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Time, equilibrium and uncertainty: Bergson and Robinson

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The philosophy of Henri Bergson can lend fresh perspectives on some central aspects of post-Keynesian economic thought. Bergson's concept of duration offers philosophical reinforcement for Joan Robinson's criticisms of the treatment of time, equilibrium and uncertainty in economics. When the economy is recognised to be a dynamic living system, in which the accumulation of capital is an historical process inseparable from technical innovation, the effect of time is of utmost importance. Duration provides greater understanding of an economy moving through historical time, while adding depth to Robinson's doubts about the validity of utility, and consequently expected utility theory. Bergson's philosophy of evolution and duration provides a valuable basis for understanding many of the classical issues in political economy.

Key words: Time, Equilibrium, Uncertainty
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1. Introduction

Throughout her work, Joan Robinson frequently questions the 'dominance of the concept of equilibrium' in economic theory and its failure to include time adequately in its analysis (Robinson, 1962B, p. 70). Robinson warns that 'a space metaphor applied to time is a very tricky knife to handle, and the concept of equilibrium often cuts the arm that wields it' (Robinson, 1962A, p. 82). Similarly, Henri Bergson, through his theory of 'duration', emphasises the common mistake of treating time as if it were like space. Bergson's concept of duration gives substance to Robinson's doubts and allows for a more fully developed critique of the equilibrium method and its treatment of time.

This paper considers areas of economics where aspects of Bergson's thought can provide theoretical development, deeper foundations, and a more thorough philosophical basis for these issues with time. In particular, this paper draws parallels between Bergson and Robinson to highlight similarities in their analysis of time. The contention is that the questions Robinson raises about time, equilibrium and uncertainty can be

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better understood viewed through a Bergsonian theoretical lens. When the economy is considered as a dynamic living system, many of the aspects of economics that Robinson takes issue with gain support from Bergson's philosophy.

For Robinson, 'the expression *post-Keynesian* has a definite meaning; it applies to an economic theory or method of analysis which takes account of the difference between the future and the past' (Robinson, 1981, p. 78, original emphasis).[1] Her focus, then, is on how to extend the short-period and static analysis of Keynes's *General Theory* into a long-period and dynamic theory of economic growth, the accumulation of capital and its consequences. This dynamic analysis, however, 'cannot explain how an economy behaves, in given conditions, without reference to a past history' (Robinson, 1979, p. ix).

The importance of time is reflected in Robinson's insistence on the importance of 'historical time', and her scepticism of the 'logical time' used in equilibrium models where the actual time taken to reach equilibrium is abstracted, along with any effects which occur during its elapsing. In logical time, past mistakes can be rectified; only in historical time does the uncertainty of the future play a significant role—both in the present and in the past.

These methodological issues are most apparent in the neo-classical treatment of capital and time, so at various points throughout the paper reference will be made to the canonical Dynamic Stochastic General Equilibrium (DSGE) model.[2] Very simply, the model contains a single 'representative' agent who optimises their intertemporal (that is, expected lifetime) consumption of a (usually single) consumer good. This optimal pattern is limited by the constraint of a 'production function' whereby consumption foregone today becomes investment in new productive capacity as a trade-off for higher consumption in the future. One or more model processes can be subject to stochastic shocks, but the assumption of 'Rational Expectations' means that the agent is fully aware of the objective and immutable probability distributions that govern all future contingency. Bergson's philosophy allows us to advance Robinson's critique of this model.

The paper is organised as follows: the next section provides a brief outline of duration and Bergson's philosophy of time. The following five sections use aspects of Bergson's philosophy to address, extend and deepen our understanding of areas of economic theory questioned by Robinson and the post-Keynesian school. The sections are grouped roughly by their deficiency with regard to time: timelessness; time as space; timeless space; time without the past; and time without the future. The final section concludes.

2. Bergson

French philosopher Henri Bergson (1859–1941) was hugely influential in the early twentieth century. His 1911 lecture tour of Great Britain marked the start of a 'Bergson Boom', but by the 1930s he had fallen into obscurity after unfavourable reviews by Bertrand Russell (Russell, 1912) and debates with Albert Einstein significantly dented his reputation (Canales, 2015). Bergson's thought has since staged a revival due to the

[1] Consequently, this paper will focus on Joan Robinson's post-Keynesian period which begins with her *Accumulation of Capital* (Robinson, 1956) as argued by Rochon (2023). It is from this point onwards that the parallels between Robinson's views on time and Bergson's become most pronounced.

[2] The term DSGE here should be understood to cover the various models (Real Business Cycle, New Keynesian and neo-Wicksellian) based on the optimisation of intertemporal utility by a representative agent.

influence of Gilles Deleuze ([1966] 1988), and 'is [now] widely regarded as one of the most original and important philosophers of the twentieth century' (Sinclair and Wolf, 2021).[3]

Robinson may have gained familiarity with Bergson's ideas via Keynes and his membership of the Bloomsbury literary set—most notably Virginia Woolf, whose treatment of time has been likened to Bergson's (Brown, 2009). That Robinson at least knew of Bergson is demonstrated by her use of a quotation attributed to him on the title page of *Essays in the Theory of Economic Growth*: 'Time is a device to prevent everything from happening at once' (Robinson, 1962A, p. iii).[4] To our knowledge, however, Robinson makes no other direct reference to Bergson or Bergson's work.

Bergson's philosophy emphasises the importance of time, and its role in the creation of novelty in living systems. Bergson introduces his theory of time in *Time and Free Will* (Bergson, [1889] 2001) as a psychological phenomenon, and extends its applicability to have broader implications in his later works, especially *Creative Evolution* (Bergson, [1907] 1998), in which it forms the foundation for a theory of evolution, and *Duration and Simultaneity* (Bergson, [1922] 1965), which attempts to provide a philosophical interpretation of Einstein's Special Theory of Relativity.

For Bergson, time, unlike space, is not given all at once. The key building block of his philosophy is the concept of duration, which reflects the fundamental difference between space and time. Although space and time are media that differ in kind and not degree, as intelligent beings our practical inclination is to treat time like space. Just so, Deleuze ([1966] 1988, p. 31) emphasises the importance of time as a 'Third Rule' of Bergson's philosophical method, namely: 'State problems and solve them in terms of time rather than of space'. Since Bergson's concept of duration is so fundamental to his thought, we first need to take some trouble to establish it clearly as much of our analysis will ultimately build on its foundations.

2.1 Duration

For a sentient being each moment in the present contains—and is potentially affected by—memories of its past. This enduring experience of time is crucial to Bergson, who calls it 'duration' (*durée*) to distinguish it from our more common practical treatment of time. In its simplest form, duration is a lived psychological time in which, by means of memory, the entire past permeates the current moment, thereby affecting it without any conscious separation. In duration, time is experienced as 'succession without distinction' since all moments melt into each other (Bergson, [1889] 2001, p. 101). As such, our psychological experience of time cannot be broken down into juxtaposed moments without losing a fundamental aspect. Our past interpenetrates the present and influences our responses, sensations and actions. Duration and memory allow choice over our actions so that we can learn, adapt and engage free will.

[3] Russell's incomprehension of Bergson reflects a still-persistent methodological conflict between 'analytical' and 'continental' philosophy. Similarly, Bergson's identification of problematic metaphysical assumptions underpinning Einstein's theory is an example of continuing and unresolved disputes between philosophers and physicists.

[4] As stated, this definition of time is trivially true and has a subtly different meaning from the more common 'time is what hinders everything from being given at once' (Bergson, 2002, p. 224). For Bergson, it is not that without time there would a single simultaneity, but the significance of time is that the future is not pre-given; time allows for a continuous creation of unforeseeable novelty.

Bergson contrasts duration with our more common mental treatment of time whereby successive moments are effectively perceived simultaneously by 'setting them out in line after having distinguished them' (Bergson, [1889] 2001, p. 102). A common representation of time is as a projection onto a line laid out in space, where it can be divided into measurements—hours, days, years. Although this mental image of time is immensely practical for train timetables and physics, it overlooks the effect of pure duration. For Bergson, this treatment of time as space is misleading and the 'analogy between time and space is, in fact, wholly external and superficial' (Bergson, [1922] 1965, p. 6).

Consider the phenomenon of music. Without memory, which allows the blending of the previous notes into the current ones and provides a qualitative impression of the entire series, we would experience nothing more than a meaningless sequence of noises (Bergson, [1889] 2001, p. 86, 100). Only via duration do previous moments affect the current one by pervading it in a way that cannot be represented by 'two images side by side' (Bergson, [1889] 2001, p. 105). Duration, as the 'continuation of what precedes into what follows and the uninterrupted transition, multiplicity without divisibility and succession without separation' (Bergson, [1922] 1965, p. 44), is most evident in the experience of melody. Similarly, the perception of colour employs memory in synthesising, what would otherwise be, a series of light pulses into a qualitative experience.

It should also be emphasised that 'duration is not a combination of separate moments' (Sinclair, 2020, p. 51), but is the 'continuous progress of the past which gnaws into the future and which swells as it advances' (Bergson, [1907] 1998, p. 4). The continuous interpenetration of past memories into present experience occurs to such a degree that, for Bergson, what we actually experience is the past in various degrees of contraction. The most contracted form is closest to the pure present; the most relaxed, dreamlike state is directed more towards the past and is less connected to the present.

Since each moment is contaminated by all previous ones, and are therefore inseparable, duration is irreversible and cannot be fully represented by space; 'the idea of a reversible series in duration, or even simply of a certain *order* of succession in time, itself implies the representation of space' (Bergson, [1889] 2001, p. 102, original emphasis). This order of succession is entirely a mental image constructed by memory since each 'before' and 'after' is perceived in the current moment. If perception were actually in entirely spatial terms without memory, then there could be no previous moments because 'space has preserved no trace of it' (Bergson, [1889] 2001, p. 105).

As an example, Bergson, [1889] 2001, pp. 104–105) considers the sixty oscillations a pendulum makes during a minute and how they can be experienced in three different ways. First, we can form a mental picture of all them simultaneously, effectively placing them side-by-side in space and thereby losing their succession. Second, we could focus on each oscillation in succession, but only by forgetting all previous ones and experiencing a continuous present. Third, we can recognise that our perception of each oscillation is, in fact, permeated by its predecessors in pure duration. For, as Bergson points out, it is the mental build-up of oscillations that is liable to make us sleepy, otherwise the most recent oscillation would have no more effect than the first (Bergson, [1889] 2001, p. 105).

For Bergson, space and duration exhibit differences in kind, not simply in degree. Because its constituents share the same fundamental nature, space is divisible, countable, homogeneous and measurable. Space is therefore a 'quantitative multiplicity'. Duration, by contrast, is a 'qualitative multiplicity'; it is indivisible, uncountable,

heterogeneous, and cannot be partitioned without changing its very nature. In pure inorganic space there is no succession—there is only ever the present moment; succession only appears in living systems. To represent these successions as space, as is our tendency, is mistaken.

2.3 Movement

Duration applied to an analysis of movement shows that, although we tend to think of the movement of a body as a series of positions in space, this representation does not embody the whole phenomenon. Movement itself is not an object; it is a *process* through time and, Bergson says, is a sensation synthesised in the mind—movement is an expression of duration. This understanding is not to deny that movement involves a transversal of space, just that the *act* of movement in itself 'has no reality except in a consciousness' that can interpret the present in terms of the past (Bergson, [1889] 2001, p. 112).

Only by illusion do we 'substitute the path for the journey' (Bergson, [1896] 2004, p. 248), or conflate the space covered by movement with the actual process of movement. Only the former can be divided. 'Every movement, inasmuch as it is a passage from rest to rest, is absolutely indivisible' (Bergson, [1896] 2004, p. 246, emphasis removed). Movement cannot be represented mathematically by a sequence of static points in space without losing its essential nature.

> Consider, for example, the variability which is nearest to homogeneity, that of movement in space. Along the whole of this movement we can imagine possible stoppages; these are what we call the positions of the moving body, or the points by which it passes. But with these positions, even with an infinite number of them, we shall never make movement. They are not parts of the movement, they are so many snapshots of it; they are, one might say, only supposed stopping-places. The moving body is never really *in* any of the points; the most we can say is that it passes through them. But passage, which is movement, has nothing in common with stoppage, which is immobility. A movement cannot be superposed on an immobility, or it would then coincide with it, which would be a contradiction (Bergson, [1903] 1912, pp. 48–49, original emphasis).

In effect, duration applies anywhere where life and time play a part. In later works, Bergson asserts that duration does not just have psychological impact, but is also relevant to biology, physics and metaphysics. It is by means of an 'organic memory' (Bergson, [1907] 1998, p. 19) that 'the organism which lives is a thing that *endures*' (Bergson, [1907] 1998, p. 15, original emphasis). 'Wherever anything lives, there is, open somewhere, a register in which time is being inscribed' (Bergson, [1907] 1998, p. 16, emphasis removed). Living beings and systems have duration, and each individual consciousness is linked to an 'impersonal consciousness' that leads to the 'idea of a duration of the universe' (Bergson, [1922] 1965, p. 45).

Bergson's theory of duration offers a valuable perspective on the questions Robinson raises over the treatment of time, equilibrium and uncertainty in economics. The concept of duration, and the understanding of time it gives us, founds a critique of those economic analyses that, in one way or another, neglect to incorporate the effects of time.

3. Timelessness: supply and demand

The most common misuse of time in economic theory is evident in the familiar Marshallian supply and demand diagram. Here, Robinson draws attention to the implicit and problematic use of dynamics in what is a fundamentally static framework.

The problem is that 'historical events are introduced into a timeless picture' (Robinson, 1981, p. 87). Effectively 'time lies at right angles to the plane on which the diagram is drawn, with the past behind it and the future in front', thereby rendering the schema misleading and incomplete (Robinson, 1978, p. 130).

Even in this simple case, we can see how the framework violates the spirit of Bergson's 'Third Rule' in Deleuze's schema. It is the absence of an adequate treatment of time that Robinson finds problematic in this workhorse apparatus with its implied movement to equilibrium. Although Robinson's complaints are methodological in nature, she nevertheless identifies the very conceptual problems that, with Bergson's idea of duration, we can now associate with analysis conducted in terms of space and not time.

To see this, consider the common interpretation of the interplay between supply and demand. It is said that 'equilibrium' is attained at the point where the supply and demand curves intersect. All other points in the price-quantity plane represent 'disequilibrium' and, it is further asserted, their occurrence triggers a tendency towards equilibrium. If supply is greater than demand, the price will fall until equilibrium is established or restored, and vice versa.[5]

Yet, as Robinson points out, 'rising and falling are movements in time' which 'may be conceived to lie at right-angles to the page but nothing in the picture tells us what happens when we move off the sheet' (Robinson, 1962A, p. 22). All of these movements, in reality, are processes in time. In describing how the process of equilibrium is attained, Robinson argues that the economist is 'using a metaphor based on space to explain a process which takes place in time' (Robinson, 1978, p. 138). The absence of time, and especially duration, invalidates the method.

3.1 Logical and historical time

Robinson distinguishes the 'logical time' used in equilibrium-based models from 'historical time' in which interactions between the economic elements actually 'play themselves out' (Robinson, 1962A, p. 23). In an equilibrium model, even though the 'equations may determine a path through time' (Robinson, 1962A, p. 24), this movement occurs in a purely logical time in which 'the past is determined just as much as the future' (Robinson, 1962A, p. 26). For example, the neo-classical 'production function' specifies the quantity of output capable of being technically produced by quantities of capital and labour, with an increasing amount of capital capable of only producing diminishing levels of output. By representing this change in capital and output as a 'movement with "time" from left to right across the page' (Robinson, 1962A, p. 24), the model operates in a purely logical spatialised time which presents the 'past' and the 'future' as a simultaneity.

The 'Cambridge Capital Debates'[6] centred on the problems of measuring 'a given amount of capital' (Robinson, 1979, pp. 100–1), but, on a deeper level, the 'real source of trouble is the confusion between comparisons of equilibrium positions and the

[5] The Marshallian and Walrasian interpretations of the supply and demand framework place any adjustment process on quantity and price respectively. The Walrasian version, which Robinson takes exception with, applies the stronger condition that trade does not take place at disequilibrium prices. Her preferred interpretation of supply and demand 'as a map' attempts to rehabilitate and interpret the Marshallian version (Robinson and Eatwell, 1973, p. 164).

[6] For a summary of the Cambridge Capital Debates see Cohen and Harcourt (2003).

history of a process of [capital] accumulation' (Robinson, 1978, p. 135).[7] Logical time must be distinguished from the historical time in which real movement takes place. 'To move implies a temporal sequence' (Robinson, 1981, p. 87) in which past expectations affect the present, the future cannot be foreseen, and the technical choices made in the past accumulation of capital are irreversible. 'Any movement must take place through time, and the position at any moment of time depends upon what it has been in the past' (Robinson, 1978, p. 177). No actual economy can experience real historical time without also experiencing technical change since

> two stocks of inputs appropriate to two different techniques cannot co-exist in time and space. There is no book of ready-drawn blueprints appropriate to different rates of interest. As accumulation goes on, technology evolves, and no technique is blueprinted before it is about to be used. (Robinson, 1978, p. 124)

Another aspect of the debate relevant to this discussion is the assumption underlying the neo-classical production function that the composition of the capital stock can be changed without difficulty. 'Output consists of a single homogeneous, divisible commodity, say, butter, which is both consumable and can be turned into a stock of means of production' (Robinson, 1978, p. 117). The reversibility of time that this malleability of output implies is a rejection of duration by simply assuming away any effect of historical time. The phenomenon of 're-switching' cannot be realised in historical time, it is a thought experiment conducted in purely logical time—different production techniques can only exist on isolated 'islands' with their own entirely separate histories (Robinson, 1979, p. xxiii).

In allowing for a smooth reallocation of capital between investment and consumption the neo-classical production function describes an artificial and isolated system fully determined by its spatialised composite parts so that 'when a part has left its position, there is nothing to prevent its return to it' (Bergson, [1907] 1998, p. 8). Consequently 'any state of the group may be repeated as often as desired, and consequently that the group does not grow old. It has no history' (Bergson, [1907] 1998, p. 8).

Robinson's logical and historical times are, in many ways, mirrored in Bergson's distinction between abstract and concrete time. Movement cannot be reconstructed from observations of position, for to do so 'is to ignore the cardinal difference between *concrete* time, along which a real system develops, and that *abstract* time which enters into our speculations on artificial systems' (Bergson, [1907] 1998, p. 21, original emphasis). Abstract mathematical time t represents only a 'certain number of simultaneities' (Bergson, [1907] 1998, p. 9) and movement is effectively represented by a series of static snapshots. In effect, because 'the business of science is to measure' (Bergson, [1922] 1965, p. 35), we 'measure the space traversed, the only thing, in fact, which is really measurable. Hence there is no question here of duration, but only of space and simultaneities' Bergson, [1889] 2001, p. 116).

The actual flux of time is missing from such 'cinematographical' models—they can be sped up infinitely without effect, there is no real succession or time (Bergson, [1907] 1998, p. 338). In these models, because time is 'spread out all at once in space', it has no creative power (Bergson, [1907] 1998, p. 345, emphasis removed). In such closed,

[7] This emphasis on historical time sets Robinson apart from other contenders even on her own side of the debate. For example, 'as the basis for analysis in a positive direction there is a difficulty about the specification of Sraffa's model in terms of logical time' (Robinson, 1981, p. 88).

isolated systems, a 'superhuman intellect could calculate, for any moment of time, the position of any point of the system in space' (Bergson, [1907] 1998, p. 8).

3.2 Comparative statics

For Bergson, abstract time, by representing time spatially, cannot capture the indivisibility of movement. 'What will flow on in the interval—that is to say, real time—does not count, and cannot enter into the calculation' (Bergson, [1907] 1998, p. 22); in the intervals between each snapshot the universe could effectively vanish. Instead, the 'systems that science works with are, in fact, in an instantaneous present that is always being renewed; such systems are never in that real, concrete duration in which the past remains bound up with the present' (Bergson, [1907] 1998, p. 22). The interval dt and, consequently, differentials representing velocity and acceleration (ds/dt and dv/dt) measure only the present (Bergson, [1907] 1998, p. 21). This dissatisfaction with differential calculus for representing historical time and movement is evident when Robinson expresses her bewilderment at being informed that 'when a mathematician says, "y rises as x falls", he is implying nothing about temporal sequences or anything different from "when x is low, y is high"' (Paul Samuelson quoted in Robinson, 1981, p. 87, 138).

Even increasing the number of measured simultaneities or intervals cannot capture the essence of movement, since

> however small the interval is supposed to be, it is the extremity of the interval at which mathematics places itself. As for the interval itself, as for duration and the motion, they are necessarily left out of the equation. (Bergson, [1889] 2001, p. 120)

Inserting more snapshots, in a futile attempt to use the essentially static, cinematographical method to reconstruct movement, is to accept the 'absurdity that movement coincides with immobility' (Bergson, [1907] 1998, p. 310). This practical reconstruction is useful in purely mechanistic systems, but is a misleading imitation when applied to living systems subject to the effect of duration and the process of 'becoming'. We can see the similarities between Bergson's abstract time and Robinson's logical time when she warns us that, although 'we can take a number of still photographs of economies each in stationary equilibrium', 'it is not allowable to flip the stills through a projector to a obtain a moving picture of a process of accumulation' (Robinson, 1978, p. 135). In the words of Bergson: 'duration, as duration, and motion, as motion, elude the grasp of mathematics: of time everything slips through its fingers but simultaneity, and of movement everything but immobility' (Bergson, [1889] 2001, p. 234).

We should therefore be cautious in using comparisons of equilibrium points to analyse change:

> There is much to be learned from *a priori* comparisons of equilibrium positions, but they must be kept in their logical place. They cannot be applied to actual situations; it is a mortal certainty that any particular actual situation which we want to discuss is not in equilibrium. Observed history cannot be interpreted in terms of a movement along an equilibrium path nor adduced as evidence to support any proposition drawn from it. (Robinson, 1962A, p. 25)

Bergson's analysis of movement provides a philosophical basis for questioning the use of the comparative statics to understand an historical process, but also, as we see next, the concept of equilibrium itself.

4. Time as space: equilibrium

Robinson identifies the deficient treatment of time and movement in the supply and demand framework, but also finds the concept of equilibrium itself problematic.[8] Having questioned the tendency for it to be attained, we can see that the idea of equilibrium as a destination unaffected by the passage of time is also questionable.

> The concept of equilibrium is incompatible with history. It is a metaphor based on movements in space applied to processes taking place in time. In space, it is possible to go to and fro and remedy misdirections, but in time, every day, the past is irrevocable and the future unknown. When bodies are out of balance with each other in space, given time, they can move towards equilibrium (Robinson, 1979, pp. xiv–xv).

Time is lost in the metaphor, since the 'equilibrium, in ordinary speech, describes a relation between bodies and space' (Robinson, 1956, p. 57); it relies on a 'concept of "stability", based on a mechanical analogy' (Robinson, 1978, p. 127). In the world we live, we are unable to move forward and backwards in time; postulating a deterministic equilibrium position is a confusion of space and time. 'Time will help you with space. But take as much space as you like—how is that going to help you with time?' (Robinson, 1978, p. 139).

Robinson, like Bergson, invokes the image of a pendulum. Equilibrium is its vertical position and the pendulum will be '*tending* towards the vertical even at those moments when it is moving away from it' (Robinson, 1962A, p. 23, original emphasis). Equilibrium is a destination reached through a movement which should be subject to duration but nevertheless maintains a timeless immutability. But

> the idea of *tending* towards a position that is never actually reached is not easy to grasp. How long are the conditions depicted in the [supply and demand] curves supposed to remain in force while the market is wobbling about? Will not movements themselves affect the position towards which they are going? (Robinson and Eatwell, 1973, pp. 163–164, original emphasis)

Consider the analogy of equilibrium as the balancing of a set of scales. Any random disturbance can disrupt the equilibrium and a continuous series of such disturbances could prevent its ever returning to equilibrium, 'but, at any moment, there is a definite equilibrium position which it would quickly reach if, from that moment, we left it alone' (Robinson, 1956, p. 57). In its mechanised and spatialised form, the concept of equilibrium itself has a teleological finalism, in which the future—namely its equilibrium position—is given, and possibly even known.

> For mechanical movements in space, there is no distinction between approaching equilibrium from an arbitrary initial position and a perturbation due to displacement from equilibrium that has long been established (Robinson, 1978, p. 127).

But 'when a market reacts to a change in circumstances, we cannot liken it to the reaction of the balance to a once-for-all change in weights', since the process of reacting to the change itself will have 'a long-persisting effect upon the position it reaches' (Robinson, 1956, p. 58). Increases in demand, which lead to increased profits and revised expectations, affect investment decisions which in turn establish changes in productive structures that cannot be easily readjusted.

The actual dynamics of an economy are bound up with the accumulation of capital and the resulting economic growth. Models assuming 'an ultimate stationary state,

[8] For Robinson 'equilibrium' means the general equilibrium associated with the timeless Walrasian and competitive allocations of (largely) given endowments.

when accumulation has come to an end' (Robinson, 1962B, p. 61) fail in this regard. For

> as soon as we envisage an economy in equilibrium with zero net investment, we are plunged into an imaginary world, for the institutions of capitalism, in actual experience, are closely bound up with the process of accumulation. (Robinson, 1979, p. 5)

The realistic analysis of a capitalist system involves 'a movement forward through time, with the stock of capital and stock of technical knowledge growing as time goes by' (Robinson, 1979, p. 5). Using a strikingly Bergsonian phrase, Robinson asserts that it is mistaken to 'pretend that "capital"', either in the form of capital goods or financial assets, is 'homogeneous, divisible, and measurable' (Robinson, 1981, p. 101). Since capital enforces the persistence of the past into the present, the accumulation of capital can be likened to an accumulation of memory. Capital is a form of qualitative multiplicity analogous to duration. 'What is meant by saying that a quantity of "capital" remains the same when it changes its form is a mystery that has never been explained to this day' (Robinson, 1962B, p. 60).

4.1 Duration and capital

The process of economic growth and change is itself subject to duration, whereby the past—most notably in the form of installed capital equipment—is part of, and continually affects, the present and future. The idea of an equilibrium position that can be readily restored is 'quite unlike a movement through time. In time, we go only one way, from the past to the future, and whatever happens once, affects what will happen next' (Robinson and Eatwell, 1973, p. 164). Equilibrium requires expectations to be fulfilled, but prices at disequilibrium may well revise expectations. An equilibrium of balance, such as that of a pendulum at rest or a set of scales, is spatial, static and teleological. When new weights are added 'the balance will wobble for a little, then settle in a new position. It does not tend to get into equilibrium, it actually gets there' (Robinson and Eatwell, 1973, p. 164).

The spatial analogy of equilibrium suggests a motionless atemporal moment conforming to a Platonic Form 'screened from the laws of time and, as it were, plucked out of eternity' (Bergson, [1907] 1998, p. 315). As such, equilibrium is 'stationed outside space as well as above time' (Bergson, [1907] 1998, p. 318). When a Platonic Form embodies what ought to be the underlying 'theoretical reality of Being', then 'sensible reality' or becoming is nothing more than a 'perpetual oscillation from one side to the other of this point of equilibrium' (Bergson, [1907] 1998, p. 317). A system out of equilibrium merely 'manifests the degradation of its essence' (Bergson, [1907] 1998, p. 343) such that duration and becoming are merely a deviation from the motionless eternal truth represented by the ideal concept of the equilibrium Form. Space and time only exist while the pendulum oscillates; once it returns to its 'normal position' of equilibrium then 'space, time and motion shrink to a mathematical point' (Bergson, [1907] 1998, p. 319) and 'suppress space and time' so that 'past, present, and future shrink into a single moment, which is eternity' (Bergson, [1907] 1998, p. 320).

At this point, it becomes necessary to distinguish between equilibrium as a state of rest or balance, from an 'intertemporal' equilibrium representing an optimum path, such as those derived from neo-Walrasian, Arrow-Debreu or Rational Expectations

equilibria.[9] The essential feature of an intertemporal equilibrium is that all agents' future plans are consistent and no better plan is available. This 'dynamic' equilibrium relies implicitly on expectations of the future, and to be anything more that momentary these expectations must reflect 'perfect foresight' (Robinson, 1962B, p. 76). Rather than a tendency that the economy may be moving towards, a dynamic equilibrium can actually be attained.

These two forms of equilibrium—static and dynamic—mirror Bergson's distinction between 'ancient' science and 'modern' science in which 'ancient science thinks it knows its object sufficiently when it has noted of it some privileged moments, whereas modern science considers the object at any moment whatever' (Bergson, [1907] 1998, p. 330, emphasis removed). The static equilibrium of a pendulum at rest represents a privileged moment, whereas the dynamic intertemporal equilibrium introduces 'time as an independent variable' (Bergson, [1907] 1998, p. 336, emphasis removed). Ultimately, however, both methods fail to escape from the cinematographical method of isolated moments—one by privileging a single Idea or Form outside of time, the other by attempting to reconstruct movement through immobile snapshots.

We can now appreciate why Robinson finds it 'absurd to talk of "being in the long period" or "reaching the long period," as though it were a date in history' (Robinson, 1971, p. 18).[10] Such an equilibrium represents a state of the world in which no agent has reason to alter their planned activities and therefore 'entails that everyone knows exactly and in full detail what consequences would follow any action that he may take' (Robinson, 1978, p. 127). Decisions—especially about investment in new productive capacity—must be made with only a very imperfect knowledge about the future. If equilibrium is a situation of no regrets in which 'no one is kicking himself' (Robinson, 1971, p. 18), then for it to be possible today, all expectations made in the past about the present moment need to have been fulfilled. This proposition is indefensible: 'Human life does not exist outside history and no one has correct foresight of his own behaviour, let alone the behaviour of all the other individuals which will impinge upon his' (Robinson, 1978, p. 127).

Even setting aside this coordination problem, equilibrium conditions require that the stock of capital equipment in existence today must be satisfactory to its owners, implying that they knew 'what expectations about the future they would be holding today' when making investments in the past (Robinson, 1978, p. 90). Since this stock comprises overlapping cohorts of long-lived capital equipment, 'an economy can be following an equilibrium path today only if it has been following it for some time already' (Robinson, 1978, p. 90).

Consequently, equilibrium paths can be followed today only if they were followed in the past that leads up to it, with the result that 'equilibrium has no meaning unless you are in it already' (Robinson, 1978, p. 144). In effect, 'it is impossible for a system to *get into* a position of equilibrium' (Robinson, 1978, p. 82, original emphasis). The concept of dynamic equilibrium, with its mathematical characterisation of time, represents a spatialisation of time 'in which nothing changes except the [logical] date as the economy moves along its equilibrium path' (Robinson, 1978, p. 90). By collapsing all

[9] Glasner (2020) provides a good summary of these various forms of equilibrium.

[10] For Harris (2004, p. 20, original emphasis) movement itself is fundamental: 'The *long period* is not a length of time. Like the short period, it is a process'.

time into space, it becomes unclear how the system can get into or out of equilibrium, it cannot *become* anything since there is no concept of duration.[11]

5. Timeless space: ergodicity

An unavoidable aspect of reality is, as Robinson says, the 'very obvious fact that expectations about the future are necessarily uncertain', and this uncertainty is so fundamental that it 'cannot be reduced to a "calculated risk" by applying theorems of mathematical probability' (Robinson, 1978, p. 126). In the context of the DSGE model, the use of Rational Expectations and calculated risk allows the representative agent to optimise the utility of their expected lifetime consumption. Mathematically, the agent maximises an objective function:

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t U\left(C_t\right) \right], \tag{1}$$

where C_t is their consumption at time t, $U\left(.\right)$ the agent's time-separable utility function, $\beta < 1$ a subjective discount factor, and $\mathbb{E}_0\left[.\right] = \mathbb{E}\left[.|\mathcal{F}_0\right]$ is the expectation operator conditional on $\mathcal{F}_0$, the set of information known by the agent at time 0. Crucially, the agent is assumed to know the objective probability distribution of the model they inhabit.

Keynes describes the method of expected utility as an 'extraordinary contraption',

> by which all possible consequences of alternative courses of action were supposed to have attached to them, first a number expressing their comparative advantage, and secondly another number expressing the probability of their following from the course of action in question; so that multiplying together the numbers attached to all the possible consequences of a given action and adding the results, we could discover what to do. In this way a mythical system of probable knowledge was employed to reduce the future to the same calculable status as the present. No one has ever acted on this theory. But even to-day I believe that our thought is sometimes influenced by some such pseudo-rationalistic notions. (Keynes, 1978, p. 518)

In what follows, components of expected utility theory are examined from a Bergsonian perspective: the subsequent two sections focus on utility and probability, respectively. This section considers the relationships between uncertainty, time and expectation values.

5.1 Parallel universes

By maximising over expectation values 'expected utility theory implicitly assumes that individuals can interact with copies of themselves, effectively in parallel universes' (Peters, 2019, p. 1218). This approach ignores the effects of time by relying on an implicit 'ergodic assumption'. By means of a brief explanation of the concept, the ergodic property (or equality of averages) can be expressed more formally as:

[11] For Robinson analysis begins with a focus on the 'main movements' of economic reality (Robinson, 1956, p. 64) and therefore must also begin with historical time (or duration). It is for this reason that the three-stage theoretical process put forward by Cohen (1993), in which stage one is to create a 'closed deterministic equilibrium model' with the addition of historical time only attempted in stage two, misses the mark. Instead, the process should involve a 'meaningful analytic treatment of the dynamic process of capital in motion in historical time' (Harris, 2022, p. 187).

The expectation value of the observable is a constant (independent of time), and the finite-time average of the observable converges to this constant with probability one as the averaging time tends to infinity (Peters and Gell-Mann, 2016, p. 1, emphasis removed).

In mathematical terms, we have (Peters, 2019, p. 1216):

$$\underbrace{\lim_{T\to\infty}\frac{1}{T}\int_0^T f(\omega(t))\mathrm{d}t}_{\text{Time average of } f} = \underbrace{\int_\Omega f(\omega)P(\omega)\mathrm{d}\omega}_{\text{Expection value of } f}. \tag{2}$$

Simply put, the assumption of ergodicity allows the agent to be indifferent between deciding on a course of action based on their experiences in an infinite number of parallel worlds or on how a single life experience would play out (to the end of time). The use of either infinite worlds or infinite time allows for the removal of randomness. The problem with this approach is that an

> expectation value of a non-ergodic observable physically corresponds to pooling and sharing among many entities. That may reflect what happens in a specially designed large collective, but it doesn't reflect the situation of an individual decision-maker (Peters, 2019, p. 1218).

The expectation value cannot represent any individual lived experience, it represents an appeal to a 'multiverse' (Peters, 2019, p. 1218) in which no-one can actually live. The method is limited to 'a static probability space, without an explicit treatment of time', which 'is dealt with quite separately, namely through a process referred to as discounting' (Peters, 2019, p. 1217), here denoted by β.

Yet, although discounting future utility appears to resolve 'the conflict between myself now and in the future' (Robinson, 1962B, p. 83) by representing the necessary reward for waiting, the 'problem cannot be resolved by any kind of calculation based on "discounting the future" for the individuals concerned in the loss or gain are different' (Robinson, 1962B, p. 123). Indeed, in the next section we will see that this problem occurs even when the individuals involved are not different.

Basing time-dependent decisions on expectation values is valid only if the decisions pertain to ergodic stochastic processes, whereby it is acceptable that 'time is essentially eliminated from the models' (Peters, 2019, p. 1216). But these cases tend to be invalid for 'systems far from equilibrium' or 'models of growth' (Peters, 2019, p. 1216). In the case where the decision strategy is in response to a non-ergodic environment, the time average offers a better assessment, and decision methods can often be constructed that do not rely on utility theory at all (Peters and Gell-Mann, 2016).

An ergodic process is one where the space and time averages coincide in tendency. Because the time mean and standard deviation converge on the true distribution mean and standard deviation,[12] the ergodic assumption permits the use of statistical averages derived from the past to 'make statistically reliable statements regarding the mathematical risk of probability of events occurring in the future' (Davidson, 1988, p. 332). As a consequence, 'economic relationships among variables are timeless, or ahistoric in the sense that the future is merely a statistical reflection of the past' (Davidson, 1988, p. 331).

[12] Without ergodicity it is not possible to use probabilities estimated from the past to predict the future. Only moments estimated from the sample paths of an ergodic process will tend to converge on the true values—for any arbitrarily small difference between the estimate and the true value, a sample size exists that will provide this level of accuracy. The accuracy increases with sample size, not just 'at infinity' as stated by O'Donnell (2014, p. 192).

The ergodic hypothesis permits the complete understanding of the dynamics of an ergodic stochastic process by observing one (sufficiently large) realisation. Since the process ranges suitably throughout the phase space (that is, all the things that can happen), any sufficiently large sample path will give an accurate indication of the moments (the mean and standard deviation) of the (stationary) distribution generating the process. In the end, all possible events occur with meaningful frequency and initial conditions are unimportant or forgotten. It is therefore possible for the representative agent to discover the probability distribution underlying reality (that is, the model) so that 'uncertainty' collapses to the 'actuarial certainty' (Davidson, 2015, p. 4), or what Robinson disparages as the 'perfect foresight', that underpins the existence of a Rational Expectations Equilibrium (Weitzman, 2007).

Viewed ontologically, the ergodic assumption could be taken as a null hypothesis, such that its rejection forms the basis of a 'technical definition of uncertainty' whereby 'uncertainty about future relationships can be defined in terms of the absence of governing ergodic processes' (Davidson, 1988, p. 332, emphasis removed). Reality itself is non-ergodic in the sense that past information provides no basis for constructing reliable estimates of future probability distributions. Yet, this assertion raises epistemological questions as to whether access to a necessarily limited set of observations is enough to establish non-ergodicity as an 'ontological state' (O'Donnell, 2014, p. 194).

The implicit ergodic assumption in much of economics and finance can be reframed in Bergsonian terms. It is apparent that the expectation value, based on an ensemble of parallel worlds, entails a spatialisation of time. Its use, where a time-based method would be more appropriate, also appears to ignore the effect of duration. Refocusing on the time average, therefore, certainly attempts to solve problems in terms of time and accords with Deleuze's 'Third Rule' of Bergson's philosophical method. Unfortunately, in correcting for one analytical difficulty, another is introduced: time averages only remove uncertainty by an appeal to infinite time—also impossible in reality. And in imagining an infinite time, are we not again treating time like space—a homogeneous symbolic representation abstracting from duration?

Distinguishing between space averages and time averages certainly satisfies the need to recognise differences between space and time, but is less convincing in its distinction between space and duration. We will return to this topic when we consider Bergson's philosophical treatment of the possible and the real to evaluate the use of the ergodic assumption when faced with the continuous creation of novelty and the technical innovation that accompanies the accumulation of capital. Before then, we will consider another area of economic thought questioned by Robinson and where the necessary effect of duration is entirely missing.

6. Time without the past: utility

Robinson's questions regarding the foundations of neo-classical thought extend to the theory of utility itself. In her view, utility is a concept with 'no scientific content' (Robinson, 1962B, p. 51), since it cannot be justified in any observable way:

> *Utility* is a metaphysical concept of impregnable circularity; *utility* is the quality in commodities that makes individuals want to buy them, and the fact that individuals want to buy commodities shows that they have *utility*. (Robinson, 1962B, p. 47, original emphasis)

Although it is unclear whether the intention is for utility to be an indication of *ex ante* desire or *ex post* satisfaction (Robinson, 1962B, p. 49), it provides the ground on which the neo-classical theory of prices is built—relative prices reflect the ratios of marginal utility of different consumer goods. But in so doing we again encounter problems with time, since it is possible to 'observe the reaction of an individual to two different sets of prices only at two different times' (Robinson, 1962B, p. 50). Similarly, to maximise the utility of their intertemporal consumption in a DSGE model, the representative agent must display a questionably strong degree of stability in tastes whereas almost 'everything develops either an inertia of habit or a desire for change' (Robinson, 1962B, p. 50).

When confronted with the concept of duration, even deeper weaknesses in the foundations of utility theory become apparent. Because of duration and memory, successions of sensations are not 'independent entities' chained together like 'the beads of a necklace' (Bergson, [1907] 1998, p. 3); the representative consumer's entire past intermingles with the present.

> From this survival of the past it follows that consciousness cannot go through the same state twice. The circumstances may still be the same, but they will act no longer on the same person, since they find him at a new moment of his history (Bergson, [1907] 1998, p. 5).

The repetition of same physical experience lived in successive moments—in this case, the utility gained from the repeated consumption of the single consumer good—cannot be the same psychological experience. For 'duration is not merely one instant replacing another; if it were there would never be anything but the present' (Bergson, [1907] 1998, p. 4). The consequences of ignoring duration in the agent's consumption choices have a significant effect on the interpretation of the model:

> Now, there are no two identical moments in the life of the same conscious being. Take the simplest sensation, suppose it constant, absorb in it the entire personality: the consciousness which will accompany this sensation cannot remain identical with itself for two consecutive moments, because the second moment always contains, over and above the first, the memory that the first has bequeathed to it. A consciousness which could experience two identical moments would be a consciousness without memory. It would die and be born again continually. (Bergson, [1903] 1912, pp. 12–13)

The memories of all prior experiences appear in our consciousness in ways that affect the sensation of the current moment. Consistency of preferences and the deep parameters that satisfy the desire for the micro-foundations of macroeconomics (King, 2012) imply that the representative agent is not in fact infinitely lived, but instead *infinitesimally* lived. For its proponents, utility allowed the rigor of 'mathematics and seemed to promise a new dawn for economics as a truly scientific subject' (Robinson, 1962B, p. 66). The cost, unfortunately, is that 'the world the mathematician deals with is a world that dies and is reborn at every instant' (Bergson, [1907] 1998, p. 22).

6.1 Intensity

Bergson shows us that yet more problems appear. Utility, which as Robinson points out, measures happiness 'as a two-dimensional quantity, the dimensions being intensity and time' (Robinson, 1962B, p. 66), commits the categorical mistake of attempting to treat a quality as though it were a quantity. The difference between space as a quantitative multiplicity and duration as a qualitative multiplicity informs Bergson's understanding

of 'psychic phenomena' or subjective experience (Bergson, [1889] 2001, p. 224). The fact that we can measure the strength of a physical stimulus—the degree to which I apply a pin to my hand, say—leads us to believe that our sensations—the feeling of pain the pin causes—are also measurable (Bergson, [1889] 2001, pp. 42–3). The mistake here is to 'associate the idea of a certain quantity of cause with a certain quality of effect' (Bergson, [1889] 2001, p. 42). For Bergson, to treat a state of consciousness, or 'intensity', as measurable is a vain attempt to quantify a 'pure quality' (Bergson, [1889] 2001, p. 225).

Utility, then, is another inappropriate use of a space metaphor. The attempt to relate utility—a quality or intensity—to the physical consumption of a commodity—a quantity—is illegitimate. Qualities or intensities are not susceptible to scientific measurement, and it is a mistake to derive a psychological effect from its quantitative stimulus. The concept of utility as a well-behaved and continuous function of a consumption good is an impossibility. Bergson's philosophy exposes the spatialisation and invalid assumptions underlying expectation values and utility theory, we now consider probability theory.

7. Time without the future: probability

7.1 The possible and the real

Bergson's analysis of possible and the real allows us to appreciate Robinson's views on the link between capital accumulation and technological novelty. In Bergson's view, a disregard of the 'radical novelty of each moment of evolution' leads to the mistaken idea that 'the possibility of things precedes their existence' (Bergson, 2002, p. 228). Because life and consciousness are creative, the future is not given and cannot comprise a set of pre-established states 'stored up in some cupboard' waiting to be selected and, hence, realised (Bergson, 2002, p. 229).

The possible, in the form of a novel creation, simply cannot precede reality without being created itself. The idea of a set of possible states only can apply to abstracted 'closed systems, subjected to purely mathematical laws, isolable because duration does not act upon them' (Bergson, 2002, p. 229). In living systems, by contrast, the future is open and the idea of the possible as an ontological aspect of reality prior to realisation is, Bergson says, absurd. 'The essence of the mechanical explanation, in fact, is to regard the future and the past as calculable functions of the present, and thus to claim that *all is given*' (Bergson, [1907] 1998, p. 37, original emphasis).

The 'possible', as we use it, is merely an illusion projected backwards in time, constructed mentally with the help of memory once the real outcome is known. A living being, subject to the effects of duration, is not limited only to the 'present state of the passing reality'; memory will enable it to 'represent the passing as a change, and therefore as a contrast between what has been and what is' (Bergson, [1907] 1998, p. 294). 'And as there is no essential difference between a past that we remember and a past that we imagine, it will quickly rise to the idea of the "possible" in general' (Bergson, [1907] 1998, p. 294). The possible does not exist before its realisation, instead 'the possible is only the real with the addition of an act of the mind which throws back its image into the past, once it has been enacted' (Bergson, 2002, p. 229).

For livings systems, therefore, the very idea of a set of possibilities that a Rational Expectations probability distribution would measure is itself confused. To believe that the next moment we experience is an 'event' selected by chance from a set of pre-existing, but not yet realised, choices is illusory. By way of example, it is not the case

that 'banana' or 'world peace' are outcomes from tossing a coin which simply do not occur because they have probability zero. It is possible to derive probabilities for heads or tails, without appeals to frequentist arguments, because the sample space is suitably closed and each case is equally likely *a priori*. Similarly, in terms of novelty and time, the Apple iPhone was not in the possibility set of the 1700s, just with (probability) measure zero. Consequently, any sample space Ω and associated family of events $\mathcal{F}$, on which the edifice of probability measures and random variables are themselves built, are not immune from the effects of time, except in limited non-living systems.[13] Although the technical conditions for measurability could feasibly allow for the definition of random variables, their probability measures would be compromised by changes in the sample space and *a priori* never 'correct'.[14]

Memory expands a living being's 'powers of action on things' (Bergson, [1896] 2004, p. 303) by allowing past perceptions relevant to the present moment 'to suggest to us that decision which is the most useful' (Bergson, [1896] 2004, p. 303). In empowering this choice of action, duration, facilitated by memory, 'frees us from the movement of the flow of things, that is to say, from the rhythm of necessity' (Bergson, [1896] 2004, p. 303).

7.2 Technology and novelty

The accumulation of capital takes place in time and is therefore inseparable from 'technical change, for accumulation never takes place without innovation' (Robinson, 1981, p. 83). Indeed, because of the 'strong connexion between the drive to accumulate and the drive to increase productivity' (Robinson, 1962B, p. 108), there can be no ready-made book of technological blueprints. Similarly, Bergson tells us that 'duration means invention, the creation of forms, the continual elaboration of the absolutely new' (Bergson, [1907] 1998, p. 11). He rejects the notion that 'things and beings merely realise a programme previously arranged', for 'if there is nothing unforeseen, no invention or creation in the universe, time is useless' (Bergson, [1907] 1998, p. 39). Time has its impact through duration whereby something new and unforeseeable occurs at each moment. '*Time is invention or it is nothing at all*' (Bergson, [1907] 1998, p. 341, original emphasis).

This continuous creation of the absolutely new further disqualifies the use of mathematics to represent living—as opposed to mechanical—systems. This limitation is not just due to its previously discussed inability to represent movement. For Bergson, 'no complication of the mathematical order with itself, however elaborate we may suppose it, can introduce an atom of novelty into the world' (Bergson, [1907] 1998, p. 217).

> Organic *creation*, on the contrary, the evolutionary phenomena which properly constitute life, we cannot in any way subject to a mathematical treatment. It will be said that this impotence is only due to our ignorance. But it may well equally well express the fact that the present moment of a living body does not find its explanation in the moment immediately before, that *all* the past of the organism must be added to that moment (Bergson, [1907] 1998, p. 20, original emphasis).

[13] As Davidson (1996) says, reality is ontologically 'transmutable' or 'creative'.

[14] For example, for a random variable X defined on a probability triple $(\Omega, \mathcal{F}, P)$, using the *law* of X defined by $\mathcal{L}_X := P \circ X^{-1}$ allows the use of the probability triple $(\mathbb{R}, B, \mathcal{L}_X)$ based on Borel sets derived from X (see Williams, 1991, p. 33). Johnson (2016) appears to argue that in this approach $\mathbb{R}$ is not incomplete even in the face of radical novelty. For further discussion of sample spaces, events, random variables and radical contingency see Ayache (2016), Johnson (2016), Roffe (2016), and references therein.

Although 'the state of an artificial [mathematical] system depends exclusively on its state at the moment before' (Bergson, [1907] 1998, p. 21), it cannot incorporate the real duration of a living system as the continuous interpenetration of time, only independent successions. As we have seen above, mathematical time is restricted to points at intervals of time, and, no matter how dense these intervals are, there can be 'no instant immediately before another instant' (Bergson, [1907] 1998, p. 21); 'every duration is thick; real time has no instants' (Bergson, [1922] 1965, p. 52).

Similarly, we could ask 'does not organic memory press it into the moment immediately before the present, so that the moment immediately before becomes the sole cause of the present one?' (Bergson, [1907] 1998, p. 21). Of course, the error here is to fail to see how duration is not a chain of successions, which is to spatialise time, but instead consists of 'a duration in which the past, always moving on, is swelling unceasingly with a present that is absolutely new' (Bergson, [1907] 1998, pp. 199–200). The abstract logical time of mathematical systems cannot represent the concrete historical time of natural systems. Although 'certain aspects of the present, important for science, are calculable as functions of the immediate past. Nothing of the sort [is possible] in the domain of life' (Bergson, [1907] 1998, p. 20).

The continuous unfolding of novelty in our lived experience is not linked to the inflexible determinism of any mechanical or mathematical law, but stems from the deliberations of conscious beings who, having duration, are able to recreate reality moment by moment in entirely unpredictable ways. Novelty and unpredictability are not due to any epistemological failure to uncover the objective probability distributions governing reality. The future is simply not given; it is continuously being created. This continuous creation precludes any form of determinism or predictability, the future has yet to form and is therefore unknowable. Since uncertainty is an ontological feature of living systems, and not a symptom of epistemological difficulties; the continuous creation of novelty adds an unconsidered ontological dimension to the question regarding the applicability of ergodicity to living systems.

Bergson rejects both mechanism and finalism as being deterministic and teleological and, therefore, antithetical to creation and the evolution of life. Nature neither has preconceived plan, nor does it work 'like a human being bringing parts together' (Bergson, [1907] 1998, p. 89). Mechanistic thinking 'assumes that everything is calculable in terms of a state' and in finalism 'everything is determined in terms of a program' (Deleuze, [1966] 1988, p. 104). Both mistakes arise from the spatialisation of time, in which it merely takes the form of 'a screen that hides the eternal from us, or that shows us successively what a God or a superhuman intelligence would see in a single glance' (Deleuze, [1966] 1988, p. 104).

It should now be apparent that the use of time averages in ergodic theory is more akin to the idea of time-as-space associated with mechanism and finalism. The time average, being based on a numerical multiplicity, cannot represent the creative time of duration. Similar arguments can be raised against the concept of time used in DSGE models, in which 'the dimension of space that has come to replace time is still called time' (Bergson, [1922] 1965, p. 60). By working within the probabilistic framework of pre-formed possibilities, both are guilty of spatialising time. With continuous creation of novelty, there can be no eternal sample space Ω on which any comparison between space and time averages or intertemporal consumption optimisations can be made.

In place of mechanism and finalism, Bergson puts forward the idea of an *élan vital*—a vital, or original, impetus—as a 'fundamental cause of variations' that 'accumulate and

create new species' (Bergson, [1907] 1998, p. 87). The *élan vital* is not a life spirit located in each individual level, but is an 'image' (Bergson, [1907] 1998, p. 257) describing a force or will behind the impulse for life as a whole, which passes from generation to generation. It signifies a tendency that differentiates over time and yet is 'sustained right along the lines of evolution among which it gets divided' (Bergson, [1907] 1998, p. 87). The *élan vital* should not be mistaken as vitalist; it represents a Kantian 'purposiveness with purpose' (Sinclair, 2020, p. 214), without either the anthropomorphic or teleological intentionality implied by mechanistic or finalistic theories.

The *élan vital* operates as an 'ascending' movement of life and consciousness which opposes and counteracts the 'descending' movement of inert matter. This descending movement lacks duration and 'only unwinds a roll ready prepared' in a way that 'might be accomplished almost instantaneously, like releasing a spring' (Bergson, [1907] 1998, p. 11) thereby making it amenable to mathematical representation. The ascending movement, on the other hand, 'corresponds to an inner work of ripening or creating, *endures* essentially, and imposes its rhythm on the first [the descending movement], which is inseparable from it' (Bergson, [1907] 1998, p. 11, original emphasis). These

> vital properties are never entirely realised, though always on the way to become so; they are not so much *states* as *tendencies*. And a tendency achieves all that it aims at only if it is not thwarted by another tendency (Bergson, [1907] 1998, p. 13, original emphasis).

By hypothetically allowing tendencies to play out in the absence of conflicting tendencies we can arrive at the idea of 'tranquillity' that Robinson uses to construct her post-Keynesian models (Robinson, 1956, p. 59). Tranquillity allows for the useful specification of a long-period situation, a construction as a 'system for combining logical with historical analysis' (Robinson, 1979, p. xxiv). Here the emphasis is not on the positions that the economy takes along some hypothetical path, nor is it on the destination itself; it is the process and characteristics of the movement itself that are of interest. Instead, the

> position that we are looking for cannot correctly be described as 'equilibrium' for it has not the property of restoring itself in the face of a chance shock. It is, rather, a position which is free from 'internal contradictions' in the sense that it can perpetuate itself continuously provided that no shock ever occurs. (Robinson, 1979, p. 26)

Thus, tranquillity represents an expression of tendencies when not subject to the counter-tendencies of novelty that would otherwise upset any confidence in expectations that may have been established. Tranquillity allows expectations regarding the past and future to be abstracted. In equilibrium analysis an economy experiences the introduction of an invention as an unforeseen 'shock' for which investment is the means of restoring equilibrium. 'But in reality, of course, technical progress is continuous, and, moreover it is, in a certain sense, foreseen and allowed for' through amortisation funds which tend to dampen the effect of shocks (Robinson, 1979, p. 102). The 'most important source of disturbances in an expanding economy lies in the very process of technical change which is the mainspring of expansion' (Robinson, 1979, p. 57).

Bergson's philosophical method looks to understand duration and movement, and hence time itself. Similarly, Robinson's method considers the variety of movement in logically constructed economies of different natures, each situated in historical time. These constructions—golden age, limping golden age, leaden age, and so on (Robinson, 1962A)—do not represent equilibrium positions or 'any moment in the

history of any actual economy' (Robinson, 1979, p. xxiv). Instead, as a 'system for combining logical with historical analysis', they provide 'a base line against which to describe the vicissitudes of a developing economy' (Robinson, 1979, p. xxiv).

Metaphorically at least, the classical long-run tendency for the rate of profit to fall as capital accumulates is countered by the 'ascending' movement of the *élan vital*. The inert and mechanistic neo-classical production function, with its established blueprint of techniques, 'contains a law of falling profits' (Robinson, 1966, p. 36). Yet, simply because 'knowledge develops as capital accumulates' (Robinson, 1966, p. 38), 'it is very unnatural to assume given knowledge in a dynamic system' (Robinson, 1966, p. 37). The declining marginal productivity is counterbalanced by the ascending effects of time and innovation, such that 'there can be no tendency for the rate of profit to fall' (Robinson, 1966, p. 38).

The accumulation of capital, as if propelled by an *élan vital* derived from the expected rate of profit, necessarily entails 'technical progress going on continuously by a succession of innovations' in a form of creative evolution (Robinson, 1971, p. 127). Capital accumulation takes place within duration and consequently can only be understood as a qualitative multiplicity, since there is 'nothing in reality which remains constant through time to provide us with neat units in which to calculate' (Robinson, 1962A, p. 88). Or, in other words: 'the time that endures is not measurable' (Bergson, [1922] 1965, p. 49). The continuous novelty and creative evolution expressed in technological advance leads to fundamental uncertainty in more than simply an epistemological sense.

8. Conclusion

Overall, four main areas of Joan Robinson's post-Keynesian economic thought have been considered and the philosophy of Henri Bergson used to deepen the foundations of, and provide new perspectives on, Robinson's thinking about time, equilibrium and uncertainty. Bergson's theory of duration—which identifies how memory affects our experience of time and consequently the fundamental difference between time and space—was used to reinterpret Robinson's questions over the use of equilibrium and the inadequate treatment of time and movement in economics. Duration, along with Bergson's ontological distinction between the 'possible' and the 'real', were used to consider uncertainty, its relationship with ontology and epistemology, and the inapplicability of ergodicity in its representation. The psychological impact of duration had ramifications for the experience of sensations and, consequently, the validity of intertemporal utility theory. Finally, Bergon's philosophy of creative evolution and the *élan vital* allowed us to reinterpret technical change and the creation of novelty that accompanies the accumulation of capital.

A Bergsonian critique of Expected Utility Theory operates in ways that go beyond the questions of epistemology and ergodicity, and confirms Robinson's doubts regarding its applicability. First, using probability theory, which is constructed on preformed state spaces, precludes any creation of novelty and technical innovation—aspects key to Robinson's long-period theory. Therefore uncertainty, when represented by Rational Expectations, entails the stochastic selection of pre-given futures and an implicit assumption of foresight and pre-drawn technological blueprints. The so-called 'intertemporal' equilibrium is derived using an inappropriate spatialised form of time. Finally, the utility function is built on a misplaced attempt to measure a pure quality.

A critique built on Bergson's philosophy lends strong support to Robinson's rejection of mathematical 'calculated risk', and also undermines the micro-foundations build on timeless preferences and technology.

Furthermore, Bergson's philosophy of life provides insights into two key aspects of Robinson's analysis of capitalism. First, duration as memory is analogous to the accumulation of capital as a process operating in, and therefore affected by, time. Second, a key force behind this durational capital process is an *élan vital* expressed in the profit motive which evolves through technological advance. Technological advance is a necessary by-product of capital accumulation and this production of novelty leads us to reject the strict ideas of mechanism, determinism or finalism. The insights we gain from Henri Bergson are those emphasised by Joan Robinson: The dynamic economy is a living system, not amenable to unqualified mathematical treatment but is always subject to the real effects of time and the continuous creation of novelty.

It is notable that two independent thinkers from different disciplines arrived at very similar views and conclusions on these complex issues. To a certain extent this coincidence serves to validate their ideas, especially when it is recognised that neither philosophy nor economics allows for experimental replication. This paper has merely scratched the surface of the potential extensions of Joan Robinson's philosophical enquiries using the spatiotemporal conceptual frameworks provided by Henri Bergson and Gilles Deleuze, as well as modern scholars continuing in their tradition.

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