ERGODICITY AND ITS CONSEQUENCES

***Comments on a study by Iván Bélyácz*[1]**

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The objective of a recent paper by Iván Bélyácz ("The debated role of ergodicity in [financial] economics") was to discuss the very important question of ergodicity.[2] For the reader little conversant in theoretical economics, this may appear to be an undoubtedly interesting but very inconsequential problem, since they will almost never encounter the concept in their everyday experience. But although the concept of ergodicity may indeed be unfamiliar to them, the problem lurking behind it is all the more important nonetheless, since the nature of the economy as an equilibrium, and both uncertainty and predictability alike, are attributes of economic operation that significantly influence their everyday activity, and these are all closely connected to the quality of ergodicity. For this reason, it is by all means worth devoting some time to it, in order to understand the importance of the ergodic hypothesis from the point of view of practical everyday life and the evolution of economic thought alike.

Besides the importance of what the study in question has to say, it is also worth highlighting its timeliness, since the global economy has just barely emerged from a major crisis. This was a crisis which mainstream economists failed to predict, nor were they able to identify its nature, and in particular to offer serviceable advice about how to recover from it. Here it pays to emphatically stress that this was a failure of the same mainstream economics which, taking the ergodic nature of economic processes as its basis, shaped the theory of automatic equilibrium in markets, optimizing economic behaviour and rational expectations. The community of economists therefore has much to face up to, and Iván Bélyácz's painstaking study may help them in confronting this.

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1 Iván Bélyácz (2017): The Debated Role of Ergodicity in (Financial) Economics. *Economy & Finance*, 4 (1), pp. 4–57.

2 Very simply put, ergodicity means that the evolution of economic processes over time is itself a periodically recurring, regular process, the characteristics of which can be identified and comprehended by mathematical and statistical means. Detailed and thorough definitions of ergodicity, and of the ergodic and nonergodic concepts, can be found in the aforementioned study by Bélyácz.

A BRIEF RETROSPECTIVE OF THEORETICAL HISTORY

If we look only at the concept and narrowly interpreted meaning of ergodicity, then the topic might genuinely be regarded as esoteric. But if we dig a little deeper, then it soon becomes apparent that very far from being esoteric, it is a very important concept with definitive significance for economic science in terms of whether we see the operation of the economy as ergodic or nonergodic. In recent decades there has been relatively little debate on this question, or if there has been, then it has tended to remain within a very narrow circle (largely among post-Keynesians in the orbit of *Davidson* (1982; 1991). For mainstream economists, ergodicity constitutes a starting axiom that is not worth disputing, but must be accepted as a foundation on which the solid structure of economics can be built. And truly this is what has happened: neoclassical economics, although not explicitly formulating the conditions for ergodicity, has nevertheless effectively built its system in this spirit, together with the rational behaviour and perfect hindsight of the economic actors who always create equilibrium in the economy.

The crisis of 1929–33 and *Keynes' General Theory*, however, threw a temporary spanner in the works, as the neoclassical model of the economy in equilibrium was not at all in keeping with the experiences of a protracted and serious crisis (30%–40% unemployment and deflation). For his part, Keynes provided a very logical and acceptable explanation for what happened: due to the fundamental uncertainty, entrepreneurs would mostly refrain from carrying out as many investments as needed to ensure full employment, consequently unemployment and the partial utilization of capacities would be inevitable concomitants of the operation of the economy. According to Keynesian teaching, the size of aggregate demand determines the macroeconomic equilibrium, which for precisely this reason may assume not only a specific value (to which the economy continually returns due to its ergodic nature), but also the contrary: a great many different states (signifying various levels of unemployment and capacity utilization). These possibilities, however, were completely ignored in the mainstream thinking of the period (or, as it was then known, classical theory).

> *"I accuse the classical economic theory of being itself one of these pretty, polite techniques which tries to deal with the present by abstracting from the fact that we know very little about the future."* (*Keynes*, 1937, p. 215)

Despite the fact that Keynes' criticism of the neoclassical tendency proved well-founded and very pertinent, it was not devastating in its impact. Although a paradigm shift in economics seemingly occurred in the 1940s and 1950s, in truth Keynesian thought never attained a dominant position. Economists as highly respected and influential as *John Hicks* and *Paul Samuelson* worked from

the very beginning to discover how to take the edge off Keynes' criticism and incorporate a tamer version into the neoclassical doctrine of equilibrium. They succeeded with the help of the *IS–LM* curves, so that equilibrium-based microeconomics came to peacefully coexist with Keynesian disequilibrium macroeconomics (more precisely christened as Keynesian, but not in reality Keynesian) under the banner of neoclassical synthesis.[3] It was no accident that it was Samuelson himself (1965) who regarded the condition of ergodicity as crucially important in the 1960s (as Bélyácz discusses in detail in his paper), since static equilibrium modelling – i.e. comparative static analysis based on the IS–LM system – could only have gained its raison d'être under this condition.

The total dismantling of the Keynesian theoretical framework took place at the end of the 1970s with the arrival of the new classical school of economics. Playing a prominent role in this was a paper by *Lucas* (1976), which later came to be known simply as the *Lucas critique*. The critique was aimed at Keynesian macroeconometric models, arguing that such models were entirely unsuitable for economic policy analysis and forecasting. This assertion, though naturally valid, does not truly affect Keynes' theory, since it was Keynes himself who firmly rejected *Tinbergen*'s attempts at econometric modelling with respect to his own formulated macroeconomic relationships. The focus of his argument was that regularly recurring, orderly processes are not determined by macroeconomic conditions, but are very individual in nature, and for this reason there is no scope for econometrically based modelling. We cannot eliminate the uncertain nature of macroeconomic processes, nor our wholly inadequate depth of knowledge of them, by inserting a well-behaved random variable (normally distributed with zero mean and constant standard deviation) into the estimation functions.[4] All this, however, is now lost in the mists of memory as the economists' community, under the influence of the new classical economists and their critiques of Keynesianism, have proven happy to rid themselves of the ballast of non-equilibrium systems and to enthusiastically accept equilibrium models that promise orderliness and harmony.

The three basic assumptions of the new classical economists – (i) optimizing economic agents, (ii) market-clearing prices, and (iii) rational expectations – mutually presume the existence of each other and are based without exception on the assumption of ergodicity. Optimizing behaviour is necessary for the formation of equilibrium, and particularly singular equilibrium (cf. the unicity theorem), since a stable equilibrium can form only if all economic agents take up an optimal position, otherwise they will continually want to modify their

3 Leijonhufvud (1968) was among the first to draw attention to the absurdity of this reconciliation.

4 See in more detail the debate between Keynes (1939) and Tinbergen (1940).

status (cf. the theorem of competitive equilibrium and simultaneous Pareto optimality). In addition, optimization obviously also requires foresight, since the decisions of economic agents pertain to the near or more distant future. This is provided by the assumption of rational expectations, which eliminates future uncertainties. However, rational expectations are only conceivable if we know the model describing the overall operation of the economy, from which we can gain undistorted estimates, since only these can constitute genuinely rational expectations. A model of the operation of the economy as a whole can nevertheless only be formulated if this operation is regularly recurring in nature, and we can only expect such regularly recurring operation if economic agents, besides rational expectations, optimize in accordance with known rules. And so closes the vicious circle of tautological proof.

FURTHER CONSEQUENCES OF NONERGODICITY

Bélyácz's study also throughly explored the ergodic hypothesis in economics from the point of view of theoretical history and the philosophy of science, coming to the conclusion that it is untenable – or, to put it more delicately, it is not an expedient assumption to make. Of the problems arising from the rejection of ergodicity, essentially he only dealt at depth – based on his initial programme of inquiries pertaining to price formation on financial markets – with *fundamental uncertainty* and the related difficulty of the forecastability of economic processes. While agreeing with his main conclusions, I would make only one supplementary and contrary observation in this regard. In my view, there is no particular contradiction in Samuelson advocating acceptance of the ergodic hypothesis, while at the same time accepting the thesis that price movements on financial markets cannot be predicted because they follow the random walk process. There is no contradiction because if prices do indeed evolve according to a random walk, then price changes contain not uncertainty but only risk, since the probability distribution of the stochastic process of change is known: normal distribution, zero (or constant) expected value, and constant deviation. It is for this reason that price changes thus remain independent of one another, with equal probability of being positive or negative, and with an absolute magnitude that is forecastable based on constant deviation. The evolution of prices over time cannot of course be predicted, because random elements have been aggregated in time (processes integrated of order one take shape, containing a unit root). In this way, the assumption of a random walk process in the evolution of prices on securities markets may well prove compatible with the ergodic hypothesis. This conclusion is by no means affected by the later recognition that in reality stock

market prices do not follow a random walk (for more on which, see the book by *Mandelbrot* and *Hudson* (2006).

Beyond questions of risk and uncertainty, however, there are other areas significantly impacted by the elimination of the ergodic hypothesis. First of all, mention must be made of the static *equilibrium paradigm*. As we discussed briefly in the preceding section, neoclassical/ new classical orthodox economics is based on this paradigm. Economic equilibrium, its existence, uniqueness and stability, is a cornerstone of mainstream economics that also supports the ergodic character of economic processes. In reality, however, the state of economic equilibrium (its existence or absence) cannot be observed because economic science does not possess – and let us add, theoretically cannot possess – the tools to signal this. According to the widely accepted definition, economic equilibrium comes about when supply and demand are equal, and when economic agents do not wish to change their situation further. However, we cannot observe either supply or demand because these merely represent purchasing and selling intentions emerging at a given time and place. As latent variables, they are not directly observable or quantifiable. Paradoxically, while we cannot observe the creation of equilibrium, we can all the more easily observe its absence. Shortages, long queues, unsold stock, high unemployment, and low or excessive utilization of capacities, all point to the absence of equilibrium. The scale of disequilibrium, however, cannot be precisely determined from these data, because even these directly manifesting anomalies do not reveal the degree to which the aspirations of all economic agents are fulfilled, as many do not declare this in an observable manner. Moreover, these indices of disequilibrium cannot be summarized in a universal indicator.

Similarly to the ergodic hypothesis, therefore, equilibrium can only be accepted as a hypothetical state, the existence of which cannot be proven or denied empirically. The assumption that equilibrium and the mechanisms thereof exist can only be legitimized by the practical usefulness of an approach to economics built on this set of fundamental conditions, one which helps us understand the functional peculiarities of the economy and assists economic agents in making good decisions. There are huge debates in this regard between economists holding traditional orthodox or new heterodox views (a pioneering role in these debates having been played by *Kaldor* (1934, 1989). We could list at length the orthodox narratives on the beneficial functions of the supply and demand mechanism and the benefits of rational and optimizing behaviour on the one hand, and the reports of market errors, economic crises and massive income gaps on the heterodox side. Resolving this historical argument, however, cannot be the task of this commentary. We have merely highlighted it in order to make clear that the question of ergodicity is not purely theoretical, but at least as much practical.

If the majority of theoretical and practical economists profess in the near or distant future that economic processes are nonergodic, then they will thereby also reject the doctrine of equilibrium. The content and nature of the new paradigm that emerges after such a rejection, and how much it is built on today's heterodox theories (institutional, behavioural, evolutionary economics, etc.), is another question entirely, but this cannot be predicted today.

SPACE-TIME, PATH DEPENDENCY

Acceptance of the ergodic hypothesis led to the question of how mainstream economics handled the investigative framework of space-time. For the most part, space and time do not even feature in mainstream economic inquiry, or are limited to narrow points in the imaginary system of coordinates in which economic processes take place in condensed form. Consequently, specific space and time have no role at all in the shaping of processes. Even when time does inevitably crop up, because economic events need to be arranged in logical order, then mainstream economists deal not with specific *historical* or *calendar time*, but rather with *logical time* and the measurement of duration. In his work, Hicks (1979) showed how the use of logical time was transplanted from the experimental natural sciences to economics – albeit in an erroneous fashion, because while the subjects of inquiry in the case of phenomena in nature have no consciousness or free will, agents in economic processes are human beings who are capable of learning from past experiences and modifying their behaviour. It follows from this that phenomena (general phenomena) to be observed can be arbitrarily reproduced as often as desired in the natural sciences, independent of specific space and time, under given experimental conditions. The combined human actions that comprise economic processes are always unique, however, and therefore take place in a given specific historical time, and it is only relevant to examine them within that specific social context (*Robinson*, 1980). Free fall demonstrated the same properties in Italy in 1327 as in Hungary in 1849, or China in 2016. The same consistency could certainly not be claimed, for example, of the factors influencing investment intentions in the aforesaid countries and years.

The concept of logical space and time can be well grasped in connection with the explanation of the equilibrium mechanism in orthodox economics. The Marshall mechanism of supply and demand prices assumes that (i) price changes according to excess demand; and (ii) supply and demand evolve in accordance with the price changes (based on fixed supply and demand functions). This dual adjustment mechanism necessarily leads to the formation of the equilibrium price and quantity. It can easily be seen that this dual mechanism only works

in this way if the economic agents in question appear concentrated in space (say, in an auction house) and if the price adjustment occurs extremely quickly within a very short space of time (say, with the help of a Walrasian auctioneer). If several adjustment periods are needed, then mainstream logic dictates that "time stands still" and all economic activity halts, except price adjustment, because otherwise the equilibrium state itself may change and it will be necessary to perpetually adjust to another specified equilibrium state (*Kornai–Martos*, 1981, p. 21). Precisely to avoid a changing equilibrium point, it is also not permissible for potential excess demand arising in the meantime to exert an influence on production because this may alter the nature of the supply function. In the words of Joan Robinson:

> *"If we construct the equations for a single self-reproducing system and then confront it with an unforeseen change, an event taking place at a particular date, we cannot say anything at all before we have introduced a whole fresh system specifying how the economy behaves in short-period disequilibrium (…) 'What would happen if demand changed?' is nonsensical. A different composition of output requires a different set of equations."* (Robinson, 1978, p. 128)

If we acknowledge that the application of historical (calendar) time, rather than logical time, is far more appropriate in economics, then this will have further corollaries: on the one hand, the phenomenon of *path dependency*, and on the other hand *causal relationships* and the difficulty – not to say impossibility – of establishing economic regularities. Path dependency means that the possibilities for the economy in the present and decisions relating to the future are essentially determined by the conditions that evolved during its operation in the past (economic structure, quantity and quality of capital and labour, reserves, social and environmental conditions, etc.) and the accumulated experiences of economic agents. Decisions taken earlier close off certain opportunities (due to the restrictive and irreversible nature of the past state), while others open up for the given economy. Successive new decisions continually alter the trajectory of progress. There is therefore no single equilibrium state or sustainable equilibrium path, as the mainstream claims, but many possible paths, from which the current one at any given time is selected based on the decisions of economic agents. And this certainly is very far from the concept of ergodicity, which designates a single, fixed trajectory along which the economy must necessarily proceed, and from which it may only be temporarily diverted by external shocks.

A very fashionable analytical tool in mainstream economics these days is the sustainable growth path, which essentially visualizes a series of macroeconomic equilibrium states over time. According to the orthodox doctrine, market economies only deviate from this path if impacted by external economic

shocks. The deviation is only temporary, however, because equilibrium-restoring mechanisms immediately leap into action and guide the economy back onto the sustainable path. If the economy were to really work this way, then we could regard it as truly ergodic, since the sustainable path of equilibrium would be determinable and easy to predict – assuming, of course, that the external shocks "behaved well" (following a normal distribution, with a given mean and constant standard deviation). The problem is that real economies never function like this anywhere.

As a starting point in understanding this, let us suppose that the economy is proceeding on an equilibrium path when it is hit by an external shock. The question is how realistic it is to assume in this case that the shock will have no effect at all on the internal structural relationship of supply and demand, the expectations of economic agents, inventories, etc. Obviously not realistic at all: if, for example, a demand shock strikes the economy, then it appears fairly self-evident that this will have an impact on the conditions of supply, with expansion in production, for instance, potentially reducing unit costs (in the case of increasing returns), or having a stimulating influence on investments, which will later bring about an expansion in the capital stock. The shock effect may also affect the labour market, potentially altering the level of unemployment. All these changes may mean that a new equilibrium situation comes about, that the initial equilibrium path is thus no longer valid, and that market forces are no longer as they were, but will divert the economy along a new trajectory. Of course, further complications will arise with regard to how shifts in the path that occur in the meantime can be identified, and how sustainable the new trajectory will be in the face of subsequent, regularly occurring shocks.

The aforementioned phenomenon is naturally not new, as economists have long been aware, for example, that temporarily rising unemployment as a consequence of negative shocks does not disappear without trace as the shocks subside. High unemployment forces up the natural rate of unemployment, as explained in the *hysteresis theory* (*Blanchard–Summers*, 1986). Empirical evidence has shown that even when the economy is subsequently impacted by a positive demand shock of similar magnitude, the rate of unemployment does not return to its orginal level. (The aforementioned authors used this to explain the very sharply different natural rates of unemployment in the U.S. and Europe.) Those who lose their jobs and are unable to find new unemployment within a few months are, as time passes, increasingly unlikely to be able to find their way back into the labour market (*Setterfield*, 2009). The same effect can be demonstrated in the evolution of investment appetite. Investment intentions diminish significantly as a consequence of major negative shocks (for example, in the event of an economic crisis), as enterprises become extremely cautious. Governments pump up aggregate demand

(even beyond pre-crisis levels) to no avail at such times, as investments will still not pick up speed (*Arestis–Sawyer*, 2009). A great many more things than this are needed before confidence can be restored.

Another important aspect of path dependency and the existence of multiple equilibria can be linked to the emergence from an underdeveloped state. For the underdeveloped country locked in the vicious cycle of backwardness, a big push from the outside can often prove suitably helpful (see, for example, Rosenstein-Rodan's big push theory). A significant rise in aggregate demand, for instance, may result in modern sectors becoming increasingly profitable compared to traditional sectors, since wholesale production – in the event of increasing returns to scale – reduces unit costs (*Pierson*, 2000). In this way, the traditional sector is then increasingly squeezed out of production, and the economy converges on a new, far higher state of equilibium than before. The key question is whether a critical level of demand will be reached which is able to break through the backwardness threshold and, as a consequence, open the way towards a higher growth trajectory.

CAUSALITY AND ECONOMIC LAWS

A very important distinction of economics in comparison to the natural sciences is that there are only very limited opportunities for controlled experiments. In the majority of cases when observing phenomena repeatedly, no guarantee of unchanged external conditions can be provided. Even when studying the simplest market transactions, we cannot be sure that the same environmental factors will prevail. Economic phenomena are for the most part not general phenomena that regularly recur, and for this reason their suitability for mathematical and statistical analyses is only very limited. Strange as it may seem, but even the transactions seen in great volume on stock markets, for example, are not general phenomena since transactions that occur later in time are influenced by the outcomes of earlier transactions, and thus cannot be considered independent experiments. The agents participating in the process themselves learn from past events and reflect on changing conditions in making fresh decisions. This reflexivity is a feature of the social sciences and in itself already hinders the operation of the economy according to rules, and hence its ergodicity.

> *"… (reflexivity) creates a cleavage between the natural and social sciences and it undermines the postulates on which economic theory has been based: rational behaviour in general, and rational expectations in particular. It gives rise to a radically different interpretation of how financial markets operate than the one proposed by economic theory."* (*Soros*, 2001, p. 22)

It follows from all this that economic relationships and laws may be only highly relative, and that certain causal relations can be expected to function at most *ceteris paribus*, or under the principle of all other conditions being constant. In the vast majority of cases, however, constant conditions do not come about because the economy is a continuously functioning and changing system. For this reason, a broad scope opens for "if…, then…" types of argument, because it is not possible to establish the error of any single theory beyond any doubt since, in the event of its failure, it is always possible to plead that external conditions had changed: the "if" did not occur, hence the "then" prediction could not materialize either.

The nonergodic nature of the economy's functioning is thus of decisive significance here, too, since it follows that laws of general validity cannot be formulated in the field of economics as they can in physics. A good number of what are termed laws do exist, such as the law of supply and demand, Okun's law, Engel's law, Gresham's law, Kaldor–Verdoorn's law, and so forth. However, these largely tend to express relationships, tendencies or directions of movement prevailing in the longer term, and not exact, causal determinations. The nature of a tendency here means that although there exist certain relations of cause and effect or balance sheet constraints (e.g. budgetary or debt limits), these can be temporarily overrided by changing conditions and thus do not make their effects felt immediately, or much more likely only in the longer term and frequently in modified form. In most cases, limits that have proven effective earlier (e.g. given debt or exchange rate levels, etc.) change to a smaller or larger extent with the modification of operating conditions. Such modifications occur not only due to changes in the external environment, but also because economic agents learn from their earlier experiences and reflect on these in their decisions.

Economics is also unable to make general correlations similar to those in the natural sciences because the economy is a dynamical system in perpetual motion. This perpetual motion is nevertheless very different from that experienced in the natural sciences since it can always only be interpreted within a system of specific space-time coordinates, as we already mentioned in discussing space-time above. An economic system generates a series of processes in successive (calendar) points in time, each differing from its predecessors to a greater or lesser degree, and thus entering successive different states. For this reason, the specific calendar time in which we view the economy carries special significance because a different picture will always emerge (so that historical or economic-historical aspects always dominate). In natural sciences that permit controlled experiments to be carried out, time does matter since processes occur in time; however, the passage of time is not chronological or according to the calendar, but only logical. In the words of John Hicks, the experimental natural sciences are static in nature, while economics is dynamic (Hicks, 1979, p. X.).

One of the most common methods of identifying laws is to gather individual observations and, based on these, to arrange phenomena in logical relationships (of cause and effect) and thus formulate correlations. It then becomes possible to test these laws with the help of controlled experiments. When it comes to examining economic processes, however, such controlled experiments cannot be carried out because very different sets of circumstances may emerge dependent on space and time, thwarting any comparison of the obtained results with the findings of the formulated correlations (laws). Although laboratory conditions can be created during economic investigations (of course primarily only in the microeconomic sphere), the conditions thus created will inevitably differ from the conditions under which we would expect economic laws to prevail. The use of controlled experiments in economics is difficult to implement because the agents of economic processes are human, and it is not possible to separate economic from social motivations in the behaviour of these humans. It is futile to arrange a series of experiments somewhere when its findings will no longer hold true somewhere else, where different people are involved or where the economic correlations will apply in a different social milieu.

Here it is worth emphasizing how few controlled experiments and empirical studies in economic science have been carried out with respect to the most important economic institution of the market, or of the law of supply and demand that describes its operation. Neoclassical and new classical economists in particular have not attached much importance to this, all the while going on incessantly about the ideal operation of the market. Obviously they declined to take on this task because it would have meant them having to face up to the fact that the market is not a simple machine into which we feed supply and demand, and price spews out at the other end. The conception of the market as a self-regulating system and a supply and demand-based machine is erroneous. The market is a complex kind of operating system run by flesh-and-blood human beings, which can assume a great many forms in space and time. For this reason, economics cannot pass beyond the boundaries of social science and cannot become the kind of exactly formalized science which mainstream economists would have liked to make it with the introduction of the ergodic hypothesis.

Hopefully this short description has conveyed the importance of ergodicity to economics – and consequently, how neglected a field it has become since the advance of the new classical school. The older generations seem to be forgetting the Keynesian teaching about uncertainty and expectations, while these things are no longer even being taught to the upcoming generations. It is our collective reponsibility to ensure that the recognized correlations and accumulated knowledge are not left to sink into oblivion.

REFERENCES

Arestis, Phillip – Sawyer, Malcolm (2009): Path Dependency and Demand–Supply Interactions in Macroeconomic Analysis. In: Arestis, P. – Sawyer, M. (eds.): *Path Dependency and Macroeconomics*. Palgrave Macmillan.

Blanchard, Oliver J. – Summers, Lawrence H. (1986): Hysteresis and the European Unemployment Problem, *NBER Macroeconomic Annual*, Vol. 1, pp. 2–77.

Davidson, Paul (1982–83): Rational expectations: a fallacious foundation for studying crucial decision making process. *Journal of Post Keynesian Economics*, 5(3) Winter, pp. 182–198.

Davidson, Paul (1991): Is Probability Theory Relevant for Uncertainty? A Post Keynesian Perspective. *Journal of Economic Perspectives*, 5(1) Winter, pp. 129–143.

Hicks, John R. (1979): *Causality in Economics*. New York: Basic Books.

Kaldor, Nicholas (1934): A Classificatory Note on the Determinateness of Equilibrium. *The Review of Economic Studies,* 1(2) Feb., pp. 122–136.

Kaldor, Nicholas (1989): The Inadequacy of Equilibrium Economics [Az egyensúlyi közgazdaságtan alkalmatlansága]. In *Gazdaságelmélet – Gazdaságpolitika (Válogatott tanulmányok)*, Budapest: Közgazdasági és Jogi Könyvkiadó.

Keynes, John Maynard (1937): The general theory of employment. *Quarterly Journal of Economics*, Febr.

Keynes, John Maynard (1939): Professor Tinbergen's Method (A Method and its Application to Investment Activity). *Economic Journal*, 49(195), pp. 558–568.

Kornai, János – Martos, Béla (eds.) (1981): *Regulation without Price Controls* [Szabályozás árjelzések nélkül]. Budapest: Akadémiai Kiadó.

Leijonhufvud, Axel (1968): *On Keynesiam Economics and the Economics of Keynes*. Oxford University Press.

Lucas, Robert (1976): *Econometric Policy Evaluation: A Critique*. *Carnegie-Rochester Conference Series on Public Policy*, No. 1, pp. 19–46.

Mandelbrot, Benoit – Hudson, Richard (2006): *The (Mis)Behavior of Markets (The Fractal View of Financial Turbulence)*. New York: Basic Books.

Pierson, Paul (2000): Increasing Returns, Path Dependence and the Study of Politics. *The American Political Science Review,* 94(2) Jun., pp. 251–267.

Robinson, Joan (1980): Time in Economic Theory. *Kyklos*, 33(2) May, pp. 219–229.

Robinson, Joan (1978): *Contribution to Modern Economics*. Academic Press.

Setterfield, Mark (2009): Path Dependency, Hysteresys and Macrodynamics. In: Arestis, P. – Sawyer, M. (eds.): *Path Dependency and Macroeconomics*. Palgrave Macmillan.

Samuelson, Paul A. (1965): Proof That Properly Anticipated Prices Fluctuate Randomly. *Management Review*, 6(2) Spring, pp. 41–49.

Soros, George (2000): *The Open Society (Reforming Global Capitalism)*. New York: PublicAffairs.

Tinbergen, Jan (1940): On a Method of Statistical Business Cycle Research. A Reply. *Economic Journal*, 50(196), pp. 141–154.