

WEA Commentaries*

A publication of the World Economics Association.
To *plurality*. The Association will encourage the free exploration of economic reality from any perspective that adds to the sum of our understanding. To this end it advocates plurality of thought, method and philosophy.

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Inside this issue:

Simpson's Paradox <i>Asad Zaman</i>	<u>2</u>	<u>html</u>
How International Corporations Could Be Taxed, and Why the US is Working to Prevent It <i>Norbert Häring</i>	<u>3</u>	<u>html</u>
The Transnational Corporation and Economics <i>Grazia Ietto-Gillies</i>	<u>5</u>	<u>html</u>
Challenges of Complexity Economics <i>Joachim H. Spangenberg, Lia Polotzek</i>	<u>8</u>	<u>html</u>
WEA Commentaries Appoints New Co-Editors	<u>12</u>	<u>html</u>
WEA contact details	<u>12</u>	

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Simpson's Paradox

By [Asad Zaman](#)

[Ed note: A longer version of this analysis can be found in Asad Zaman and Taseer Salahuddin (2020) "Causality, Confounding, and Simpson's Paradox" *International Econometric Review*, Vol 2, Issue 1 (forthcoming in April)]

Statistics and Econometrics today are done without any essential reference to causality – this is much like trying to figure out how birds fly without taking into account their wings. Chapter 2 of Judea Pearl's (2018) *The Book of Why: The New Science of Cause and Effect* tells the bizarre story of how the discipline of statistics inflicted causal blindness on itself, with far-reaching effects for all sciences that depend on data. This article elaborates and explains the introductory chapter of Pearl, Glymour, & Jewell (2016) *Causal Inference in Statistics: A Primer*. The first steps to understanding causality involve a detailed analysis of the Simpson's Paradox. This is described in five points, summarized here and with more detail if you follow the links:

[Simpson's Paradox 1](#): Suppose that there are only two departments at Berkeley, and that they have different admission ratios for women. In Humanities 40% of female applicants are admitted, while in Engineering 80% are admitted. What will be the overall admission ratio of women to Berkeley? The overall admission ratio is a weighted average of 40% and 80% where the weights are the proportions of females who apply to the two departments. Similarly, if 20% of male applicants are admitted to Humanities while 60% are admitted to Engineering, then the overall admission ratio is a weighted average of 20% and 60%, with weights depending on the proportion of males who apply to the two departments. This is what leads to the possibility of Simpson's Paradox. As the numbers have been set up, both Engineering and Humanities favour females, who have much higher admission ratios than male. If males apply mostly to Engineering, then the overall admission ratio for men will be closer to 60%. If females apply mostly to humanities, their overall admission ratio will be closer to 40%. So, looking at the overall ratios, it will appear that admissions favour males, who have higher admission ratios. The key question is: which of these comparisons is correct? Does Berkeley discriminate against males, the story told be departmental admission ratios? Or does it discriminate against females, as the overall admission ratios indicate? The main lesson from the analysis in this article is that the answer cannot be determined by the numbers. Either answer can be correct, depending on the hidden and unobservable causal structures of the real world which generate the data.

[Simpson's Paradox 2](#): Here I elaborate on Bickel et al

(1975) discussion of the Berkeley admissions paradox. Their explanation can be understood as a causal path diagram where gender affects choice of department. Both gender and choice of department affect the admissions rate. With this causal structure, gender is a confounding variable when it comes to departmental admission ratios. These must be calculated conditionally on gender – that is, separately for men and women. However, departments are NOT a confounding factor when it comes to the effect of gender on admissions rate. Gender affects admissions through two channels – one is a direct effect on admissions ratios, and the second is an indirect effect via choice of department. Female gender affects admission positively via the direct affect which is favourable. However the indirect affect is negative since females choose the more difficult department in larger numbers. The numbers can be set up so that the negative indirect effect overwhelms the positive direct affect, creating the Simpson's Paradox. But this entire analysis is dependent on a particular causal structure, and different causal structures can lead to entirely different analyses for exactly the same set of numbers. This is my main point – to show that the hidden and unobservable real world causal structures MUST be considered for meaningful data analysis. Current econometrics and statistics does not pay attention to causality and hence often leads to meaningless analysis.

[Simpson's Paradox 3](#): We can consider alternative causal structures for Berkeley admissions which lead to conclusions radically different from Bickel's original analysis. We first consider a case where gender affects department choice, while the admission ratio depends only on department, and is completely gender neutral. If females choose more difficult departments, there will be a spurious correlation between admission ratios and gender, creating a misleading impression of discrimination against females. A second example is considered where admissions depend purely on SAT scores, and has no relationship to gender or to department. Nonetheless, if gender affects SAT Scores and choice of department, we can replicate the exact same numbers of the original data, which would create the misleading impressions that departments discriminate by gender, and some departments are more difficult to get into than others. In fact, admissions policy is same across departments, and depends only on SAT scores. The point of these analyses is that exactly the same observed data can correspond to radically different causal structures, and lead to radically different conclusions about discrimination with respect to gender.

[Simpson's Paradox 4](#): Contrary to the perspective taken

by conventional statistics texts, and some forms of econometric analysis (VAR models), **we cannot do data analysis without understanding the causal structures of the real-world which gives rise to the data.** The jobs of the field expert and the statistical consultant cannot be separated. To illustrate this point, we consider the same data generated for the Berkeley admissions, and consider it as batting averages of two different batters against left and right-handed pitchers. Then the Simpson's Paradox takes the following form. Frank and Tom both perform worse against left-handed pitchers. Frank has higher batting average than Tom against left-handed pitchers and he also has higher batting average than Tom against right-hand pitchers. However, the overall batting average of Tom is higher than that of Frank because opposing teams tend to use left-handed pitchers against Frank. Similarly, **better surgeons can have worse operating results because they are given the more difficult cases.** Consequently data alone are not enough. Context matters.

Simpson's Paradox 5: To further drive home the fact that data analysis cannot be confined to numbers, and be divorced from the real world environment which generated the data, we consider a third interpretation of the same data set used for Berkeley admissions. In this interpretation, we look at the effect of a drug on recovery rates from a disease. The Simpson Paradox takes the

form that the drug decreases recovery rates in females, and also decreases recovery rates in males. So, it is bad for males and it is bad for females. But when we look at the population as a whole, if the gender ratio in the control group is different from that in the test population we may find that the drug improves recovery rate. So, the drug appears to be good for the general population. A causal path diagram shows that gender must be exogenous – it cannot be affected by the drug. Thus gender is a confounding variable, we must condition on this variable to get the right measure of the effect of drug on recovery. Thus we conclude that the drug is bad for everyone, and lowers the recovery rate for everyone, even though the overall data tell us otherwise. But now consider the same data set with gender replaced by blood pressure, and suppose that the drug affects blood pressure. Suppose low blood pressure is a positive factor in recovery, while the drug has a toxic effect so that the direct impact is negative. However, the drug also lowers the blood pressure, which creates a positive factor for recovery. The combined effect can be favourable, and this is what should be considered when administering the drug.

Bickel, PJ, Hammel, EA, O'Connell, JW: Sex Bias in Graduate Admissions: Data From Berkeley. *Science*. 187(4175), 398–404 (1975)

How international corporations could be taxed, and why the US is working to prevent it

By [Norbert Häring](#)

The OECD and the EU want to change international tax principles to curb tax evasion. The United States is opposed to the plans as they would affect its internet companies and other US multinationals.

The US has stepped up its fight against taxes on digital corporations. Shortly after President Donald Trump's threat of special tariffs on French goods, US Treasury Secretary Steven Mnuchin asked all countries in early December to abandon similar plans for taxes that would hit US internet corporations in particular. In a letter to the industrialized country organization OECD, Mnuchin stated that an agreement should instead be reached at the OECD level. At the same time, however, he warned of changes to the taxation right, which this same OECD has been planning to introduce. These could damage established pillars of the international tax system, he wrote.

The US is thus questioning the OECD's plan to curb rampant tax avoidance by international corporations and also low-tax competition by national governments. To this end, the OECD wants to change long established

principles of international taxation rights, if possible by 2020.

An outdated system

"The system of corporate taxation is outdated," wrote Clemens Fuest, head of the Ifo research institute in Munich, Mathieu Parenti and Farid Toubal. "The states are therefore forced to cut taxes. According to a study by Thomas Torslov, Ludvig Wier and Gabriel Zucman, corporation tax rates were more than halved from 1985 to 2018 on average worldwide from 49 to 24 percent in 1985.

Large scale tax evasion by international corporations causes severe revenue shortfalls for governments and distorts competition with domestic medium-sized companies which have to pay regular tax rates.

For some years now, international committees have been discussing reforms of the taxation principles that enable multinationals to shift profits to low-tax countries. The most important of these principles states that international subsidiaries of corporations be taxed separately where they are active, regardless of their mother

corporation.

A third-party comparison of intra-group transactions is intended to ensure that profits are not transferred via unreasonable internal transfer prices to where the tax is lowest. But that works badly, because there are no objective market prices for many payments, for example for patents, licenses or brand rights. In addition, the arrangements chosen are often very complex.

It works particularly badly for digital corporations. The EU Commission has therefore proposed a digital tax for large corporations in the internet industry as a temporary solution pending an international agreement on new rules. France has closely followed the EU proposal with its special tax, which the US has been fighting vehemently. Other important countries such as Spain, Italy, Belgium, Turkey and India have also introduced special taxes on digital sales.

A two-pronged OECD plan

The OECD reform agenda, on the other hand, is two-pronged. The industrial country club wants to leave everything as it is for the routine business of the corporations. Part one of the proposed reform would make so-called residual profits in a tax haven which go beyond a certain profit ratio taxable in the countries in which the corporations sell their goods.

The second prong of the OECD proposal is a uniform minimum tax rate worldwide. This should be enforced in such a way that the country of domicile of the holding or mother company can tax profits from foreign subsidiaries if these are taxed below the minimum tax rate. If the parent company itself is located in a tax haven with a tax rate that is too low, the subsidiaries' home countries would be allowed to refuse tax deductibility of intra-corporation payments to the mother.

Fuest and his co-authors have analyzed the effects of the OECD proposal for the French government advisory body Conseil d'analyse économique. One result is that the first pillar of the reform option of the OECD, the redistribution of residual profits, would yield only negligible tax redistribution effects. Only the second pillar, the global minimum tax rate, would change the tax distribution significantly. It would lead to a significant decrease in profit shifting and to significantly higher tax revenues. The three authors therefore propose to drastically simplify the first pillar, and to simply agree on a share of the profit that is to be redistributed according to sales.

Mnuchin's letter, in which he instead proposes a system of exceptions that is not known in detail, has called into question the OECD countries' plan for reform. In a reply letter, OECD head Angel Gurría pointed out to Mnuchin in December that such a move had never been

discussed with the United States in the drawn-out consultations. Now the proposal threatens to go beyond the tight time frame set by the 135 participating countries. French finance minister Bruno Le Maire rejected the US proposal, stating that it boiled down to US companies being able to choose how they would like to be taxed.

The EU alternative

The EU Commission has drawn up an alternative reform plan for the EU. It provides for a group-wide profit to be calculated and the taxation right for this "unified tax base" to be divided among the countries with company locations. Allocation criteria would be assets, sales and employment in the respective countries. Governments could then apply their individual tax rates on their share. Various scientists and commissions also propose this principle of the unified tax base for the global tax distribution.

The International Monetary Fund (IMF) has calculated the changes in tax incomes the EU reform model would imply for the different country types, if it was applied globally. With unchanged tax rates and unchanged corporate behavior, the IMF economists determined that tax havens would lose up to 80 percent. Most of the other countries would benefit. However, the fund's experts warn that the tax competition between governments would remain intense and that new opportunities for manipulation would arise.

There is, however, a more important sticking point in both reform proposals, warns tax expert Lorenz Jarass from the Wiesbaden University of Applied Sciences: "Why should the countries benefiting from the current system voluntarily agree to new rules?" Doing so would reduce their share of tax income and also the number of high-paying tax avoidance jobs on their territory.

The same point applies to the home countries of the corporations, as the current US push shows. Jarass therefore sees a chance of progress only if large countries such as Germany go ahead with unilateral measures to take some of the ill-gotten tax base from the tax havens. If they did this, the tax havens and the corporations benefiting from the current situation, would not have so much to lose from a cooperative solution.

Measures that Jarass claims would be legally possible and effective include a ban on deducting payments that are not adequately taxed in the target country. Individual countries are already implementing such measures. The digital tax is also an example of such a unilateral measure to exert pressure on countries that refuse to agree on new rules, in this case the US.

The transnational corporation and economics

By [Grazia Ietto-Gillies](#) ¹

1. Where are we on the study of TNC?

There is now a very large body of literature on theories of the transnational corporation (TNC) and the subject has reached a suitably mature stage to have a history of economic thought about it.² The first theory of the 'International Firm and its Operations' was developed in 1960 by Steven Hymer, a Canadian student working for a doctorate under the supervision of Charles Kindleberger at the Massachusetts Institute of Technology. A British scholar at the University of Reading was, contemporaneously, researching the effects of American investment in the UK. John Dunning later developed his own very successful theory (1977 and 1979) and continue to do theoretical and applied research in the field till his death a few years ago. Many theories and studies have been developed on both sides of the Atlantic in the intervening decades, in particular the so-called 'Internalization theory' by Peter Buckley and Mark Casson (1976) also at the Reading University. The theory has recently been updated by Casson (2018).

The subject of 'International Business' is now well developed and most theories of the TNC are developed and taught in its multi disciplinary context. However, the study of TNCs has not been fully accepted within the academic economics profession – including the non-orthodox academics - and is rarely an integral part of the curriculum though there may be a few lectures within the context of a course on industrial economics. I should, however, add that among the theories developed in the last few decades are the so-called New Trade Theories of the transnational company which have engaged high profile economists such as: Krugman, Venables, Markusen.³ These are developments from the internalization theory and both strands fall generally within the neo-classical paradigm. They are interesting, but they do not alter the fact that, on the whole, the subject matter is highly marginalized in economics curricula. Yet the TNCs as a whole and often single TNCs have profound effects at the macro level including those on government policies. The relevance of TNCs' activities at the macro level should be clear from a couple of statistics: world wide TNCs are responsible for some 80 percent of world trade. Their location strategies affect the geographical and sectoral structure of trade. Moreover, about a third of such trade is intra-firm (UNCTAD, 2013). As the XXI century progresses the activities and relevance of TNCs for the world economy are increasing.

I should first explain why I consider a study of TNCs and their activities important and indeed necessary in the current phase of capitalist development. To the lay person it would seem obvious that we need to study the activities of the most important economic agents operating today: transnational companies. Yet, though we see now and then in economics journals publications on FDI, the study of TNCs as a whole and of their multifarious activities has made few inroads into the main theoretical body of economics. To paraphrase Robert Solow – my old and excellent teacher at the MIT in 1967 – you can see the transnationals everywhere but in the economics curricula.⁴

Why this state of affairs? We could dismiss this issue as just some evidence of the divorce between theory and reality on the part of many economists, particularly those working within the mainstream paradigm. There may be some truth in this but it is certainly not the whole story. Moreover, non-mainstream approaches fare no better on this issue.

There are deep reasons – linked to both methodology and subject matter – why economic researchers have been unable or unwilling to fit the TNC and its various activities into the main body of their theories. There are also very good reasons why the topic should now be given a stronger role in economics research and curricula. To both of these I now turn.

Let us begin by trying to see the reasons why the TNC and its activities have no specific place in economic theory. Let us assume for a moment a wholly theoretical world in which all national barriers and frontiers have come down; one single currency circulates; a single tax regime is in operation. In other words, the world becomes one single country/nation-state and is governed as such. In such a world we would have no theory of international production and of TNCs: there would be no need for it. We would work within the confines of spatial location theory to explain where production is located and with theories of the firm, business governance and market structure to explain the growth of firms, their boundaries, their organization and their behaviour vis-à-vis other firms. Thus we would not need a theory of transnational companies to understand *who* invests, *where* and *why*. Theories of transnational companies and of foreign direct investment are needed because we have nation-states and frontiers.

In fact we do not attach much relevance to the identity of the investors when they originate from other regions within the same nation-state, for example when a Texan firm invests in Michigan or a Tuscan firm invests in

Calabria. Why should we consider the origin of the firm as relevant when it is from a foreign country?

In general, when analysing economic activities, economists tend to ignore the actual nationality of the investor. Instead, the main focus has been on issues such as: the firm in general or in relation to its size; the market structure of an industry; the production, investment or trade of the macroeconomy independently of the nationality of the firm producing, investing or trading. This is exactly what we do when we study, for example, international trade theory: we analyse the comparative conditions and advantages of the trading countries and/or the impact of trade on them independently of the national identity of the exporter firm. Why should we bother with such identity when the operator is someone investing in many countries?

Might theories of TNCs and foreign direct investment be redundant and trivial? Could it all be subsumed under theories of investment independently of the nationality of ownership or the investor? Or under the theory of the firm in general? Is there much point in developing theories of 'international' production and investment or the 'international' firm? Would not theories of production, investment and the firm take care of everything there is to know about the location of investment and production, and of the behaviour of firms and their entry modes into foreign markets?

This is indeed the – tacit – approach taken in most traditional economics departments in which the international economy is dealt with at the macro level by teaching and research into issues of international trade, the balance of payments and exchange rates. Moreover, at the micro level, theories of the firm and investment are not usually analysed in the context of the 'nationality' of the investor or the country in which the investment has taken place. Characteristics of companies other than multinationality (such as size) are considered in the context of oligopoly and of market structure theories in general. On the teaching side, multinational companies, their existence, growth and range of activities, are usually dealt with in a couple of lectures within a unit on industrial economics or the students are advised to attend lectures in a business/management department to learn about TNCs.

2. Why we need specific theories of the TNC

The traditional approach can indeed be justified if one takes the view that the nationality of the investor and the transnationality of operations make no difference to the geographical pattern of investment and production or to the overall amount of production or to its impact on the country where the investment takes place. Economists have traditionally looked into the identity of the investor when analysing the investment by public versus private firms. The reason for this is clear: the public investor is assumed to have different *objectives* compared with the private one and therefore the private identity versus the public one does matter. However, this is not the case when the investor is a TNC. Whether the firm is foreign or domestic, whether it is a multinational or a uninationa firm, the objectives are not different; they are profit or profit-related objectives.

In fact, the reason why in our case the uninationa or multinational character of the investor matters, has nothing to do with objectives but with *strategies*. The argument for specific studies of the TNCs and for their incorporation into the main body of the economics curriculum is that *the existence of nation-states has a bearing on firms' strategies*. Such strategies affect the levels and patterns of world investment, production and trade, and they affect the economic and social context in which other agents – such as labour, uninationa firms or governments – operate. They do, in particular, affect the context of government policy. This is the main reason why a study of TNCs and their activities is important, and indeed basic, for an understanding of the activities of firms, industries and national economies in the global context.

The nation-states generate opportunities for specific strategies for companies that operate across them. The strategies are connected with the fact that each nation-state has specific regulatory regimes on:

- Rules and regulations regarding the social security system and in particular different regimes regarding labour and its organization
- Fiscal regime including corporation tax and customs and excise duties as well as non-trade barriers
- Currency regimes
- Regime of industrial policy with regard to incentives to businesses

By operating across different nation-states, TNCs may face extra costs compared to location at home where the environment is better known to their managers. However these are compensated by the extra advantages that operating in several foreign countries gives them. For a start they can achieve advantages of: (a) risk spreading; and (b) acquisition of knowledge and innovation from the diverse environments. But the main advantages are in terms of operating in the context of different regulatory regimes; this allows them advantages in negotiations with spe-

cific actors. In particular:

1. Negotiations with trade unions pay and conditions
2. Negotiations with governments about tax concessions or special subsidies

Moreover, the different tax regimes give scope for arbitrage strategies designed to minimize the overall tax liability of the company world wide. The fiscal advantages deriving from operating in different nation-states can be several and become cumulative. There may specific concession in terms of lower tax rates for foreign investor by governments eager to attract investment, create jobs and gain electoral advantages. But operating in different countries generates also scope for financial engineering: by creating new companies and locating them into low-tax regime countries, companies can syphon-off profits. Moreover, operations in many countries characterized by different rates of corporation tax allows them scope for the manipulation of transfer prices (OECD, 2010; letto-Gillies, 2019a, Ch. 23). Such manipulation is illegal but very difficult to detect; other strategies are legal such as the setting up of special companies in tax havens countries. There are losers in these games: the governments and the countries whose legitimate profits have been syphoned-off.

The digital companies, mostly headquartered in the USA – such as Facebook and Alphabet – the owner of Google – are in a particularly advantageous position in this respect. Their profits are very difficult to track down given their specific business models.⁵ However, their revenue can be tracked down and allocated to the countries where it is raised. Hence the OECD proposals first to avoid low-tax competition by countries and second to tax revenue rather than profits which is something many countries do with the Value Added Tax or Sales Taxes. Discussions about a revenue tax have been going on for some time particularly at the level of the EU. In July 2019 under pressure from the *gilets jaunes* movement, President Macron has introduced such a tax. However, President Trump has reacted negatively and threatened retaliatory policies. The issue is ongoing.

The many issues related to the digital companies – from theoretical issues in respect to the definition of TNCs to home versus foreign assets to location of profits for tax purposes – are discussed in letto-Gillies (2019b) a paper prepared for the WEA Conference on Digitalization: [GOING DIGITAL: What is the Future of Business and Labour?](https://goingdigital2019.weaconferences.net/papers/digitalization-and-the-transnational-corporations-rethinking-economics/) 15th November – 20th December 2019.

3. Conclusions

The study of the TNCs though highly developed within the ‘International Business’ academic community, is not yet fully incorporated into research and teaching by the economics community. This is a very unsatisfactory state of affairs particularly given the very large and growing relevance of TNCs in production, trade investment and world development. The relevance is with regards to their growth and impact on countries and societies but also with regards to their impact on policies.

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1. Emeritus Professor of Applied Economics London South Bank University and Visiting Research Professor, Birkbeck, University of London. Grazia has been one of the founding members of the WEA
2. See Grazia Ietto-Gillies (2019a) for a comprehensive review of theories in their historical context as well as of relevant concepts and effects of TNCs' activities.
3. See Barba Navaretti and Venables (2004); Krugman (1998); Markusen (1984).
4. Solow (1987: 36) wrote: "You can see the computer age everywhere but in the productivity statistics"
5. See also UNCTAD (2017).
6. See Norbert Häring in: <https://www.worldeconomicssassociation.org/newsletterarticles/international-corporations-tax/>

Challenges of complexity economics

By [Joachim H. Spangenberg](#), Lia Polotzek

In recent WEA Commentaries, the issue of complexity theory and its implications for economics have rightfully gained some prominence. However, while the authors picked up some relevant points, the issue deserves a more comprehensive treatment in new economics, beyond mobilising some arguments to bolster ongoing debates. It should be recognised instead that complexity requires a different way of thinking, and of asking questions in economics. Only then the specific tools used in complexity research, unconventional as they are from a standard economics point of view, come into play. Thus we will briefly describe what we see as core elements of complexity, the corresponding world view, and the tools used.

Complexity

Complexity economics is a genuine theoretical approach based on applying complexity analysis to the economic system; it requires a world view different from the one of neoclassical economics, moving from reductionist linear thinking to non-linear approaches of conceptualising the economy. In system science parlance, a 'system' is any set of things within a common frame (the system boundary) that is ruled by a given set of interactions (the system rules). Applying the terminology to the whole of the outside world, three systems have to be distinguished (Sayer 2000; Spash 2012): The '*real-world system*' or 'the reality' is the object we would like to know more about. However, this system is not accessible to direct human observation since our perception is limited by the senses and instruments we have and interpreted by our brain.

The result is a '*mental model*', an imagination of reality, a simplified system which provides our ontology. The ontology shapes expectation and questions asked, is the basis of the interpretation of experiences and observations, and shapes the recommendations derived from them. However, it is usually neither reflected nor made explicit, often rather being an unconscious model of the world and its functioning the analyst holds. Ontologies, like all mental models, are best described in qualitative narratives or storylines. The third system, *computer models*, are the tools used to quantify a selected set of the expectations raised by the mental models. They are limited by the system margins and the necessarily relatively simple descriptions of a limited number of interactions within the system. Which elements are taken into account (i.e. realised in the computer model), and which interactions are considered and thus programmed, depend on both the ontology and the limitations imposed by the modelling technology chosen. Surprisingly, most public trust lies in these most simplified models.

While the system boundaries can be defined according to the research question analysed (choosing the subsystem of interest), this is not the case for the system rules which are defining the functioning of a system and its subsystems. The number of rules needed to describe the system functioning is a good measure of the respective system's complexity – the more rules are given, the more system behaviour is constrained and less complex. On the basis of Allen (2001), we can define five distinct rules, which, if they all apply, signal maximum determination. The five system rules are, simply expressed:

1. It is possible to distinguish between ‘the system’ and ‘its environment’. Defining the border line is crucial as what the system can describe is only what is inside; it is a condition for the very existence of a system. When economists regret that their predictions did not correctly predict real-world developments, explaining that with unforeseen ‘external factors’, they essentially indicate that they have drawn the border line in the wrong place, excluding factors decisive for the functioning of the system.
2. All system components can be recognised and distinguished, which means it is possible to describe and at best understand their interaction.
3. The active system elements are all identical, or at least the range of their behaviour is normally distributed around the average. In an economic system, for instance, consumers and producers are key active system elements. Microeconomics tries to understand their interaction by analysing the interplay between ‘representative agents’ – one consumer representing all consumers and one producer representing all producers. To be able to do so, one must assume that all consumers and all producers are identical regarding their behaviour in the situation analysed. In a biological system, the range of behaviour of individuals of the same population tends to be centred around an average (if two dominant patterns exist, they can be considered as the core of behaviourally different subpopulations, which are system elements).
4. The individual behaviour of the system elements can be described by average interaction parameters which characterise the system behaviour. This implies that producers, consumers and others always follow the same set of behavioural rules and norms (with some stochastic variation); they are extremely stubborn, do not learn or change their behaviour towards others, at least not as groups (this is not a statement about individual behaviour and learning, and similarities with known professions are purely incidental). The rationality of the selfish human in standard economics embodies these characteristics. The result is a deterministic development, with at most a random variation around the predicted outcome.
5. The system develops towards a stationary equilibrium, which permits defining fixed relations of system variables. If this is the case, the future is perfectly predictable as the development trajectory of the system is defined and unchangeable. This is an abstraction, a mechanistic contract: machines behave like that but no natural, biological or social system does. Using the five rules, we can distinguish the levels of complexity between different complex adaptive systems. Geo-physical systems like the climate system fulfilling rules 1 to 4 can evolve and adapt, which makes transitions towards different attractor basins possible when external conditions change, a phenomenon we also know as crossing tipping points. Biological systems only match rules 1 to 3. They have a higher degree of complexity due to the individual behaviour of agents which can deviate from the standard behaviour of a representative agent and its fuzzy borders, making transitions towards different attractor basins even easier. Again one dimension more complex are anthropogenic systems (societies, economies, etc.) restricted only by rule 1 and 2, as here the agents are capable of anticipation. Modification of behaviour not randomly but based on expectations can avoid structural changes, but – if as so often expectations are wrong – can also result in accelerated and intensified changes. Unlike for biological models, taking this trait into account is a necessary condition for suitable economic models (alternative mental models, imaginaries – computer models so far fail to deal with this level of complexity). Thus when Maria Alejandra Madi discusses complexity theory in Commentaries 8(4), she is right defining it not as tool driven, but a genuine theoretical approach, but when equating the complexity of natural and anthropogenic systems, she underestimates the systemic differences.

World views

The complexity theory approach is part of a distinct world view. The philosophical literature on the concept of worldview dates back to Immanuel Kant, who coined the term “Weltanschauung” in 1790. In the literature, the elements most frequently discussed as constituents of a worldview are ontology, epistemology, axiology and anthropology (Hedlund-de Witt 2012). Ontology is a section of philosophy dealing with questions concerning the nature of being, and in particular questions regarding how and under what circumstances entities exist or may be said to exist and how such entities may be grouped, related within a hierarchy and subdivided according to similarities and differences. Epistemology is the branch of philosophy dealing with the theory of knowledge. It studies the nature of knowledge, justification and the rationality of belief, describing the kinds of knowledge we can have about an entity identified by the ontology (hence the distinction of three levels of models is already part of our epistemology). Axiology is another branch of philosophy, encompassing a range of approaches to understanding how, why, and to what degree humans should or do value objects (entities), whether the object is physical (a person, a thing) or abstract (an idea, an action), or anything else. According to Hedlund-de Witt (2012), it should include a societal vision. It also determines the ethics pursued and thus should be made explicit when developing proposals for action (the discount rate built into current economic models determines the

value of future development, making it an implicit ethics causing a lack of transparency). Philosophical anthropology describes the *conditio humana*, the essentials of human existence, and the nature of human beings, the latter typically used in the context of ambiguous subjects such as moral concerns and human reflections on the meaning of life.

The neoclassical economics world view describes a world consisting only of monetary flows, with the economy the meta system. The ecological economics ontology which we endorse considers the environment as the meta system in which society is embedded, and the economy is a subsystem of society. Together they form a dynamic panarchy (Gunderson, Holling 2001). All three are complex evolving systems of different complexity, and tend to follow some variant of the Holling cycle of resilience (Holling 2001). In this cycle a phase of expansion, growth and development is followed by one of stabilisation, a metastable state with still dynamic changes, but fixed underlying structures and key relations. It is followed by a phase of disruption, usually a rapid process after passing a tipping point which can start as slow degradation accelerating or happen without previously observable indications. Then reorganisation happens, making use of resources left from the previous cycle but developing a new system. Phases of apparent stability should not be misinterpreted as equilibria: they are rather dissipative patterns far-from equilibrium, with their basic patterns maintained by the permanent throughput of matter and energy (Prigogine, Stengers 1984). The slow-to-no growth situation of most affluent economies can be understood as the metastable interlude between expansion and disruption.

The epistemology used in neoclassical economics is a positivist one, based on the assumption that the world can be fully understood and measured. As opposed to that, the one we use is rooted in the assumptions of critical rationalism. The world is a concrete reality, a complex system characterised by prevailing and unavoidable risk, uncertainty and ignorance. We can perceive reality only indirectly through senses and instruments, which influence our perception, often unconsciously (as critical realism postulates and environmental sociology shows). Our ontology influences the interpretation of observations with a tendency to realign them as long as possible. Models are recognised as delivering incomplete information which needs to be understood in the context of the mental models and ontologies behind them, and be critically reflected. While complexity economics is accepting diverse value systems, the axiology of neoclassical economics is dominated by “economic rationality”, considered an anthropogenic constant which – together with the methodological individualism considering each individual as independent from social influences – is also

shaping its anthropology. As opposed to that, complexity economics accepts human beings in their ambivalence as social beings, their behaviour influenced by both egoistic instincts and genuine social practices, shaped by their respective social, institutional and infrastructure context (Spangenberg, Lorek 2019). While according to the insights of sociology, psychology and political science this is more realistic than the standard economic assumptions, it makes predictions almost impossible as there is not one binding logic all individuals must follow at all times.

Tools

Greg Daneke in Commentaries 9(2) rightfully describes complexity economics as using specific, unconventional tools such as “a variety of computational tools (nonlinear math, neural nets, cellular automata, adaptive algorithms, etc.) to simulate the co-evolutionary interaction of heterogeneous agents (exhibiting cooperative, reciprocal, and even altruistic behaviours) and their institutions”. To this list focussed on new models and algorithms qualitative methods, text and discourse analysis, empirical methods, polls and questionnaires should be added. Complexity economics is methodologically diverse; models do not play a dominant role as in standard economics but are rather support tools for more complexity bearing narratives.

Thus complexity economics indeed uses different tools than standard economics, and for good reasons. Analysing the available tools from a complexity perspective makes it crystal clear that the tools of economics are undercomplex and will not be able to deliver results adequately describing economic developments (see also Ciarli, Savona 2019). Equilibrium models follow rules 1 to 5 and system dynamic models rules 1 to 4; both are deterministic and have problems dealing with uncertainty and ignorance (stochastic variation as in fuzzy models is not uncertainty). As relative equilibria are considered to be just an interim phase of the Holling cycle, equilibrium models are only justifiable – if at all – for analyses of short term developments. However, in standard economics and in the Integrated Assessment Models (IAM) used in climate science, they are used for the opposite. Agent-based modelling uses identical agents (but usually defines more than two groups of agents) to analyse the interaction mechanisms of societies and adheres to rules 1 to 3. No model matches the complexity of reality (and most mental models); the best available option appears to be a combination of agent based models for social and economic processes, embedded in a system dynamics environment model.

Generally speaking, in order for computer models to be adequate (scientifically rigorous and socially robust), though, the mental model – already a simplification of reality – must first capture the major behavioural traits

of 'reality', reflect and integrate them as the basis for deriving strategies effective when applied in a real-world context. Only then can the required technical tools be chosen or developed, attempting to enable them to express the main characteristics of the mental model, many of them qualitative in kind, and quantitative functions derived complementing and illustrating the qualitative mental models. As the mental model, expressed in scenario narratives or story lines, can accommodate qualitative aspects in a way no computer model can, the mental model narrative is the matrix in which diverse and complementary computer models can be embedded, illustrating and quantifying specific aspects of the scenario (Alcamo 2001). As both mental models and even more so computer models are simpler than the reality they describe, we should be aware how the simplifications that are inherent to the model (and that indeed is, to a certain degree, its purpose) impact the recommendations derived. In particular, when 'the reality' makes itself felt, confronting our expectations with unexpected experiences in a way that cannot be overlooked, the prevailing construction of the two derived systems must be considered falsified and due to change. Unfortunately, this basic principle is not always adhered to in standard economics.

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A comment on Market-value: Its measurement and metric

Market-value: Its measurement and metric is a remarkable contribution of Edward Fullbrook for a better understanding of the weaknesses of the basic concepts of mainstream theory. Fullbrook's book paves the road for a critical stance about orthodox economics. It is an essential tool for everybody interested in economics and epistemology of economics.

Gustavo Marqués

WEA Commentaries appoints new co-editors

It is time for a change. There is a younger generation of economists who will be shaping the course of our discipline over the coming decades. The World Economics Association aims to be a platform to assist in this. Consequently *WEA Commentaries* has appointed six co-editors from around the world and with diverse backgrounds to help us in this endeavour. They briefly introduce themselves here. Feel free to contact them:

Ceyhun Elgin is a lecturer in the Columbia University Department of Economics as well as the Director of the MA program in economics. Previously, he was a professor of economics at Bogazici University in Turkey. He obtained his Ph.D. in economics from the University of Minnesota in 2010 and published extensively in the fields of economic growth, public economics, and macroeconomics, with a particular emphasis on the economics of informality.

Ana Luíza Matos de Oliveira is an economist, with an MSc and PhD in Economic Development. She is currently a visiting professor at FLACSO Brazil, analyst at Fundação Perseu Abramo and co-editor of *Brasil Debate* (brasildebate.com.br).

Sergio Sotelo-Sosa is an international economist with experience in consulting and business management, agricultural trade policy, and public outreach. He is a bilingual Mexican-American currently based in Dallas, TX.

Irene Sotiropoulou is a heterodox economist currently based at the Energy and Environment Institute of the University of Hull, UK. She specialises in ecological, feminist, solidarity and non-capitalist economics, heterodox theories and practices about money and finance, non-monetary economics and sharing modes. For analyzing everyday and folk culture with reference to grassroots economic knowledge, she has been awarded, along with Dr Ferda Dönmez-Atbaşı (Ankara University), a Newton Mobility Grant by the British Academy. She is a Fellow of the GEM-IWG/GEM-Europe and World Social Science Fellowship programs, and a Fellow of the Monetary Research Center (UNWE) at Sofia. She is happy to discuss Commentaries related to her expertise and any Commentary that is related to a nature-friendly and humane economy.

Mitja Stefancic holds a PhD in 'Economics and Business' from the University of Ljubljana, an MPhil in 'Modern Society and Global Transformations' from the University of Cambridge and a BA in 'Sociology, Culture and the Media' from the University of Essex. He was Fellow in Political economy ("cultore della materia in economia politica") at the University of Trieste. He has published in journals such as the *Journal of Entrepreneurial & Organizational Diversity*, *Review of Innovation and Competitiveness*, *Organizacija*, *Studi Economici*. He has recently provided entries for a forthcoming encyclopedia on global economics. Past research has been on social enterprises for the European Institute on Cooperative and Social Enterprises based in Trento and on local institutions and ethnic minorities at the Slovene Research Institute and at the Jacques Maritain institute, both based in Trieste. He completed a working experience with a financial holding that was in the past based in Gorizia, and has been employed for two years by an Italian cooperative bank. Mitja is currently working both on projects related to knowledge and technology transfer in Slovenia and on other projects that focus on providing essential support to micro, small and medium-sized enterprises. Mitja is fluent in Italian, Slovenian and in the English language.

Hailai Weldeslassie is currently a PhD research fellow at the School of Accounting, Economics and Finance, University of KwaZulu-Natal. Research areas relate to Multidimensional and Uni-dimensional Poverty, Inequality and Food Insecurity, Impact (economic) of climate change and Sustainable Environment, Women Empowerment and Child Poverty, Socioeconomic Impact Analysis and Randomized Control trial Impact Analysis, Development Economics, Micro finance Institutions, Poverty and Inequality, Welfare economics, Agricultural Economics, Education Economics, Health Economics, Applied Microeconomics, and Energy Economics.

Contact the Association

Journal editors:

RWER: Edward Fullbrook fullbrook@worldeconomicsassociation.org

Economic Thought: ETEditor@worldeconomicsassociation.org

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Conferences: Chair of Conference Organizing Committee:

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