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ECONOMIC CYBERNETICS

This paper begins with a consideration of the work of Leijonhufvud, who, in the 1960's, introduced what he termed "cybernetics" to correct many of the perceived weaknesses in macroeconomic theory. The authors use current advances in systems thinking to develop their own definition of Cybernetics and provide an example to illustrate how this definition of cybernetics can produce meaningful economic questions. The paper concludes with a synthesis of economic and cybernetic ideas which is termed "Economic Cybernetics". This term is common in the former Soviet countries but is unfamiliar to western audiences.

Keywords: Economics, Cybernetics, Mathematics.

1. Introduction

The following quote is taken by from a recent paper by the 2018 Nobel prize winner, Paul Romer.

For more than three decades, macroeconomics has gone backwards. The treatment of identification now is no more credible than in the early 1970's but escapes challenge because it is so much more opaque. Macroeconomic theorists dismiss mere facts by feigning an obtuse ignorance about such simple assertions as "tight monetary policy can cause a recession." Their models attribute fluctuations in aggregate variables to imaginary causal forces that are not influenced by the action that any person takes. A parallel with string theory from physics hints at a general failure mode of science that is triggered when respect for highly regarded leaders evolves into a deference to authority that displaces objective fact from its position as the ultimate determinant ofsc ientific truth [26].

As an example of economic practice, to resolve the 2008 crisis, governments began to use economic policies that current academic theory rejected as incorrect. Mason [16] argues cogently how leading New Keynesians resurrected previously rejected policy models relating to inflation, monetary policy,unemployment, liquidity traps and the effectiveness of fiscal policy to reinterpret the core of the 2008 global crisis [30]. Stiglitz [34] argued that such a volte face was necessary as the New Classical orthodoxy ignored behavioural economic issues and placed too much reliance on representative agent models (such as DSGE models) [32]. Mason [16] showed that the USA moved from an ineffective balanced budget fiscal policy, to a policy that used deficit finance as a core lever in the alleviation of unemployment and GDP instability. So, within a 5-7-year gap, fiscal policy in the USA (so heavily criticised by previous Councils of Economic Advisors) was seen as vital for stabilisation policy. This was a U-turn on a major scale. The gist of Mason's case, behind this policy reversal is that the gulf between theoretical macroeconomics and its empirical / policy counterpart is so immense that they seem to two separate sub disciplines.

At the heart of the Mason paradox lies the perception of what economics is. If it is regarded as a positivist theory (with definite and well-defined economic reasoning) that uses Newtonian scientific thinking, then problems will escalate. The academics are seen as presenting the practitioners with a set of rules and procedures for solving their problems and when they fail to work, their names and sub discipline area are besmirched. A negative feedback loop develops where the reputation of Economics declines and, if not corrected, result in its death [22].

The main research agenda for Leijonhufvud [15] was to completely debunk the Hicks-Hansen interpretation of the General Theory that focused on the aggregative income-expenditure model. Among other things, Leijonhufvud not only argued that this was a misinterpretation of Keynes' ideas, but that Keynes was searching for an algorithm that could explain the simultaneous existence of deflation and unemployment, in the old Classical system bound by Say's Law [29].

Leijonhufvud's principal thesis was that Keynes reversed the time spectrum of the Marshallian time period model [17] in such a way that aggregate quantities adjusted faster than prices and this combined with the multiplier, led to a continual dynamic reduction in effective demand which prevented the attainment of full employment irrespective of wage-price flexibility; such that the economy could persistently slump into a disequilibrium state. In which case, Real Balance Effects or other correlated effects were irrelevant for predicting or, explaining a return to normal, full employment equilibria. Hence, Leijonhufvud's fundamental argument was that the true message of Keynes' General Theory represented a call for a deep re-appraisal of the dynamic adjustment processes that govern the aggregate economy in terms of the true price /quantity vectors that determine equilibrium [6]. This required the search for an ideal dynamic algorithm underpinning income change rather than price change trajectories in the economy. Therefore, instead of the Walrasian Approach, Leijonhufved proposed a "Cybernetic Approach" in the spirit of Keynes General Theory, with no presumption that the system would in an equilibrium state [12]. This approach would require modelling the economy with a dynamic algorithm which determined how the state evolves from any given set of initial conditions. The state includes agents, initial data, initial beliefs, inherited expectations, trading relationships, labour/capital market relationships, capital /labour endowments, debts, contractual and financial obligations, together with financial and real assets.

This Cybernetic Approach would specify the set of actions that each agent could execute in a given state and develop a set of behavioural rules for choosing between them. This cybernetic environment would specify an institutional framework within which trading could take place

and would imply a set of outcome functions determining what happens if a given set of rules or behaviours were adopted for any given situation. Hence trading at dynamic disequilibrium -false-prices is possible within the systemic interactions. Amongst these outcomes there could be the changes involving the variables defining the state of the system. This was the start of the cybernetic approach in economics which this paper wishes to develop and with which it will define "Economic Cybernetics".

Essentially, Leijonhufvud (ibid) demonstrated that the IS-LM model developed by Hicks [14], which dominated undergraduate intermediate teaching particularly with regards to investment, interest, growth and saving was such a myopic version of Keynes that it represented a serious misinterpretation of the core dynamic principles of the General Theory, whence quantities changed faster than prices particularly in short run periods.Thus a macroeconomic interpretation of economic change including the multiplier, meant that velocity changes in output /income were likely much faster dynamic processes than changes in equilibrium price vectors. Keynes had effectively reversed the chain of causation inherent in the Classical model.

2. Current Definitions of Cybernetics

The science of Cybernetics arose in the 1940's from the conferences that were sponsored by the Joshua Macey Foundation and ran from 1941 – 1960. Their aims were to pursue meaningful communication across scientific thinking and to unite Science. The first conference, which was entitled "Feedback Mechanisms and Circular Causal Systems in Biological and Social Systems" was attended by an unprecedented network of great minds at the time including Norbert Weiner who coined the word "Cybernetics" (taken from the Greek word "kubernētikós" meaning steersman) [5]. It has been applied in the social sciences by many practitioners.

A basic cybernetic principle is that "structure determines behaviour." [6] Structure is defined as a stable form of interactions that allow people to operate together as a whole. People are constituted as roles which transform disembodied relationships (meaning) into embodied relationships (identity, content and structure.) Let us define a Viable System as one that can survive by absorbing changes in its environment. A key discovery of cybernetics is that all viable systems may be mapped onto each other under some transformation. That is a technical way of saying that every viable system obeys the same balancing law of information and energy flow, and that therefore all viable systems have structural commonalities. The title of Wiener's book (Cybernetics: or Control and Communication in the Animal and the Machine) emphasises this – the same laws apply to all – computers, servo-mechanisms, corporations, populations of animals [36]. This is the essence of Cybernetics.

The title of Weiner's book " Cybernetics: Or Control and Communication in the Animal and the Machine" was well meant but perhaps unfortunate because the subject became associated with control engineering. The science of cybernetics is a much broader school with many overlaps with System Thinking. Several processes used by cyberneticians are now discussed:

2.1. Variety Engineering

In the mechanised world, complexity can be roughly equated with size i.e. the more parts there are, the more complex it is. In a systems world, the complexity resides not in size but in the connections between the parts. Thus, a very small system can still be highly complex. As an example, a marriage. is between two people so has only two parts, but experience shows that because of the myriad factors connecting these parts with each other, it can be a very complex system indeed!

In the 1960's, Lorentz discovered non-linear behaviour which was given the name "Chaos Theory." Cybernetics was aware of such a concept but named it variety – the number of states an entity can assume. In general, if one considers n objects then there are a possible 2^n different states. Seven objects thus generate a variety of 1024. In any organisation, the thing to be controlled has a certain variety and the controller has normally a smaller variety. Control is simply ensuring that these varieties balance by attenuating one and amplifying the other. Ross Asby insisted that only variety can absorb variety and formulated what is commonly known as Ashby's Law of Requisite Variety.

Thus, organisational problems are basically problems of variety engineering.

2.2. Feedback

Feedback between variables is not a new concept but cybernetics uses feedback loops, This is where there are causal connections between variables which link back to the start. Demand can affect price which then can affect demand. It is circular – the ouroboros eating its own tail. In logic (and excel spreadsheets) this is forbidden, but it was the genius of Weiner which developed it.

2.3. Synthesis

The classical philosophers understood the idea of synthesis but the scientific revolution in the seventeenth century, led by Descartes and Newton, introduced the idea of analysis. The notion of synthesis and its power as a tool was all but destroyed. One must turn to Hegel in the eighteenth century for its re-emergence. Instead of analysing synthesis out of existence, he erected it as a higher outcome of the simultaneous existence of opposites – thesis and antithesis [11]. Subsequently, systems became a means where terms are related and are an integral part of the whole. What were mutually exclusive opponents can now be collaborators. Instead of breaking things apart, it is often advantageous to put them together. This posits the idea of a holistic approach to a situation rather than a reductionist one and can be regarded as a fundamental principle of Cybernetics.

2.4. The Systems Paradigm

Many of the original Cyberneticians were excellent scientists brought up on the Scientific paradigm of Newton and Galileo. But they had come to realise the limitations of such thinking and initiated a new paradigm – The Systems Paradigm. To understand the Systems paradigm, an agreed meaning of the word "system" must be established. The word is used in many contexts such as a set of rules and procedures (typified by the sayings "He is playing the system", "I have a system for making breakfast".) or as an object ("a sound system" or a "computing system.") In the cybernetic context, the word "system" has a precise meaning which is best summed by Ackoff

A system is a set of parts where no single part has an independent effect on the whole. Thus, a system is a whole that cannot be divided into independent parts. One can say:

- *The essential properties of a system derive out of how its parts interact and not on how they act taken separately;*
- *The defining properties of any system are properties of the whole which none of its parts have;*
- *When the whole is disassembled, it loses its essential properties and so do all of its parts;*
- *In any system, when one improves the performance of the parts taken separately, then the performance of the whole does not necessarily improve and frequently gets worse;*
- *It's the way the parts fit together determine the performance of a system [1].*

The Systems paradigm rests on this definition. It uses synthesis as opposed to analysis and holistic as opposed to reductionist thinking. It also replaces the traditional view of a static state in perfect harmony and/or balance (a mechanical concept) with the idea of homeostasis or dynamic equilibrium. The systems paradigm also encourages interdisciplinarity. Specialisation is regarded as the enemy of true knowledge. The more sub-groups there are in any branch of knowledge, the less chance there is of communication between the researchers. "This "specialised deafness" hinders the spread of knowledge [6]. One objective of Cybernetics is to develop "generalised ears" It can regarded as skeleton on which to hang the flesh and blood of particular disciplines.

Since its inception, Economics has dealt with dependent variables. For example, the formula p=f(S,D) indicates that price depends on a combination of two variables Supply and Demand. This is the normal concept of dependent variables. But, what if Supply and Demand are themselves dependent on each other. Then the mathematics becomes extremely complicated. There is a great difference between inter-dependence of variables and dependence of variables.

This distinction is intrinsic to Cybernetics.

2.5. A Teleological Approach

Aristotle introduced the idea of teleological cause based on something existing for the sake of a goal, the good to be achieved [27]. A goal causes an activity to occur or things happen or exist because of some further good they help to produce. Goal oriented behaviour is more easily explained by its effects than its causes. Thus, there are two ways of analysing phenomena:

- by examining the causes of the phenomenon, making hypotheses and testing. This is the current economic epistemology;
- by optimising certain variables. Examples are the use of Fermat's Principle in determining the path of a light ray and the use of the Hamiltonian to determine motion. This approach was extended by many mathematicians and led to a new topic in mathematics called the "calculus of variations". This consists of finding the most efficient path to arrive at a goal. This is goal oriented behaviour. (Optimisation is widely used in Economics, but the use suggested here is different in that the optimisation determines the path taken to achieve a particular goal rather than a stationary point in some trajectory).

2.6. Self-regulation

There are three broad categories of systems – simple, complicated and complex. An example of a simple system is a deterministic one. We invest some capital in a bank with a stated compound interest and wish to calculate its growth. There is a formula for doing this and the answer is incontrovertible. Let us decide to divide our capital into say one hundred parts and invest in fifty countries each with a different interest rate. Furthermore, let each country have two political parties – one which is an interest rate raiser and one which is a interest rate diminisher and let each assume power every four years. One could call this situation more complex, but the correct word is complicated. There are still fixed rules and the answer is still determinable. A complex situation occurs when there is collusion and feedback between the parties i.e. they are not independent. Complex systems will follow one of three behaviours – convergence, oscillation or divergence – and it is not always possible to predict which will occur. Very small changes can cause the behaviour to switch from one to another. The counter-intuitive insight of cybernetics is that it is not complication that causes the chaos – it is the connections between the entities. It is perfectly possible to create complex or chaotic behaviour using very simple rules if there are interdependencies. Commonly studied examples are the flocking of birds (which can be simulated using three simple rules) and Conway's game of Life.

One way that cybernetics deals with the "vagaries of fate" is by introducing self-organisation. Let us use the human body as a metaphor. The brain has a purpose / theory/ direction of controlling the heartbeat. But is one conscious of the heart rate all the time? (only if you have an Apple watch!) No, the brain sets up a subsystem which monitors the rate and as long as it is within certain limits, the subsystem gets on with it while the brain can concentrate on more important matters. it is known that a certain combination of inputs will produce a certain set of outputs. It is not normally necessary to understand exactly what is happening inside. Obviously, it is possible to "go inside" when needed. These can be termed "black boxes" When there is a shock to the system, then messages are instantly sent to the brain which asserts control. This is a self-regulatory or self-organising system.

3. An Economic Application

This example involves the exit of the UK from the European union. (Brexit) which is chosen to illustrate the cybernetics processes discussed in section 2.

3.1. Aggregation

The following statement is taken from the BBC website.

Economic growth tumbled to its joint weakest in nine years at the end of 2018 as the UK joined the slump that has spread across much of the eurozone. GDP rose by 0.2% in the three months to December, slowing from 0.6% in the previous quarter. It takes growth for last year to 1.4%, the same level as 2012 and the joint-worst performance since the recession of 2009. The picture is not expected to improve into 2019.

This relates to Romer's remarks quoted at the beginning of this paper. What precisely is GDP? this is the total value of goods and services ('output') produced, aggregate income or, aggregate expenditure. Although, IMF national accounting conventions are normally followed which are consistent with traditional Keynesian income determination models, the decision as to what should be included or, excluded on the labour market side, particularly with respect to household division of labour is completely arbitrary and a different choices affect the results. This confusion in meaning can be used to manipulate statements. If one accepted an accuracy of half a percent in the UK GDP, then the uncertainty is £10 billion which is more than twice the quoted drop!!

3.1.2. Inflammatory remarks

"Economic growth tumbled. "Is there a need for the word "tumbled"? There is no real understanding in this headline with regards to the nuances of economic growth theory. To this day, economic growth represents a mystery for academic economists and leading exponents in the field [31]. Indeed there is a plethora of growth theories [13, 10, 33, 26, 28]. Some of the confusion revolve around the interpretations of : the stationary state, the savings ratio in relation to term structure of interest rates,the Solow Residual or Total Factor Productivity.[33,35] However, it is seldom pointed out that this growth statistic is highly suspect and dependent on incomplete data. Moreover, since the Paris Accord, diesel cars are being phased out and total sales falling as more hybrid and electric cars are entering the market. Such consumption behavioural change will impact on short run GDP but this is simply a reflection of changing market preferences.

3.1.3. Misuse of Mathematics in Economics
3.1.4. Spurious Causalities

- *"When GDP goes up, the economy is growing – people are spending more and businesses may be expanding. For this reason, GDP growth is a key measure of the overall strength of the economy."* This not necessarily true. If one takes the income measure, then one cannot draw this conclusion. Even taking the spending definition, a changing GDP could reflect levels of investment. Germany has a good GDP growth, but as the German people are naturally savers, spending did not increase. (This is the saving-growth paradox evident in the Solow and Ramsey growth models) [32, 26].
- *"… as the UK joined the slump that has spread across the Eurozone*" There is no justification for this remark. There is no proven relation that would correlate UK GDP to EU GDP. The EU have a different currency and many problems are caused by the management of this currency over 20 countries.
- It is natural as the date for BREXIT has come and gone, that business are still not investing. This was a political decision and not an economic one. Therefore, economic conclusions should not be drawn given the degree of uncertainty regarding future trading relationships with the EU or the rest of the world.
- There is an assumption that there is some correspondence between GDP figures in previous years. Why should this be so since serious structural breaks may occur. A major development in UK is the rise of technology and the uses of big data. This is growing exponentially from year to year. One would suppose that this should increase the GDP. but it takes time for new procedures to embed themselves and so the full impact of technological change may not be reflected in present GDP statistics.
- *The picture is not expected to improve in 2020.* What justification is there for this statement? The term GDP is an aggregate of many interconnected and interrelated components. Its behaviour is thus not predictable but "emergent"

4. A Cybernetic approach to Economics

As mentioned, the word "Cybernetics" comes from the Greek word for steersman and this metaphor is a good one for understanding its purpose. Cybernetics can be seen as a vehicle (boat) aiming to reach a distant land. Even though it is not precisely known where this land is, there is a direction of travel – an objective or goal. Two important comments can be made here:

- Seas are treacherous things and many obstacles require the skills of the steersman. There are hidden currents, whirlpools, waterfalls, rapids – all to be negotiated. So, the ship will deviate from its course many times but each time readjusting to the agreed direction. The obstacles are not a surprise. They are expected and a good ship with a good steersman will withstand them. In Cybernetics, this is called Viability. Economics is sometimes hazy about its purpose: – is it understanding, predicting or setting up a process of behaviour. Whichever, it will need to negotiate the whirlpools of political dissent, the rapids of global shocks and the sheer unpredictable currents of human behaviour. One problem with modern economics is that these obstacles are seen as extra difficulties whilst following a set path (Keynesian, Classical, Laissez-faire etc) as opposed to what would be expected on a normal voyage. This is "the deference to authority "that Romer referred to.
- What is the ultimate goal i.e. purpose of Economics? Is it to explain and predict perceived economic behaviour or, as Stafford Beer states "to promote a state of well-being in the community" which he called eudemonia? In the Ramsey model, the pursuit of a bliss point could be extracted as the dominant goal of economic theory [24]. That is, the interpretation of growth and happiness for different generations and different income groups in society. The Ramsey model predicts nonetheless that the rich will get richer and the poor will get poorer, in any normal growth case.
- In 2019, New Zealand introduced its first "well-being budget" [8]. This constituted the first practical attempt to enunciate happiness as a state of Aristotelian "flourishing", an activity rather than state of being as the dominant economic teleos.

If the purpose is to efficiently produce the best (optimum?) solutions in a certain economic environment, (i.e. goal oriented) then using deep learning techniques, intelligent algorithms and data analytics will be more efficient and reliable. Economic theories will become superfluous. Perhaps a new epistemology of Economic Cybernetics would involve using variational calculus to optimise a "well -being" function in order to arrive at an efficient economic solution. Hence, we are espousing a concept of a dynamic Bliss point or Bliss path. This has long been studied in static welfare theory and the political economy of median voter models using static Grand Utility Welfare Functions. However, it has scarcely been discussed in mainstream macroeconomic theory.

If economists believe that objective economic laws exist which govern the current economic landscape, then these laws should be taught and developed. At present, there is a plethora of competing theories (none of them with a track record of success) but that does not mean that a valid dynamic theory could not be discovered. Economists have always asked the question "which theory is best for this particular problem?" i.e. is our methodology right? whereas maybe they should be asking" what is the best goal for this particular problem" i.e. are we trying to do the right thing? The answer to this dilemma has implications on problem solving, understanding, philosophy, teaching and learning.

The authors appreciate Leijonhufvud' s work and his attempt to introduce cybernetic ideas but think he did not go far enough. Their opinion is that economics should be synthesised with cybernetic principles and morph into "Economic Cybernetics". This latter should at least incorporate the following issues.

4.1. Systems Thinking

There must be a shift from the underlying and dominant scientific paradigm to the systems paradigm (which includes cybernetics). The scientific paradigm used by economists gives the wrong priority and emphasis to mathematics. In the last few decades, there have been significant advances in mathematics that now allow stochastic data to be analysed and reasonably accurate trends to be discerned (Bayesian Analysis, Kalman Filters, Hodrick-Prescott Filters, VAR-regression techniques). Economics should continue to embrace these developments. This is an effective use of mathematics. What is now possible though is the inclusion of much more detailed time series data. Instead of just economic data, the new Artificial Intelligence techniques can be applied to accurately analyse decision making under that involves political and social factors which can only help the economist. What is not appropriate and should be changed is the positivist thinking of mathematics. Mathematics is designed to give exact, precise answers and Economists should not attempt this (as in the case of Osborne(ibid). Economics should move towards more qualitative analysis which is interdisciplinary and predicts trends and possible futures with appropriate health warnings. The reaction might be that governments, businesses and companies need forecasts in order to plan investments. This is likely but the data that are calculated using the scientific paradigm are not robust and this has been shown time and time again. Plans can, however, still be made on the basis of probable trends.

An interesting paradox is that as economics begins to use mathematics more scientifically, it may become less of a science and more a useful body of knowledge.

Over the centuries different conceptualisations of how economies function (Classical, Keynesian, Post-Keynesian New Keynesian, New Classical) have been developed. It is not being suggested that these are discarded but all should be recognised as stylised interpretations of actuality. The problem requiring critical appraisal, however, has been that these interpretations have become dogmas and attracted zealots. Thus, there is an unhealthy rivalry existing inside the community of academic economists. This is in contrast to the stable and successful management accomplished by ants and bees i.e. cooperation rather than competition. This would be a major gain for the advancement of economic science.

4.2. Social Context

Economics does not exist in a vacuum. Decisions, investments, the demand for labour, inequality, supply and demand, all have to be interpreted in the context of the reality vicissitudes technological change. In recent decades, there have been revolutions in how homo sapiens view themselves in relation to each other,and to the environment. There have been significant changes in the societal role and the status of women. There is now an unstoppable drive towards gender equality and diversity. The planet is now perceived as being in critical danger and laws are being passed the on the use of diesel fuel, recycling and resource exploitation. These legal constraints will have significant impacts on the economies of the world and can only be accommodated in Economic Theory by taking a more interdisciplinary, holistic approach. Since, many economic predictions have been inaccurate (by orders of magnitude), this has fed the general mistrust that the public has developed regarding the views of experts. This is a dangerous populist trend and must be discouraged. However, this can only be attained by more judicious predictions which may be recognised as being in tune with current social mores.

There are signs in the recent literature that some of these issues are being taken up and discussed in a meaningful way. The work of Thomas Piketty which is a study reminiscent of an earlier branch in the development of Economics exemplified by Adam Smith in the Wealth of Nations [30]. Hence, Piketty focuses upon the acute enhancement of wealth inequality in Europe and the United States since the 18th Century.Piketty [23] postulates that wealth taxes are necessary to ameliorate concomitant income disparities as economic growth continues and returns to capital continually increase relative to labour. As elites get richer and the poor get poorer well-being and happiness is linked to egalitarianism. This notion has its roots in the Aristotelian definition of happiness, whereby the happiness of the individual is reliant upon the flourishing of the polis. The development of Piketty's thesis is consonant with the concept of a Social Contract in a socio-economic environment which should be accommodated by economic theory.

4.3. Ethics

The fundamental idea of economic growth must be re-orientated. Thus, instead of Gross National Product, focus should move to Global Natural Product with an emphasis on sharing the wealth together. Economics must be seen as a way of achieving this goal even though it might never be reached at least in a short period of time. This is consistent with the holistic nature of systems thinking, thereby scoping the big picture. Global climate change protagonists and their anti-economic growth protestations present a view which is consistent with this holistic thinking: namely that the well-being of global society should be the overriding well -being objective function and that economic growth models should instead be re-calibrated as climate neutral, welfare enhancing systems in the Aristotelian spirit. This creates some distance between traditional growth models which focus on simple questions such as: 'How much should a nation save?' This should perhaps be re-cast as 'How much should a nation save to reduce carbon emissions and save the planet?' The 2018 Economics Nobel laurate W. Nordhaus echoes some of these sentiments develops new departures for growth theory [18–21].

Mathematicians may dispute the results of theories and indeed this is how mathematics develops but doctrinal disagreements in economic theory are ultimately unresolvable. There is no reality to test them against. There is a danger that Economics becomes overly self-indulgent and seen as clever people arguing in a vacuum. It should not be forgotten that economic decisions play a very important part in society. Should economics maintain its utilitarian stance where it is about maximising the common good or, is there a deontological aspect where duty and obligation play a role? Until recently, moral actions by agents played no part in economic theory. Perhaps it is time that this changed. Economics should not be seen as "competencies without comprehension" [9].

Moreover, the emphasis on economic growth has been used indiscriminately. Different organisms should have different priorities. For businesses the creation of wealth is important, for governments it is important to manage deficits but there are organisms such as universities which need different conceptions of economic growth. It is regrettable that ideas of treating universities as businesses and all that entails have developed. It could be argued that it is not the fault of economists that universities have adopted a questionable business model and are mis-using economic theory, but economists do not do enough to counter this mentality. Economics needs to display the ethical consequences of its theories. Economics is seen as a detached amoral science, but humans are moral creatures. To gain the trust of the public, morality must be brought back into Economics. One purpose of economics is to provide plans for effective management but there should be an underlying message of prosperity for everyone. Unfortunately, as wealth inequality grows, economic theory is seen as complicit in this growth.

Economics is currently regarded as a detached amoral science, but economic agents are moral beings. Morality must be at the centre of economics in order gain societal acceptance. Cybernetics shows that deeply ingrained, reciprocal moral behaviours are the glue that holds society together. Understanding that the market economy as just an amoral machine that provides incentives and distributes resources, but rather that it is a human moral construct is essential, not for creating a more just economy, but also for understanding how the economy actually creates prosperity.

5. Conclusion

There have always been problems concerning macroeconomics, but they have become more apparent since the economic crisis of 2008. This was not predicted by econometric /forecasting models and was difficult to even explicate using the new classical macroeconomic theory prevalent at the time. This illustrates a gap between what is being practised by governments and what is being taught in universities. It therefore goes to the heart of the problem with Economics – is it an explanatory tool of possible realities or, is it a tool to dictate economic policy making?

The paper proposes and justifies a change in perception and the adoption of Economic Cybernetics. Economic Cybernetics should use the systems paradigm, which is

interdisciplinary, holistic, more qualitative and abductive rather than inductive. Typical of this approach is the Santa Fe Institute who recognise the complexity of social phenomena which can produce unintelligibility and the unpredictability in the behaviour of socio-economic systems i.e. there is no one answer to a problem and the task of academics is to explore and present alternatives. The new perception should encompass:

- A new approach to economic growth – cooperation and competition;
- A re-definition of inclusion – the global economy;
- New labour market relationships – algorithmic management;
- Impact of new technology especially analysis of big data;
- Cybernetic models of regulation and optimal control theory.

The new economic thinking must unleash the potential of regenerative design in order to create a circular, not linear, economy – and to restore agents as full participants in Earth's cyclical processes of life.

Economics should be regarded as an intelligent attempt by intelligent people to interpret social behaviour. It does not recognise that there are definitive economic models and thus rejects the determinism inherent in Mason's case. Practice is a consequence of competing theories not enveloping theory. Economics should offer practitioners of economic policy-making, a raft of different models, each with its own assumptions and constraints and where none are presented as the undisputed cause of events. The practitioners will use their judgement to select the theory that harmonises with their weltauunschaum. As history unfolds, circumstances change, and different economic models will be needed. Economics as a subject evolves and develops. When practitioners change their economic models it is seen as a natural consequence of systemic behaviour. It will reflect on the strengths of Economics and be to its benefit not detriment as an academic discipline.

Economics has tended to confuse complication with complexity. As an economic situation becomes more complicated, economists look for more sophisticated mathematics to explain it. This is missing the point. The research should be on the connections not the mathematics which could be simple.

However, a weakness of such an approach is that accurate prediction is not possible. Realistically, this should not be a surprise as any student of history will know. What can be studied is the key leverage points in the system. By identifying and experimenting with these, understanding can be reached. This lessening of the predictive power of economics and econometrics could may be a boon. It would protect it from the criticisms of professional incompetence.

In fact, what is being advocated is that a new purpose should be defined for Economics – Economic Cybernetics. This is to understand how economic forces and variables interact and the possible consequences of these interactions. In our view, Economics as discipline is focused on a complex adaptive system. If this is accepted, then the methodologies used and the mathematics employed need to be drastically revised.

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ЕКОНОМІЧНА КІБЕРНЕТИКА

Розглянуто роботи Лейонхуфвуда, який у 1960-х роках представив те, що назвав кібернетикою, щоб виправити багато виявлених недоліків макроекономічної теорії. Використано сучасні досягнення в системному мисленні для розробки власного визначення кібернетики, на прикладі продемонстровано, як таке визначення може поставити значущі економічні питання. Синтезовано економічні та кібернетичні ідеї, які називають "економічна кібернетика". Цей термін поширений у колишніх радянських країнах, але не знайомий західній аудиторії.

Ключові слова: економіка, кібернетика, математика.

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ЭКОНОМИЧЕСКАЯ КИБЕРНЕТИКА

Рассмотрены работы Лейонхуфвуда, который в 1960-х годах представил то, что назвал кибернетикой, чтобы исправить многие из обнаруженных недостатков в макроэкономической теории. Использованы современные достижения в системном мышлении для разработки своего собственного определения кибернетики, на примере продемонстрировано, как такое определение может поставить содержательные экономические вопросы. Синтезированы экономические и кибернетические идеи, которые называют "экономическая кибернетика". Этот термин распространен в странах бывшего СССР, но не знаком западной аудитории.

Ключевые слова: экономика, кибернетика, математика.

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ІМПЛЕМЕНТАЦІЯ МІЖНАРОДНИХ СТАНДАРТІВ ВИЩИХ ОРГАНІВ АУДИТУ У ФІНАНСОВІ АУДИТИ РАХУНКОВОЇ ПАЛАТИ УКРАЇНИ

Узагальнено досвід Рахункової палати з розробки, апробації та затвердження "Посібника з питань фінансового аудиту", який містить детальні інструкції, аудиторські процедури та шаблони аудиторської документації, що застосовуються при проведенні фінансових аудитів, які відповідають вимогам міжнародних стандартів вищих органів аудиту (ISSAI). Досліджено досвід вищих органів аудиту країн Європи з оприлюднення таких посібників і визначено ризики надання вільного доступу до посібника, розробленого Рахунковою палатою України. Узагальнено результати шести фінансових аудитів, проведених Рахунковою палатою у 2019 році за новою методологією. Визначено, що якість фінансової та бюджетної звітності установ, підприємств та організацій державного сектору є невисокою, а ідентифіковані в ході проведення аудитів ризики шахрайства, недоліки внутрішнього контролю й облікової політики мають системний характер. Сформовано пропозиції щодо створення належних умов для подальшого впровадження Рахунковою палатою якісних фінансових аудитів, які відповідають вимогам ISSAI.

Ключові слова: фінансовий аудит, Рахункова палата, міжнародні стандарти вищих органів аудиту (ISSAI), методологія фінансового аудиту, посібник із фінансового аудиту.

Постановка проблеми. Упровадження міжнародних стандартів вищих органів аудиту (ISSAI) у діяльність Рахункової палати України є необхідною умовою для вдосконалення аудиту публічних фінансів, забезпечення позитивного впливу Рахункової палати на ефективність управління державними фінансами, подальшої інтеграції України у європейський простір. Проведення фінансових аудитів з дотриманням вимог ISSAI є особливо важливим з огляду на невисокий рівень якості, прозорості, повноти та достовірності даних фінансової та бюджетної звітності суб'єктів державного сектору, підвищення якого є метою модернізації системи бухгалтерського обліку та фінансової звітності в державному секторі, що триває в Україні вже більше десяти років [1, 2]. У 2019 році за підтримки членів Рахункової палати Невідомого В. І., Огня Ц. Г., Яремчука І. М. Рахунковою палатою розпочато системне та планове здійснення фінансових аудитів. У діяльності Рахункової палати збільшується кількість здійснюваних фінансових аудитів. Так, у 2014 році було заплановано та проведено лише три фінансові аудити, у 2019 році – шість. Також збільшується частка цього виду аудиту в плані роботи Рахункової палати, яка при зменшенні загальної кількості заходів становила 7 % у 2019 році проти 2,4 % у 2014 році [3]. При цьому фінансові аудити проводилися у 2019 році на основі посібника, розробленого фахівцями Рахункової палати спільно з