future is then connected to asking such things as 'what if in the past I had done such-and-such instead of what I did,' followed by, 'how then should I act now, adjusting for what I did but could have done differently earlier.'

To begin to lay out connections such as this between past and future uncertainty, I offer a simple model of how agents behave when they think in terms of the past-present-future temporal sequence. One way to think about this, if metaphorically, is to say that how people adjust to the future involves their looking backward in order to look forward. That is, they see themselves operating in the entire past-present-future sequence, not just in the present they occupy. In effect, the present is both backward-looking and forward-looking. More concretely, what thinking in this way involves is a process of evaluation and assessment whereby from the vantage point of the present judgments are made about the past in light of judgments to be made about the future. That is, we specifically need a dynamic model of adjustment behavior in which the means by which individuals make decisions is by comparing and connecting their present beliefs about past and future.

Looking backward in order to look forward is a reflexive activity. The meaning of the concept of reflexivity is of something referring to or acting upon itself – metaphorically, a backward-referring idea.

The reflexivity concept has been used in philosophy, logic, mathematics, political science, psychology, and economics to explain reflexivity as a property of certain types of conceptual systems made up of multiple propositions (e.g., the Cretan liar paradox, Gödel's incompleteness theorems, fixed point theorems, the Grunberg-Modigliani prediction problem, various impossibility theorems, etc.). What distinguishes these systems is that they include at least one proposition that refers to itself, often generating interpretation paradoxes for the system those propositions represent.⁵

However, a systems application does not provide an analysis of reflexive individual behavior such as presented here. No system of propositions with a self-referring proposition is involved when individuals compare and connect their present beliefs about past and future. Nor is there anything paradoxical about individuals behaviorally looking backward in order to look forward. Revising past beliefs may produce unexpected, even surprising changes in how a person understands the past, and past beliefs may seem inconsistent in an informal, non-logical sense with choices being made about the future. But there is nothing inherently paradoxical about saying individuals behave in a reflexive manner and behave as reflexive agents.

In economics, there are many examples of reflexive behavior that illustrate this. Bank runs (Merton, 1949) and 'Minsky moments' (Minsky, 1982) are two well-known cases. What occurs in each is that agents find in light of a future developing in unanticipated and often problematical ways that their past decisions and their understanding of their basis were somehow mistaken. This causes what I previously termed 'belief reversals' in which agents reflexively recalculate in a combined backward-looking and forward-looking way how they think the past and future are connected as concerns their need to make choices in the present (Davis, 2020). Thus, their expectations of the future draw upon their reappraisal of the past, and given that both are uncertain they know this sort of circumstance will occur again in the future. This creates a continuous dynamical process of adjustment in which optimization never occurs, or if one wants to insist agents see themselves as 'optimizing' in some loose sense, it is conditional upon them regarding their priors as at best provisional. This is not how mainstream economics understands how people form priors with its naïve view of facts as simply facts. Better then, as Simon emphasized, say that agents 'satisfice' or do the 'best they can' under the circumstances they regularly encounter.

The reason I call this a 'simple' model of reflexive adjustment behavior is that it describes how individual agents behave in a past-present-future world while abstracting from their interaction with other agents. Of course in the bank run and 'Minsky moments' cases how individual agents behave depends very much on how other agents behave. For example, in a bank run individual depositors think in terms of what they believe other depositors are likely to do.⁶ Yet in both cases how agents influence one another presupposes an understanding of how they individually address their situations. Importantly, their individual situations are different from one another, if sometimes similar, but different because they necessarily occupy different positions in the world. Thus, to explain their interaction we first need to know what kind of behavior they exhibit, and then explain how it is influenced by the behavior of other agents. Ultimately the rationale for this two-step strategy derives from the problem of explaining agency in the world. To say people initiate courses of action requires we first say where that initiation occurs – I claim it is individual agents– and then proceed to explain how initiated actions are affected by social interaction.⁷

One illustration of this is complexity theory agent-based modelling (ABM) which explains agent interaction in complex systems given assumptions made about individual agent behavioral rules. By comparison with mainstream optimizing agents, agents in ABM are quite simple. They do not optimize in any global fashion but simply apply sets of simple decision rules to address their immediate choice situations. Those rules can indeed be very elementary – 'do *x* when *P* happens' but 'do *y* when *Q* happens.' In the bank run case for the depositor agent, *x* could be withdraw your deposits and *P* could be an auditor issued a report saying the bank is insolvent. Alternatively, for the depositor agent, *y* could be leave your deposits in the bank and *Q* could be the central bank has guaranteed deposits.

More complicated sets of decision rules can then be hierarchically ordered, giving sets of conditions that activate additional rules. Explaining these kinds of cases was once beyond economists' technical-mathematical skills, but ABM has made them straightforward by employing computational methods developed with advances in computing technologies. This development now pervades science

⁵ For a discussion of how reflexivity operates in economic methodology, see Davis and Klaes (2003).

⁶ In another famous example, Keynes's 'beauty contest,' individual investors make decisions based on what they believed are other investors' decisions (Keynes, 1936).

⁷ This strategy of course deserves more than a single sentence statement. I have tried to provide that in my books on individuals and identity, e.g., Davis (2024).

in multiple fields.⁸ At its heart is the assumption that simple rules agents employ, whether singly or in structured manifolds of rules, make it possible to give explanations of complex interactions between many agents.

There are now many applications of ABM in not only economics but also in biology, business theory, technology diffusion, social science etc. In economics, early influential examples are the El Farol bar problem (Arthur, 1994) –how people decide to go to a popular bar– and the Santa Fe artificial stock market analysis – how a set of individuals each employing simple decision rules continually adjust their stock market portfolios as a result of their interaction with one another (Arthur, Holland, LeBaron, Palmer, and Tayler, 1997; Brock and Hommes, 1997, 1998; see Tesfatsion, 2004). What is often emphasized as distinctive about ABM in these and other examples is how they incorporate heterogeneous agents and reject the mainstream representative agent idea. Indeed, this allows ABM to exhibit learning, adaptation, and emergent system properties, which standard mainstream general equilibrium/representative agent thinking does not recognize.

Yet at its core, ABM just employs a simple model of reflexive agents with their sets of decision rules framed in terms of the need for continual adjustment. When circumstances change for agents, they adjust by working back through their sets of decision rules to make new choices, thus reassessing what they relied upon in the past in order to evaluate their future prospects. Much of the development of ABM has been motivated by the challenge created by how small changes in sets of decision rules ascribed to agents can produce significantly different multi-agent outcomes. To do this, ABM has employed a computational-experimental sort of method to investigate what sets of decision rules applied to agents generate what kinds of multi-agent outcomes. This outcome-based, pairing method of investigation is very useful because it can generate significant new knowledge about the world.

ABM also addresses one of the challenges that has long faced models of decision-making alternative to the mainstream optimization model: providing an analysis that is not only realistic but also possesses comparable generality and versatility. However, as computational modelling skills increase among young economists, it is reasonable to suppose that ABM adjustment models will find more and more applications – thus addressing the generality issue. Indeed, there was also a learning curve for optimization analysis (post-1950) that delayed its adoption in economics for a time. Regarding the versatility issue, here matters are even more promising since optimization models are tied down by a number of restrictive, equilibrium requirement assumptions (especially about preferences axioms) determining when optimization models can be used. ABM is not tied down by those equilibrium requirement restrictions. Moreover, that ABM borrows from the panoply of simple decision rules now being investigated in behavioral economics (BE) means it possesses considerable potential for generating explanations of behavior not available with the optimization approach.

This paper shares these ABM goals but is different in focusing on what we can say behaviorally about the nature of agents' simple decision rules when we emphasize their temporal character. The argument above is that when examine how the past-present-future sequence operates in decision-making we see that important to it is the relationship between future uncertainty and past uncertainty. Past uncertainty has been less investigated, so questions naturally arise regarding what sorts of phenomena it involves.

The next section discusses how people's counterfactual thinking underlies their reflexive adjustment behavior. The main advantage of this focus is that counterfactual thinking works through how it connects past and future uncertainty. A further advantage is that it allows us to begin to determine what types of simple decision rules agents exhibit according to research in psychology on different patterns of counterfactual thinking. I will distinguish two such patterns and comment briefly on how they might differentiate two ways in which people address surprise and unexpected events.

5. How Counterfactual Thinking Links Future Uncertainty and Past Uncertainty

Since 1982 when Daniel Kahneman and Amos Tversky argued that counterfactual thinking is functional to human behavior rather than an indication of irrational behavior (Kahneman and Tversky, 1982), the literature on counterfactual thinking in psychology explaining individual decision-making has grown significantly. In the simplest sense, counterfactual thinking involves what is often called 'what if' thinking. This 'what if' thinking specifically refers to how, on further reflection, individuals might find the world different than they had been supposed, and then use this to determine the choices they make. In this regard, the basis for counterfactual 'what if' thinking lies in how people evaluate what they take to be

⁸ For example, in psychology it operates in the 'fast and frugal heuristics' approach developed by Gerd Gigerenzer and others (e.g., Gigerenzer and Todd, 1999).

facts about the world, recognizing that they might actually be different, even contrary to what they had believed them to be (Roese and Olson, 1995; Byrne, 2002, 2016).⁹

A different understanding of counterfactual ‘what if’ thinking exists in mainstream economics in connection with policy choices. It is not uncommon for policy-makers to ask what the ‘counterfactual’ is should a certain policy adopted. The ‘counterfactual’ is the alternative state of affairs that a policy would bring about. This is not the sense of counterfactual ‘what if’ thinking above. When a new policy regime is enacted, individuals do not engage in reconsideration of what the facts about the world are, but simply, as before, choose rationally without imagining that what were taken to be facts might not be facts. That is, they only find themselves confronted with a new sets of existing facts appropriate to the changed state of affairs.

Mainstream economic agents are Bayesians, meaning their choices begin with sets of prior probabilities based on given statistical facts. They update those probabilities as new statistical facts emerge, but they do not ask what, contrary to existing fact, might form the basis for an entirely different possible sets of prior probabilities, where the meaning of ‘prior’ is adjusted to accommodate previously unrecognized possible facts. That is, for mainstream economics counterfactual ‘what if’ thinking only applies to different possible states of affairs, given whatever are taken to be the facts about the world, not to individual behavior.

However, when one reflects upon how people ordinarily engage in counterfactual thinking – something which the universal use of the subjunctive mood in natural language shows us is part of how people think– one sees that that people often ask whether beliefs about the past rests on what are conjectured to be facts, that is, what at the time are generally taken to be ‘facts’ but which people are well aware can cease to be facts. Recognizing this, agents regularly speculate about how facts could be different than believed, and on that basis examine how they could have acted differently in the past and perhaps should act differently in the future.

In mainstream economics facts are always facts, and as such can never change their status. This doctrine parallels the mainstream’s temporal sequence conception whereby statements about time never change their truth value. Together, it is fair to say, this produces what philosophers and methodologists of economics would regard as at best epistemologically primitive view of economics and economic agents. More practically speaking, its consequence is that neither the future nor the past are can be fundamentally uncertain, so that rationality in the mainstream sense always applies.

Counterfactual thinking’s ‘what if’ type thinking as applied to individual decision-making, then, combines backward-looking and forward-looking thinking and thus concerns how the former supports the latter. In a popular example used in the literature, a person might say, ‘I studied enough for the exam’ –a presumed fact– but then later say that since their score was poor, perhaps it was not a fact that they studied enough. Then their inference might be, ‘I didn’t study enough but could have’ –an alternative fact– then ask ‘what if’ I had, what would my score have been?¹⁰

Bayesian economists could of course say that this is all quite speculative and consequently has no place in a scientific approach to economic behavior. However, there are several reasons to dismiss this response. First, as noted above, linguists and psychologists have shown that people commonly engage in counterfactual thinking, as does the nearly universal use of the subjunctive mood in human language. Second, the Bayesian view that what counts as fact in human thinking is clear is surely both philosophically indefensible and in virtue of its reliance on statistical foundation in normal distributions also unrealistic. Third, the idea that counterfactual thinking is highly speculative by nature is inconsistent with the evidence that most often when people employ it they think in terms of what are called ‘close counterfactuals’ or ones that, because they depart from presumed facts only moderately, address real choice possibilities.

The literature on ‘close counterfactuals’ (Kahneman and Varey, 1990; Doan, Denison, and Friedman, 2023) also provides a means of distinguishing different individual behavioral patterns in counterfactual thinking. Since ‘close counterfactuals’ concern circumstances in which agents investigate relatively small departures from presumed facts (e.g., ‘I studied enough for the exam but maybe I didn’t’), they apply to a large number of cases in everyday life when people make choices about activities that are regularly repeated over time. Thus, they generally get their facts mostly right, or right enough most of the time, and their counterfactual thinking only explores relatively small margins of error around what they regard as fact.

⁹ For how in a behavioral economics framework counterfactual thinking influences attribution substitution in choices people make, see Davis and Koutsobinas (2021a, 2021b). For a general review of counterfactual thinking, including in relation to abduction, see Davis (2024, ch. 4).

¹⁰ Another popular, everyday example is being late to an appointment having thought it was a fact the traffic would not be bad.

Contrast this with non- 'close counterfactuals' where people get things drastically wrong, and are surprised, such as occurs in cases such as bank runs and Minsky moments, and find they need to rethink what they are doing in a more fundamental way. In this less common sort of case, whole structures of facts and beliefs may be jeopardized, people engage in re-examination what conceptually counts as fact, whole theories upon which facts rest can come into question, and new theories built upon apparent new facts emerge.

Another way to further distinguish these 'close' and 'non-close' cases is in regard to the role social interaction plays in each. For 'close counterfactuals' agents usually proceed in a relatively autonomous manner, but for non-'close counterfactuals' their usual adjustment strategies that exploit margins of factual error fail, and whole structures of facts and beliefs come into question. Then they begin to look to others to see how they are addressing the surprising breakdown of conventional views, demonstrating the role conventions play in agents' epistemic grasp of the world.¹¹

Here I put these more significant adjustment cases aside to distinguish two broad patterns of counterfactual thinking psychologists have investigated: *downward* and *upward* counterfactual thinking (Epstude and Roese, 2008; Roese and Morrison, 2009). Downward counterfactual thinking is associated with how things could have been worse for a person had they acted differently, and thus focuses on errors or mistakes that were actually avoided. In the unexpected exam result example, an individual might say recognizing the fact they had not studied enough: 'I would have gotten a lower grade if I hadn't studied as much as I did.' Functionally, downward counterfactual thinking is treated as an affective, 'coping' mechanism, whereby people regard themselves as fortunate that their actions turned out as well they did, and concentrate on maintaining their existing situation.

In contrast, upward counterfactual thinking is associated with how things could have been better had a person acted differently, and is focused on opportunities missed. For the unexpected exam result example, an individual might say, recognizing the fact they had not studied enough: 'I would have gotten a higher grade if I had studied more.' Thus, upward counterfactual thinking is characterized as an affective, 'preparative' mechanism which people employ to put themselves in a better position to achieve their goals in the future, where their focus is instead on developing their situation.

When we introduce interaction between individuals in connection with non-'close counterfactuals,' it is not clear whether agents respond more often in a downward or in an upward way. It may be that some individuals respond in one way and other individuals respond in the other way. Supposing there is an identifiable distribution of responses across these two orientations, then the dynamics of crises could play out in terms of how the two groups interacted, with 'coping'-oriented people essentially adjusting in a more conservative, cautious manner, and 'preparative'-oriented people effectively adjusting in a more exploratory, experimental manner. This could provide foundations for a theory of social dynamics of crises, but here I put this off for later investigation in order to briefly take stock of what has been argued above.

Thus, when we adopt a more realistic view of how individuals negotiate time than the one the mainstream employs, we can replace the rationality optimization behavioral adjustment paradigm with a simple dynamic model of reflexive adjustment behavior that has several main components. It employs the past-present-future sequence in which statements about events can change truth value over time. It assumes uncertainty applies to both the past and the future, though in different ways. It represents decision-making as a continuous reflexive adjustment process in which, when agents' choices do not produce what was expected, they look backward at how they used the past to make them, and then ask how the past should be re-explained in making subsequent choices. This opens up economics' analysis of adjustment behavior to extensive literatures in psychology on the nature of counterfactual thinking. In the closing section, I briefly link these ideas to what heterodox economists said about such phenomena as (i) irreversibility and path-dependence, and (ii) emergence, and cumulative causation, and then argue this implies a need for an open rather than closed economic thinking.

6. Heterodox Economics and Historical Time

Heterodox economists generally reason in terms of historical rather than logical time (Setterfield, 1995; Morgan, 2023a, 2023b). Consequently they have emphasized such phenomena as (i) irreversibility and path-dependence and (ii) emergence and cumulative causation, which indeed provide important conceptual foundations for an economics alternative to mainstream economics. I argue, however, that when we explain behavior as a reflexive adjustment process, and focus on how individuals address

¹¹ Again, Keynes (1936) was insightful in this regard, noting that investors adhered to conventions about investments until those conventions broke down, then particularly looking to what others were doing.

their uncertainty about the future by re-examining their uncertainty about the past, we need to modify how those phenomena are often interpreted.

The two sets of phenomena do different things. Irreversibility and path-dependence concern how we understand sequences of events, and emergence and cumulative causation concern how we interpret the overall effects in time of those sequences. At the same time, irreversibility and path-dependence, though both are about sequences of events, have slightly different meanings, and emergence and cumulative causation, though both are about the overall effects of those sequences of events, have somewhat different meanings as well.

Irreversibility looks backward, and generally means a succession of events cannot go backward and a return to the past in the future cannot occur. Path-dependence looks forward, and generally means what happens in the future depends in some way on what happened in the past. Both ideas are based on a lock-in type idea, though in different ways. Irreversibility tells us that past-future sequence is a locked order: the past leads to the future but the future never leads to the past. Path-dependence tells us that the events of the future have been locked-in by events in the past, so the future always recalls the past.¹²

However, when we think not just in terms of the nature of historical time *per se* but in terms of how agents reflexively adjust their behavior in time, we see we should modify the lock-in character of these ideas. Agents reflexively adjust over time by reworking their understanding of the past and its uncertainties in making choices that address future uncertainties. By engaging in counterfactual thinking, they unlock aspects of the past that seemed fixed, and in effect reactivate aspects of the past. Thus, when future behavior depends on reinterpreting the past, irreversibility is modified. It is still true that successions of events themselves cannot go backward and a return to the past in the future cannot occur. Yet behaviorally speaking individuals can change how the future succeeds the past, so that the future in a way also leads to the past. Accordingly, for path-dependence, while the future depends on the past, the past also depends on the future.

Emergence and cumulative causation concern how we interpret the overall effects and character of sequences of events. Emergence refers to the appearance of something new and novel arising out of a sequence of events. Cumulative causation refers to the additive or compounding character of the continual emergence of novelty. That is, novelty is not only emergent because the past is succeeded by the future but the cumulative deepening of novelty derives from that ordering as well.

Yet when we see individuals reflexively adjusting in time by employing counterfactual thinking, we can see that novelty is also emergent upon their re-examining the past, not just because the future succeeds the past. When people reason counterfactually, their interpretation of the past derives from the reasoning about the future. Thus, the cumulative deepening of novelty also depends on movement in both directions, the future succeeding the past and the past succeeding the future.

I suggest, then, that there are two undesirable consequences of seeing i) irreversibility and path-dependence and (ii) emergence and cumulative causation in the conventional ways that emphasize lock-in and the additive or compounding character of emergent novelty. First, recalling Aristotle, this promotes fatalism in thinking about time and sequences of events. Lock-in tells us the past determines the future largely irrespective of what we do. Some things must inevitably come about because of the past. Yet we surely have some discretion over how we make the future play out, even if the past narrows and restricts the degree to which we can exercise that discretion. That is, when we unlock aspects of the past that had been taken as fixed, we weaken lock-in, and in recognizing how it had affected sequences of events we see occurring, we make it possible to alter those sequences. Then, what produces novelty is not just its continual, relentless accumulation, but also our own determination of what we believe counts as emergent and novel.

Second, the conventional understanding of these time phenomena promotes closed rather than open economic thinking (Davis, 2024, ch. 1). Closed economic thinking involves abstractly identifying sets of theoretical assumptions and principles, and then in a top-down way logically inferring a set of conclusions from them regarding how economies must always function. Scientific progress is then restricted to refining these assumptions and principles through their empirical investigation, though this risks confirmation bias and science bubbles (*ibid.*). In contrast, open economic thinking involves advancing hypothetical sets of theoretical assumptions and principles, and then in a combined top-down and bottom-up way allowing their empirical investigation to revise and overturn them when called for, allowing altogether new sets of theoretical assumptions and principles to be proposed.

¹² Path-dependence is often associated with as hysteresis, a concept originally developed in physics. I prefer path-dependence because it is specifically associated with social-historical systems whereas hysteresis risks confusing physical properties with social ones. For discussion of both concepts see Dutt (2023).

Heterodox thinkers have emphasized the importance of open economic thinking, for example, Tony Lawson (2003) and Sheila Dow (2004). Their arguments for it emphasize epistemological issues, as does the previous paragraph. However, this paper also makes open economic thinking depend on two specific ontological ideas: how we understand time in connection with concept of temporal sequence, and how we understand agency when we explain agents as beings that reflexively adjust their choices in the face of interrelated past and future uncertainty. To the extent that ideas of this kind are employed in open economic thinking approaches, economics holds promise of escaping the confining, closed thinking that characterizes much of current mainstream economics. To the extent that this paper contributes to this, it does so by expanding how we think about time in connection with uncertainty, reflexivity, and counterfactuality.

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