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Against the clock: Economics 101 and the concept of time

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1. Introduction: the shit we're in

The question posed for this collection was 'How can we construct an economics consistent with the biophysical limits to economic growth?'. As any ecological economist is aware, this is a foundational issue not an afterthought chapter tacked on to the end of a textbook or delegated to a sub-disciplinary specialist who can 'deal with that for us'. Doing either of those has been part of the problem. Mainstream economics takes as its primary focus the microeconomics of price signalling in systems of market exchange and assumes efficiencies in dynamic market processes are sufficient to ensure best use of resources and eventual development of alternative ways of achieving what we want and need (through a combination of behavioural change, investment and technology). At the same time, the macroeconomy is conceived through a circular flow of income and targets continual economic growth. This implicitly equates health of an economic system (as a source of both progress and wealth) with continual economic growth (bigger is better rather than different can be good) and this growth is conflated with the possibility of solving problems created within the system, including environmental ones. Economic growth implicitly becomes the basis of solutions rather than merely source of the problems we see around us. This mirrors the basic socio-economic drivers of our dominant ways of living (the apex which others aspire to and which 'development' assumes is the way to go), capital-accumulating industrial-consumption economies presuppose growth and, government stabiliser policies notwithstanding, if growth fails to occur this is deemed a signal of crisis (and this remains the case despite the proliferation of alternative indexes of human development and wellbeing).

What is very obviously not foundational is the basic fact that an economy is a material-energy process on a finite planet involving metabolic flow and waste, that a bigger global economy observably outstrips any 'efficiency savings' to the extent that the biosphere has been profoundly altered and polluted. Environmental economics has taken its cue from mainstream economics. Its main focus has been relative scarcity rather than absolute scarcity, addressing market failures (taxes, subsidies and regulation to get the price right, altering behaviour while also working to induce market processes that promote technological transitions), and if there is no market, creating property rights and securitisable assets to essentially create synthetic markets (trading pollution and valuing nature for its preservation). All of this simply ignores the basic problem of socio-economic drivers, implicitly assumes technology will mainly solve problems and underplays the need to rethink how society and economy are organised – around a concept of 'a good life within planetary boundaries' and a concept of 'enough' (a different concept of 'abundance'). These are just not questions and issues either a mainstream economist or an environmental economist can meaningfully address within their skillset and framework of thinking (and this remains the case despite growing concern among world scientists regarding trends and

despite some limited progress at the annual COP meetings – in which issues like financing, just transition and so on have become legitimate subjects of discussion).

A future threat has become a present reality and ecological breakdown, climate change and erratic and extreme weather events are now all around us. We are only at 1.1-1.2°C of heating. Worse is yet to come and an avalanche of statistics makes it very clear that rhetoric has not yet translated into action with sufficient urgency. We are on the clock and time is against us.¹ This is obvious and there is some danger that a collection of essays focused on economics and biophysical limits to economic growth will provoke considerable duplication insofar as common sense (if not yet political sense or public consensus) dictates you cannot solve a problem unless you reorient theory and method to better explain and understand actual causes as a precursor to realistic (in the sense of what a liveable planet allows) solutions... With that in mind (the danger of duplication) I am going to take the concept of time in economics as my subject matter. This is not a digression or evasion. It is not 'beside the point'. How economists have conceived what happens in time is also a problem of how they have conceived of time. I say 'conceived', in fact there has been relatively little discussion of the adequacy of the concept of time in economics. Given the relatively strict word limit for these essays concision is required and I will be brief, the main point I am going to make is that the dominant concept of time is unrealistic and lacks an adequate focus on causal temporality – put another way, it lacks process and complexity.² This has two consequences, unrealistic theory of how things happen and inability to address within economics the big questions of what could happen (what we need to happen). So, for Economics 101, get the concept of time right and arguably everything else follows (or at least can follow)...

2. Two concepts of time: logical time and historical time

Anyone familiar with standard undergraduate economics will be aware that the dominant treatment of time decomposes into statics, comparative statics and dynamics. In statics there is representation of variables and their relations but no explicit time (the archetype is the graphical representation of demand and supply with axes for price and quantity). In comparative statics two or more sets of positions of variables are overlaid (the archetype is a shift in demand and supply). In both statics and comparative statics formulas, functions and decision rules dictate the values variables take (typically built from axioms that determine what an agent does) and also determine how sets of variables interact (the archetype is a convergence on equilibrium). So, in the absence of time there is a presumption of *activity* necessary to determine an outcome (again, typically an equilibrium or jump from one equilibrium to another – a before and after). Statics and comparative statics are timeless yet time dependent. Dynamics in contrast introduces a time variable, a T_1 , T_2 etc. However, this shares with statics and comparative statics some carefully defined formulation that determines the values (or range of values) taken at each point in time (T) – functions, structural equations etc.³ This is usually subject to the overriding assumption of convergence (again, archetypally an equilibrium which dictates movement and allows a solution) and/or manipulates the infinite future to facilitate a discounting process that dictates some determinable quantity at a particular point in time (T) – though this may not

¹ The idea of apocalypse of one kind or another is, of course, not new and there is a long list of end of the world predictions that have not come to pass, though it would be reckless to place the problem of anthropogenic climate change within his category. Visit: https://en.wikipedia.org/wiki/List_of_dates_predicted_for_apocalyptic_events

² A lot of what follows draws on the book I have been writing on and off (for over a decade) with Heikki Patomäki on time and economics. See also later references (and hopefully at some point the eventual book).

³ Or at least defines pathways from which data is deemed to deviate – for example, an 'output gap'.

necessarily be deemed dynamics in the strict sense. Those familiar with economics will know numerous strategies are involved in the manipulation of time – assumptions of complete information, regular activity and outcomes, Bayesian learning, ergodic processes etc. All of these (statics, comparative statics, dynamics) and their associated strategies of theory construction, proof, modelling and empirical/data applications fall into the category of ‘logical time’.

As the name suggests, representations of economic phenomena in logical time begin from defined logical relations – how one (or more) defined thing stands to another, how one thing acts in terms of another, responds in terms of another etc. Logical time does not need to take a mathematical form, but in economics it overwhelmingly does. In any case, logical time has several key characteristics. First, the determinations of activity that dictate the values variables take exhibit ‘time reversibility’, which means whether one runs the determinations forwards or backwards the outcomes remain the same (to be clear this can remain the case for a stochastic process). Second, and often as a consequence of the first characteristic, logical time ‘spatialises’ time, treating it as a set of coordinates. Third, irrespective of whether a specific time variable is absent or takes the form of T_1 , T_2 etc., the present has no unique status for the purpose of the treatment of time. In a real present there is always the possibility of action and outcome which is novel, unexpected or unaccounted for. In logical time determinations and coordinate placement remove the possibility that things can be otherwise in any fundamental sense *from within the theory or model framework* (there can, of course, in some approaches be ‘structural breaks’, but this is not a transition to a different treatment of time). In logical time, in statics and comparative statics (which either presuppose time has taken place or formally assume instantaneous outcomes) the present is either rendered irrelevant or is simply meaningless. In the case of dynamics the present becomes merely T_{now} in a well-specified series of coordinates and the past (logically if not empirically) is composed of former T_{nows} while the future simply becomes T_x that is yet to happen.⁴ Though a comparison to clock time may not be exact for all treatments of logical time, the basic analogy to time as a standardised, quantified, and universalised point-to-point count does capture the spirit of logical time.⁵

When economists argue that culture, socialisation and history matter for ‘how things turn out’ and that contingency, diversity and multiplicity (causal complexity) are intrinsic to an observably continuously changing and evolving economy (relative stability of institutions in time and place notwithstanding) they are invoking ‘historical time’. Historical time does not just mean ‘pay attention to history’. It is rather a set of claims about the nature of temporality. Historical time is characterised by cumulative causal process, irreversibility, path dependence but only relative stability in time and place, and the perpetual possibility that things can be otherwise, leading to open futures and fundamental uncertainty. It speaks to not only quantitative but also qualitative change (not easily captured in logical time), the specificity of time and place and thus to the need for very different approaches to theorisation and research on determinations (multiple, granular etc.).

The contrast between logical time and historical time ought to be familiar to anyone who has read or engaged in methodological discussion regarding the meta-trends and characteristics of economics over the last two hundred years or so.⁶ That said, the focus of debate has mainly been what happens in time as a way to critique different theory, models and schools of thought, rather than on time itself –

⁴ Standard econometrics and error terms etc. in classical probability merely complicate this.

⁵ For an excellent account of the sociology of time see the work of the founding editor of *Time & Society*, Barbara Adam (2004).

⁶ For background see one of the few books dedicated to time in economics, Currie and Steedman (1990).

debates over the nature of economic man, the role of culture and institutions, universalism, formalism, economics as science, whether economic laws exist and so on. Perhaps the best-known use of the language of logical time and historical time is among post-Keynesians (though one can find it in Schumpeter's work and various others too).⁷ Perhaps the best-known essay using the terms (other similar ones have been used) is Joan Robinson's 'Time in economic theory' (Robinson 1980).⁸ Perhaps the most interesting treatment of time is found in George Shackle's work (which covers a great deal of similar ground with the philosopher Henri Bergson on the psychology and phenomenology of time – Bergson questions the coordinate spatialisation of time and whether physics is adequate to the task of expressing the full meaning and significance of the experience of temporality – Shackle focuses on decision making and the capacity to think and act differently in the continually moving present).⁹ But for our purposes perhaps the most important work on the difference between logical and historical time and of the need for historical time comes from Nicholas Georgescu-Roegen. For Georgescu-Roegen, time is a 'plurichromatic' concept i.e. is many faceted. His work brings together the physics of processes and thus issues I referred to in the previous section that ecological economists draw attention to (the importance of material-energy use or metabolic flow, waste and entropic processes etc.) and an understanding of human consciousness and agency (drawing on Shackle, Schumpeter and Bergson). This leads to a concept of entropic-historical time that is qualitative/ordinal and unidirectional.¹⁰

Insofar as mainstream economics has been dominated by logical time, the main claim made in the introduction should now be relatively clear: the dominant concept of time is unrealistic and lacks an adequate focus on causal temporality – put another way, process and complexity. The first of the two 'consequences' should also be clear: an unrealistic theory of how things happen. There are numerous examples one might draw attention to in order to illustrate this. Perhaps the most appropriate is the Integrated Assessment Models (IAMs) that populate many of the studies the IPCC draws on for its synthesis reports and which inform Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs) (unidirectional linear change, curve fitting, calibrated discount rates and damage functions, and representative agents abound – complex cumulative interconnectivity with feedback, transitions, thresholds and exponential consequences and realistic scenarios do not, for this *anthropogenic/capitalogenic* catastrophe in motion). These models are dynamic but the dynamism conceals a host of failings (as almost everyone seems to acknowledge these days). This brings us to the second consequence, an inability to address within economics the big questions of what could happen (and what we need to happen).

⁷ See the survey from the (broadly) post-Keynesian Mark Setterfield (1995).

⁸ For a recent 'reconstruction' of Robinson's work focused on her later split from post-Keynesians over modelling and in the context of her approach to time see Martins (2023). For a comparison to Bergson, see Culham (2023).

⁹ Most of Shackle's work is built around theory of time. For a concise discussion see his published guest lecture series (Shackle 1958). For comparison to Nicholas Rescher see Latsis (2015).

¹⁰ One of his final ruminations on time is published in a collection dedicated to John Hicks, a pioneer of comparative statics who moved towards historical time in later life (Georgescu-Roegen 1994). See also Bobelescu (2017).

3. Logical time and what we need to happen

In the introduction I suggested that the other consequence I was going to pursue was an inability to address within economics the big questions of what could happen (what we need to happen). On this subject one could just say (in addition to what I have suggested from the ecological economics critique): much of economics has difficulty addressing big questions, it often lacks a capacity to deal with its normative implications or make a normative case, and it tends to present itself as a simple data science of the kind 'if we assume x and you do y then the likely outcome is z' (subject to using data to test concepts and concepts to test data). But this is a short essay on the problem of time in economics. If we return to the implications of logical time then it ought to be clear that there is a basic problem in making sense of transformative action intrinsic to this concept of time – and this is the 'what we need to happen' in an ecological context. In logical time the present is simply T_{now} in a well-specified series, which means the past is composed of former T_{nows} and the future is merely T_x that is yet to happen according to a specification. Clearly, reality as we observe it and policy as it is pursued do not reduce to economists using logical time. But logical time is still problematic, given the way it represents reality and restricts the imagination. If we are to have real agency (if we are to do 'otherwise') this cannot be accommodated by logical time. And, of course, we *do* have real agency. In reality what we do resists specification and so the past is not really a simple series of such specifications and the future will never come into being as merely a manifestation of successive T_{nows} . There is contingency and uncertainty and at the same time (no pun intended) there are futures we want and futures we don't. But the existence of uncertainty (with its question mark over prediction) means historical time too might seem to be potentially unhelpful. But this is an apparent rather than real problem and to see why this is the case we need to start thinking of historical time in terms of the open future and we need to start thinking about the special status of the present and its significance. The future is not merely predicted, the future is made – albeit there is a popular version of the metaphysics of time that seems to say differently.¹¹

4. Cumulative causal complexity and the complications of the special status of the present (back to the metaphysic)

There is a set of arguments regarding the 'block universe' which conjecture that the whole of space-time exists together and so the experience of time is a limitation of perception rather than a feature of reality. From this point of view the special status of the present is rejected and things can never be otherwise since all space-time coordinates already exist. However, if this is so then our capacity to make things otherwise has already happened and we have made our choices (in a universe that came into being all together) and the fate of the planet and our species is moot (we have either 'chosen' to do what is necessary or we haven't). Of course, from a spatiotemporally limited perspective of the human mind we can't know if thinking about this context affected how we responded in context and so was part of a block universe in which we fail to flourish or was instead a counterproductive surrender to the illusion of the inevitable, if we in fact fail to flourish. In any case, if we put the block universe aside and opt for what is called dynamic theory of time (not to be confused with dynamics in economics) then reality is tensed.¹² It is in the present that we act, the past consists of former presents and has (Einstein's 'relativity of simultaneity' notwithstanding) happened and cannot be changed, the future is the present that is yet to be and remains contingent until it becomes the present. We do not get to

¹¹ For brilliant work on the subject of process and prediction see Rescher (1996, 1998).

¹² I discuss the metaphysics of time in Morgan (2023), as well as in the book with Heikki.

choose if this happens, since it is intrinsic to time's arrow that we progress through time, but we *do* get to choose (if not without condition) *what we do in time*.

Let's consider some features of the metaphysics of time. If we add in the concept of process then temporality is not just a movement between points, and if we accept the implication of this, then process is *cumulative* insofar as what happens affects what then happens. Moreover, if we then add in a concept of causation then the concept of the present within process becomes an even more interesting issue. Action coalesces in an event (just as a cause has a consequence) and an event becomes one in a series. This is the flowing present conceived as an ordering of events and it is only in the particular event – in time and space – that something happens that could have happened otherwise but did not. However, it is observably the case that the causes of events are not reducible merely to the events. Events can have *multiple* causes. Now, if we translate these back into processes and think of causes as part of processes it is no great leap to realise that not only are there many different kinds of causes (which we might think of as the product of the way of acting of particular things and systems that have powers and potentials based on their organization or constitution – physical, chemical, biological, conscious-intentional, social, economic etc.) but the processes in which these are instantiated can be operating over different time scales and spatial extents. What else after all is anthropogenic climate change if not a product of multiply causal spatiotemporal process?

Let's reconsider the concept of the present.¹³ In an event sense the present becomes the past and is done (is over) but in a process sense its relational significance can be incomplete. Carbon emissions occurring now, quickly become past events but their significance is for future average global temperatures and consequent climate system changes that someone then gets to experience as part of their present. Incompletion (which is just another way of saying processes continue) is especially interesting if we start to think about the attributes that human consciousness and reflexivity bring to reality. The meaning of the past for the present can itself be under review in ways that affect what happens in the present. Put another way, if we start to think of historical time as cumulative causal process and then start to think of the past as still active in the present (and there are many ways this might be so, not just via being 'under review') then it becomes possible to start to not just describe a geo-historical reality (making a claim that 'this is how things are' – so historical time is more realistic than logical time), it becomes possible to *think* in terms of the significance of a geo-historical reality. Our understanding of the flow of time, of the many 'causal' processes we are entangled in (and of which we are part) and especially of the nature of institutions, can alter and so our attitudes to design can be different and our reasons to act can be different – affecting what we do and how we act. In historical time, agency in the present has the quality of altering determinations. A reflexive agent can learn to think geo-historically and arguably this provides a more productive way of approaching the future that mediates between, on the one hand, contingency and uncertainty and, on the other hand, closing down some futures and opening up others.

With all of this in mind then, the concept of historical time is, potentially, not just a more realistic theory of time. Our reasons for adopting historical time can be more than just 'because it is more realistic'. Thinking in historical time becomes a medium for progress because thinking in terms of it allows us to appreciate the nature of opportunity built into the processes active in time and this itself is part of learning to be different in the world with consequences for the world (reclaiming agency in a world of cynicism, scepticism and fear of 'the inevitable'). This doesn't seem much like economics does it? It

¹³ The basic argument here draws on Heikki's ideas and also Roy Bhaskar's but plays down some parts that might be confusing regarding the idea of the extended relative present (Patomäki 2023). I'd also been reading Sayer (2011) and Lawson (2019) on social theory – not temporality.

might also seem trivial. But stop for a moment to think about the two consequences I suggested in the introduction I would be pursuing: unrealistic theory of how things happen and inability to address within economics the big questions of what could happen (what we need to happen). Logical time has its uses, but it is clearly insufficient to address the problems around us and that includes climate emergency. The switch is perhaps not so trivial...

5. Conclusion

I stated in the introduction that you cannot solve a problem unless you reorient theory and method to better explain and understand actual causes as a precursor to realistic (in the sense of what a liveable planet allows) solutions. What I meant by this in terms of a focus on theory of time should now be clearer. However, there's always a danger of overcomplicating any theory of complexity. The simple point I have made is that once we start thinking in terms of causal process the present becomes qualitatively different as a concept and our perspective on time becomes different. Causal process changes temporal dynamics and gives depth and nuance to historical time and historical time seems to be more adequate than logical time. One might, of course, think this too difficult for Economics 101, but the whole becomes less mind-bending and/or ephemeral once we start to think about focusing on the data for material-energy processes on a finite planet involving metabolic flow and waste and marrying this to exploration (and decomposition for particular discussion) of the many causal processes that are operating and our role within them. This leads to focus on social redesign and institution building – exploring the legitimization of ways of doing things in terms of say, wants and needs.

There are many issues that need to be addressed. For example, not only is there an approach that presupposes continually expanding economies, but there is also a general argument that we need bigger economies to afford the changes we want to see. This is often misdirection. The UK, for example, is currently the sixth biggest economy in the world by annual GDP. In current \$US terms, according to the World Bank, the UK's annual GDP was \$73 billion in 1960 and over \$3 trillion in 2022 (so larger by over \$2.9 trillion, since \$100 billion would be a tenth of a trillion).¹⁴ Yet the UK has a cost of living crisis, a public and private debt crisis, a housing availability and affordability crisis, low levels of investment, failing infrastructure, degenerating public services and welfare system, rising poverty and massive wealth inequality and entrenched income inequality (exacerbated by chronically low social mobility). Exactly how big does an economy have to be before it can 'afford' to treat its people and the planet better?¹⁵

Pessimism is everywhere at the moment – we have leaders who struggle with object permanence, never mind truth. For our purposes, however, economics has to be able to tell a story of rational hope and for this to be so there has to be the possibility of better and this should be basic to Economics 101. In his book *World Statehood: the future of world politics*, Heikki Patomäki introduces the phrase 'self-transformative capacity of contexts' (Patomäki 2023). I like this phrase. There are numerous other works offering ways forward that one may or may not agree with. The work of Clive Spash (2024), Kate

¹⁴ Visit: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=GB>

¹⁵ There is, of course, continual technological change and a great deal of focus now on technology for climate purposes. For example, the *Financial Times* recently reported a possible breakthrough by Toyota in commercial solid state electric batteries for vehicles etc. However, in the same week new research taking into account the aerosol effect reduced the remaining carbon budget for 1.5°C from approximately 500 billion tonnes of CO₂ to about 250. Visit: <https://www.ft.com/content/f4353d2b-f941-475b-bc1d-a64475503ea6> and: <https://www.thetimes.co.uk/article/less-time-to-avoid-breaching-1-5c-limit-n8j9bsj06>

Bayliss and Ben Fine (2020), the Foundational Economy Collective (2022), Jason Hickel (2020), Anitra Nelson (2022), Erik Olin Wright (2019), Hamed Hosseini and Barry Gills (2023) etc.¹⁶ There are many others, including the collection this essay appears in, but the point though is to at least expose students to ideas and for debate to be had. This, I suppose, might render economics what Andrew Sayer refers to as 'post-disciplinary' – in economics' case this can only lead to a progressive oxymoron.

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¹⁶ See also: <https://doi.org/10.1080/14747731.2021.1906006>

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