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Arne Heise

**Whither economic complexity?**

**A new heterodox economic paradigm or just  
another variation within the mainstream?**

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## I. Introduction

Economics is in considerable disarray. Neoclassical orthodoxy still remains the ‘normal science’ standard procedure and provides the foundation for economic education. However, for some time now many economists have claimed that its scientific research programme as a problem-solving tool has been squeezed out and is no longer at the cutting-edge of research (see e.g. Colander/Holt/Rosser 2004, Holt/Rosser/Colander 2011, Arthur 2013).

After the recent global financial crisis, the time seemed right for a scientific overhaul of the whole discipline of economics under the heading of ‘new economic thinking’, an idea promoted as much by economists unhappy with the state of the discipline as by economics students unwilling to learn something apparently irrelevant for the real world and by economic and business practitioners and patrons who sponsored research that, in the past, few were willing to support financially.

It seems obvious that heterodox economics – the part of the scientific community which had been critical of the state of the discipline long before the outbreak of the global financial crisis and which long before had demanded a ‘new economic thinking’ – could have been seen as a natural candidate for a scientific research programme or paradigm that could assume the spotlight. However, heterodox economics is a blurred description of a scientific paradigm comprising quite different thought collectives and is based on very shaky analytical grounds (see e.g. Mearman 2012).

In this contribution, we will take a closer look at a scientific research programme which has often been cited as the one whose time is about to come: complexity economics (see e.g. Buchanan 2004, Colander 2003, Beinhocker 2006, Davis 2008; Roos 2015). Before we attempt to describe the paradigmatic foundations of complexity economics and arrange them in the context of the orthodox/heterodox divide, we need to explain our understanding of the concept of a paradigm and clarify what makes a paradigm orthodox or heterodox and why it is important to classify a paradigm as either orthodox or heterodox. The paper will conclude with a statement about the paradigmatical position of complexity economics and its significance for the future of the economic discipline.

## II. Why should we care about the orthodoxy/heterodoxy divide?

When Thomas Kuhn’s *The Structure of Scientific Revolutions* was first published in 1962 (Kuhn 1962), it was met with great interest by many economists who believed they had lived through the advent of a paradigmatic shift in economics after the publication of Piero Sraffa’s *Production of Commodities by Means of Commodities* in 1960 (Sraffa 1960), the renewed interest in John Maynard Keynes’s writings and the sudden discussion about ‘what Keynes really meant’ (see e.g. Clower 1965, Coddington 1974).<sup>1</sup> Although this ‘Keynesian revolution’ never occurred, the late 1960s and early 1970s saw, at least, the rise of paradigmatic approaches that considered themselves clearly in

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<sup>1</sup> According to Kuhn, a scientific revolution can be triggered either by the proof of internal theoretical inconsistencies within the mainstream theory or by empirical falsification. Yet, it will lose its dominant position only if an alternative is available to replace it. The Sraffian critique was considered just such a proof of internal theoretical inconsistencies and the (post) Keynesian theory as the necessary alternative.

opposition to the neoclassical mainstream (see Fine 1997: 148, Lee 2009, Heise/Thieme 2016). While the label ‘heterodoxy’ became popular only later, this oppositional perspective taken by, among others, Marxian, Sraffian, Post Keynesian and Radical economists established the dualistic divide between orthodox or mainstream economists on one side and heterodox or non-mainstream economists on the other. Despite being criticized for ignoring too many shades in between – e.g. dissenters within the mainstream or mainstream heterodoxy, new heterodoxy and traditional heterodoxy (see Lavoie 2014: 8f., Davis 2008) – or for being too static, this dualistic division is useful in order to distinguish between a meaningful pluralism which builds on clear paradigmatic opposition and less meaningful variation, multitude or specialisation which can be achieved within paradigmatic monism (see Heise 2016a).

The distinction between orthodoxy and heterodoxy and the classification of paradigms as belonging either to the one or the other is not only interesting from a philosophical point of view, but it is also important in order to understand the development of a discipline: if in the course of events a heterodox paradigm becomes dominant (and, thus, assumes a position that would be called ‘orthodoxy’ or ‘mainstream’ henceforth), this would truly mark a paradigmatic revolution - something the history of the economics discipline has yet to experience despite assertions to the contrary.<sup>2</sup> Moreover, if the pluralism campaign finally gains momentum and results, for example, in institutional support for otherwise neglected or downplayed heterodox paradigms, then in order to prevent free-rider behaviour it must be clear which paradigms can rightly claim to be heterodox and which cannot.

### III. Scientific Paradigm – weasel word or concept of substance?

The orthodoxy/heterodoxy divide rests on the distinction between different scientific paradigms which themselves are based on inherent incompatibilities and incommensurabilities framing the oppositional perspective of the dualism. Taking Kuhn’s (1962: 10) definition of a scientific paradigm as “universally recognized scientific achievements that, for a time, provide model problems and solutions for a community of practitioners”, one is left without clear orientation or concise delineation. While the openness and flexibility of the concept may, on the one hand, have been crucial for its career in the philosophy of science, they make it difficult, on the other hand, to apply in a distinct way. Therefore, in order to avoid rendering it a scientific weasel word, we will borrow substance from a related concept which, moreover, appears better suited to the social sciences: Imre Lakatos’s scientific research programmes (srp).

Using Lakatos’s concept of scientific research programmes as a framework, we can identify the dimensions that constitute a scientific paradigm: (1) the **methodical dimension**, i.e. a methodology and related research methods that are considered acceptable, or ‘scientific’ and that direct the research perspective (e.g. static-equilibrium or dynamic-disequilibrium oriented); (2) the **epistemological dimension**, which centres around a series of core assumptions (axioms) that underlie those models or theories comprising a paradigm. This core is surrounded by a protective belt of auxiliary assumptions which,

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<sup>2</sup> Best known, of course, is the ‘marginalist revolution’ which marked a radical methodical shift, but involved no clear rejection of the ‘classical’ ontology – more on this in the next part. And the ‘Keynesian revolution’, as another contender, never really was (see e.g. Blaug 1991, Laidler 1999, Hutton 2001).

if they are varied, are responsible for an epistemological variation within a paradigm. And, most importantly, (3) the **heuristic (or ontological) dimension** must be mentioned, which builds on ('ex ante' synthetic<sup>3</sup>) pre-analytic visions, 'model-solution' or 'ideal types'. They form postulates that correlate with the core assumptions of the epistemological dimension and that must be accepted ('positive heuristics') or, at least, not called into question ('negative heuristics') if allegiance to a paradigm is to be maintained. The heuristic dimension is critical as it frames a shared belief of the adherents of a paradigm about the nature of the subject under investigation. The nature of the subject is to be distinguished from the perspective from which the subject will be investigated. More concretely: if the economic system is ontologically understood as primarily involving intertemporal exchange relations ('market economy'), this does not exclude the possibility of different perspectives which will be addressed in the epistemological or methodical dimensions: The assumption of either strictly rational or 'bounded rational' choices at an epistemological level is not inconsistent with a common heuristic, nor is the focus on either static or dynamic properties of a complex, evolving system at a methodological level.

Theories and models that share the same methodical, epistemological and heuristic dimensions can, thus, be said to form a common paradigm; theories and models that differ in one or more of these dimensions would be regarded as forming different paradigms. Yet, however fierce the intellectual competition may be between paradigms that differ in the epistemological and methodical dimensions, as long as they share the same (at least negative) heuristic, i.e. as long as they are based on the same pre-analytic vision, they could be seen as compatible and commensurable. In terms of the previously mentioned orthodoxy/heterodoxy divide, all paradigms that are based on the same pre-analytic vision as the dominant paradigm constituting the 'normal science' of a discipline would be part of the wider mainstream, although regarded perhaps as 'dissenters' from the orthodoxy (see tab. 1).<sup>4</sup>

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<sup>3</sup> Immanuel Kant, the German philosopher, distinguishes between analytic and synthetic judgements. Analytic judgements are contained within the object in question; they do not bring us any new knowledge (e.g. the 'gray horse' is white); synthetic judgements, by contrast, provide us with new knowledge, since they are not already contained within the object (e.g. 'the horse eats grass').

<sup>4</sup> Backhouse (2004) distinguishes between 'disagreement', 'controversy' and 'dissent'. Disagreement can be seen as normal procedure for scientific advancement, controversy as a temporary phenomenon usually settled (not necessarily resolved) eventually and dissent as lasting opposition. This differentiation appears to fit our classification with disagreement and even controversy centring around epistemological and methodical questions within the mainstream, while dissent would be reserved for heterodox opposition to the mainstream. Yet, Backhouse blurs this exact dividing line by maintaining that there are orthodox (accepted by the mainstream) and heterodox (marginalised by the mainstream) dissenters. Although this imprecise notion of 'dissent' has become prevalent in the literature, I prefer to use 'dissent/dissenter' only for disagreement or controversy within the mainstream.

Table 1: Orthodoxy and Heterodoxy

<b>Heuristic B, C, D</b>			<b>Heuristic A</b>	
<b>Non-Mainstream</b>			<b>Mainstream</b>	
Theory J	Theory I	Theory F	Theory D	Theory A
		Theory G	Theory E	Theory B
		Theory H		Theory C
<b>Heterodoxy</b>			<b>Dissenter</b>	<b>Orthodoxy</b>

Sometimes, the broader conjunction of paradigms sharing the same heuristic dimension as the dominant one is called ‘orthodoxy’ and the narrower one ‘mainstream’ (see e.g. Lavoie 2014: 8f. who, again, refers to Backhouse). I have opted for the opposite naming because it better complies with the common usage of ‘orthodoxy’ as the pure doctrine to be found, for instance, in textbooks, while ‘mainstream’ commonly indicates a broader current.

Let’s put some flesh on the bones by considering a variety of theoretical thought collectives: it appears safe to say that *D*(ynamic)*S*(tochastic)*G*(eneral) *E*(quilibrium) theorizing constitutes the economic orthodoxy (see tab. 1). It is an amalgam of New Classical Economics and neo-Keynesianism which is based on the same core assumptions of rationality, ergodicity, and substitutionality exhibiting the hallmarks of social exchange theory (see e.g. Davidson 1984, Davidson 2007) at the epistemological level. In addition, the DSGE relies exclusively on formal-mathematical, positivist deductive reductionism (see Lawson 2006) at the methodical level. Over the course of the so-called ‘empirical turn’ during the past three decades, this constellation of elements has been combined with sophisticated systems of micro- and macroeconometrics, as well as experimental designs that harness approaches used in the natural sciences, such as physics and chemistry (see Schmidt/aus dem Moore 2010). The postulates of (long-term) stability, optimality and neutrality (Walras's Law, monetary neutrality, policy inefficiency), which are operational *a priori* in the core assumptions of DSGE theory, guide the ‘ideal solution’ (*Musterlösungen*) at the ontological level, thus functioning as a metric for negative heuristics, i.e. the research approaches not to be called into question. Ontologically, DSGE models can be said to occupy an allocational perspective (‘constrained optimisation’). The ostensibly large differences in forecasts delivered by the hyperstable equilibrium models of New Classical Economics compared with the dis-equilibrium models of standard Keynesianism and neo-Keynesianism (i.e. Theories A, B and C in tab.1) are attributable to modified assumptions within the ‘protective belt’ (e.g. concerning adjustment speeds, price and quantity rigidities, expectation formation, etc.), yet these differences are not(!) evidence of divergent paradigmatic origins<sup>5</sup>.

<sup>5</sup> Accordingly, both approaches are found in modern textbooks, where a distinction is made between short-term forecasts (the neo-Keynesian model) and long-term forecasts (the neoclassical model). For more, see Abel/Bernanke (2005); and Blanchard (2006).

**Behavioural economics**, assuming that this rather new approach is given the status of a paradigm of its own, discloses little about its ontological basis. The fact that prominent protagonists for this paradigm hasten to claim alliance with and allegiance to the DSGE orthodoxy<sup>6</sup> suggests that they share (positive heuristic) or, at least, do not oppose (negative heuristic) the real exchange ontology of the DSGE paradigm. If one still maintains a paradigmatic distinction from the orthodoxy, differences must be found either at the methodical or epistemological levels. Indeed, the experimental character of behavioural economics and the rejection of the rationality axiom (as an outcome of the experiments as much as a behavioural assumption) can be seen as methodically and epistemologically different enough to grant it a paradigmatic status on its own – however, not one that is in opposition to the orthodoxy but rather a dissenter as in tab. 1.

**Post Keynesianism**, as a third example, comprises different Kaleckian, Sraffian and Fundamentalist approaches (i.e. Theories F,G and H in tab. 1). These all, by and large, share the methodical dimension with the orthodoxy, yet reject the rationality, substitutability and ergodicity axioms at the epistemological level and, crucially, draw on a different pre-analytic vision: the economic system is not primarily understood as a network of (real and symmetric) exchange relations but as a system based on (asymmetric and nominal) obligations or power relations (see Heise 2016b). Ontologically, Post Keynesianism claims a social provisioning perspective<sup>7</sup>. Therefore, it surely forms not only a distinct paradigm, but also one that clearly opposes the orthodoxy and must, thus, be rated as heterodox (see tab. 1).<sup>8</sup>

#### IV. Complexity economics – its paradigmatic substance

Although economics is often lamented to be a colonizing, imperial discipline particularly with respect to the other social sciences, it has also throughout its existence always borrowed from other disciplines: from history, physics, biology and informatics. Basing its methods, methodology and epistemology solidly on other sciences was usually meant to import authority and professionalism. What was acceptable in the highly reputed sciences seemed good enough for economics. While the neoclassical mainstream emulates the concepts of hydraulic physics<sup>9</sup>, complexity economics is part of an interdisciplinary project of complexity sciences covering physics, biology, chemistry and informatics<sup>10</sup>; some already talk of this as a revolution in science from the predominant

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<sup>6</sup> See e.g. Smith (2003: 505), Cartwright (2011: 4).

<sup>7</sup> “...the theory of output and employment *as a whole*...” as Keynes (1936: 293) had put it in his General Theory. For more on the heterodox concept of social provisioning see e.g. Jo (2011).

<sup>8</sup> Sometimes the vehemence by which leading Post Keynesians try to set themselves apart from standard or neo-Keynesians (see e.g. Davidson 1992, Lavoie 2014) appears abstruse and difficult to convey – our claim that they are not only part of different paradigms but on opposing sides of the orthodoxy/heterodoxy divide might help understanding this behaviour.

<sup>9</sup> This is probably best illustrated by the ‘Monetary National Income Analogue Computer’ (MONIAC) constructed by Alban W. Phillips and displayed e.g. at the University of Cambridge.

<sup>10</sup> A major cornerstone in the development of complexity science was the foundation of the Santa Fe Institute (SFI) in 1984 which brought together a number of leading scientists from the natural sciences as well as the social sciences and humanities. The research agenda was about ‘complex adaptive systems’ in which systems could be economic, biological, physical, chemical or social.



**reductionist** approach of the past to **emergentism** as the future of science (see Fromm 2004: 4ff.).

‘Complexity’ and ‘complex systems’ are ill-defined terms; Perona (2007), accordingly, speaks of ‘the confused state of complexity economics’. Despite the fact that some ingredients seem to be uncontroversial, the ontological and epistemological character of complexity economics is anything but clear and uniform. Let’s start with the less controversial ingredients (see e.g. Durlauf 2012; Arthur 2013; Roos 2015):

- \* a large number of heterogenous interacting agents
- \* self-organisation, self-adaptability
- \* non-linear dynamics
- \* non-equilibrium

These ingredients form system properties, which again, appear uncontroversial: emergence and (theoretical) unpredictability<sup>11</sup>. By ‘emergence’ is meant a system property which combines determinacy (due to the assumed existence of interconnections between all system elements) with downward causation (i.e. the assumption that macro-level outcomes cannot be deduced entirely from micro-level properties) and, therefore, gives rise to unpredictability (see e.g. Christen/Franklin 2002). However, two distinct approaches can be broadly identified in the literature which differ in focus and accentuation (see e.g. Bronk 2011): 1) ‘**Epistemological complexity**’ concentrates on the non-linear interconnections of heterogenous interacting agents resulting in emergent macro-outcomes at the epistemological level. As the system is assumed to be closed and (macro-)determinate at the ontological level, complexity translates in ‘complicatedness’: “It is a vision that sees the economy as so complicated that simple analytical models of the aggregate economy – models that can be specified in a set of analytically solvable equations – are not likely to be helpful in understanding many of the issues that economists want to address” (Holt/Rosser/Colander 2011: 358). In contrast to neoclassical orthodoxy, this school of complexity economics rejects reductionist constraint optimisation at the methodical level as too simplistic and replaces it with an emergentism that relies on algorithmic computation rather than linear optimisation. As science is based on a reduction of the complexities of reality, epistemological complexity economists praise neoclassical economics for their historical merits in the formation of the discipline (see Foster 2005: 881) but claim that deductive reductionism has eliminated too many essential features of economic reality to still be of use: Ockham’s razor has simply been too sharp. Although, as far as I am aware, this has never been stated explicitly, there seems no reason why complexity economics of this kind would – at the macroeconomic level – reject Walras’ law since it shares the same pre-analytic vision with the orthodoxy as a heuristic device. 2) ‘**Ontological complexity**’ blows up the monistic vision of economic reality as a closed system in favour of an open system ontology which enhances emergence towards contingency<sup>12</sup>. Contingency relates to a representation of reality which is non-deterministic and non-ergodic in the sense that the future occurrence of a variable cannot be traced by its past developments and, thus, cannot be fully analysed and rationally expected using probability calculus because it is funda-

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<sup>11</sup> Theoretical, as opposed to inductive unpredictability (for the difference see Christen/Franklin 2002), simply means that from the bare axiomatic (micro) structure of a theory, no unique macro outcome can be predicted.

<sup>12</sup> The concept of contingency originated in Niklas Luhmann’s systems theory; see e.g. Provost (1986).

mentally uncertain. Fundamental uncertainty is not to be confused with non-predictability: As Davidson (1993; 1996) has shown, fundamental uncertainty does not need to rely on non-linear dynamics (as non-predictability), while Rosser (2006: 89) argues that non-predictability, unlike fundamental uncertainty, also occurs in ergodic environments – leaving it open which of the two conceptions is the more general one. Epistemologically and methodically, both complexity conceptions follow similar routes: algorithmic, non-equilibrium modelling based on bounded rational, heterogenous and socially interacting agents engaged in intertemporal exchanges in network structures<sup>13</sup>. Again, it has never been made explicit how complexity economics of the ontological kind positions itself with respect to the validity of Walras’ law. Yet, in open, non-ergodic systems Walras’ law does not necessarily hold if the pre-analytic vision is different from a real-exchange economy (see Heise 2016b and Keynes 1933a; Keynes 1933b). In this domain, the ontological kind of complexity economics remains unclear and inaccessible.

By way of summary, it should be pointed out that complexity economics forms two different paradigms that show a close ‘family resemblance’ (Arthur et al. 1997: 2) with respect to the epistemological and methodical dimensions of their respective scientific research programmes, yet do not share the same ontological basis. The two paradigms called complexity economics I and complexity economics II, for want of better names at this point<sup>14</sup>, may have more in common (non-equilibrium orientation, algorithmic formalisation, bounded rational operation) than separating them (closed versus open, emergent versus contingent, deterministic-ergodic versus non-deterministic-non-ergodic), yet the distinction should not be overlooked and may be important with respect to the orthodoxy/heterodoxy divide.

## **V. Complexity economics: on which side of the orthodoxy/heterodoxy divide?**

The majority of complexity economists group around the epistemological notion as used, for example, by the renowned and influential Santa Fe Institute (SFI; see Peroni (2007: 41ff.). Authors such as Steven Durlauf, Lawrence Blume and Brian Arthur are confident about the new opportunities that complexity economics brings to the economics discipline in addition to orthodox neoclassical economics. Nevertheless, they clearly do not see their paradigm in opposition to and, therefore, as a challenge to neoclassical economics but rather as a modernized, probably more general version of it or, perhaps more appropriately, an addition to it. As Steven Durlauf (2012: 45f.), longtime project leader at SFI, puts it: “. . . I argue that complexity thinking can enrich the way in which economists conceptualize various phenomena, but that this enrichment is complementary to current economic methodology. The claim is justified by considering a range of definitions of complexity in order to highlight the features of complex systems that differ from conventional economic reasoning. In doing this, I reject suggestions that com-

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<sup>13</sup> Foster (2005: 884) highlights the importance of the network structure of the connections for complexity economics as distinct from the neoclassical orthodoxy which focuses on actors. Taking into account his belief that networks must always be seen as open systems, the complexity economics he has in mind refers to ‘ontological complexity’.

<sup>14</sup> Rosser (2006: 76) also distinguishes two approaches to complexity science: broad tent and small tent complexity. However, as his distinction does not entirely conform with my distinction, I refrain from using these labels.

plexity represents a new paradigm for the social sciences”. And Brian Arthur (2013: 17ff.; italics in the original), one of the founding fathers of the economics programme at SFI, focuses on the different, yet compatible perspectives of neoclassical and complexity economics (of the epistemological kind): “There are two great problems in economics. One is *allocation* within the economy: how quantities of goods and services and their prices are determined within and across markets. This is represented by the great theories of general equilibrium, international trade, and game-theoretic analysis. The other is *formation* within the economy: how an economy emerges in the first place, and grows and changes structurally over time. This is represented by ideas about innovation, economic development, structural change, and the role of history, institutions, and governance in the economy . . . It is now clear to economists that the mathematical analysis of allocation far from covers all of economics and operates poorly with questions of formation, exploration, adaptation, and qualitative change . . . Complexity economics by contrast is very much about these questions of creation and formation of structure, and it studies the mechanisms by which these operate.” And he adds: “Complexity economics is not a special case of neoclassical economics. On the contrary, equilibrium economics is a special case of nonequilibrium and hence complexity economics” (Arthur 2013: 19). A third problem, that of social provisioning, which is addressed particularly by Post Keynesian and Marxian economists and gives rise to an alternative pre-analytic vision, is neglected.

This appraisal goes along very well with the paradigmatical categorisation given above (see tab. 2): Complexity economics I – which we will dub ‘mainstream complexity economics’ (MCE) henceforth – is based on different epistemological and methodical foundations than neoclassical (DSGE) economics but shares by and large the same ontology. And even here, as with the differences in the epistemological and methodical dimensions, the distinction is one of perspective, not of substance. It, therefore, appears appropriate to categorise MCE as part of the mainstream, albeit as a dissenting part. This assessment is reinforced by the fact that proponents of MCE (are allowed to) publish in the most highly reputed economics journals (such as *American Economic Review*, *Journal of Political Economy*, *European Economic Review*, *Economic Journal*) which are usually not open to heterodox contributions.

Table 2: Classification of paradigms

Paradigm	Epistemological dimension (Axioms)	Methodical dimension	Ontological dimension (heuristics/postulates)	Status
<b>Neoclassical economics (DSGE)</b>	<ul style="list-style-type: none"> <li>• Rationality</li> <li>• Ergodicity</li> <li>• Substitutionality</li> </ul>	<ul style="list-style-type: none"> <li>• Reductionism</li> <li>• Linear optimization</li> <li>• Static-equilibrium</li> <li>• Empiricism</li> </ul>	<ul style="list-style-type: none"> <li>• Symmetric exchange</li> <li>• Closed system</li> <li>• Allocational perspective</li> <li>• Acceptance of Walras' law</li> </ul>	Orthodox
<b>Complexity economics I (mainstream complexity economics MCE)</b>	<ul style="list-style-type: none"> <li>• Bounded rationality</li> <li>• Substitutionality</li> <li>• Ergodicity</li> <li>• Heterogeneity</li> <li>• Non-Linearity</li> </ul>	<ul style="list-style-type: none"> <li>• Emergentism</li> <li>• Non-linear algorithmic computation</li> <li>• Non-equilibrium</li> <li>• Simulation</li> </ul>	<ul style="list-style-type: none"> <li>• Symmetric exchange</li> <li>• Closed system</li> <li>• Formational perspective</li> <li>• Acceptance of Walras' law</li> </ul>	Dissenter within the main-stream
<b>Complexity economics II (heterodox complexity economics HCE)</b>	<ul style="list-style-type: none"> <li>• Bounded rationality</li> <li>• Substitutionality</li> <li>• Non-Ergodicity</li> <li>• Heterogeneity</li> <li>• Non-Linearity</li> </ul>	<ul style="list-style-type: none"> <li>• Contingentism</li> <li>• Non-linear algorithmic computation</li> <li>• Non-equilibrium</li> <li>• Simulation</li> </ul>	<ul style="list-style-type: none"> <li>• Symmetric exchange</li> <li>• Open system</li> <li>• Formational perspective</li> </ul>	Heterodox
<b>Post Keynesianism</b>	<ul style="list-style-type: none"> <li>• Bounded rationality</li> <li>• Non-substitutionality</li> <li>• Non-ergodicity</li> </ul>	<ul style="list-style-type: none"> <li>• Reductionism</li> <li>• Linear modelling</li> <li>• Narrative reasoning</li> <li>• Empiricism</li> </ul>	<ul style="list-style-type: none"> <li>• Asymmetric obligations</li> <li>• Open System</li> <li>• Social provisioning perspective</li> <li>• Rejection of Walras' law</li> </ul>	Heterodox

Complexity economics of the ontological camp shares neither the epistemological and methodical dimensions nor the ontological dimension with neoclassical economics. Whether this distinction is of substance depends primarily on the judgement whether or not the open systems claim is based on a different pre-analytic vision (including the rejection of Walras' law). As noted earlier, in this respect complexity economists of this camp remain vague and unclear<sup>15</sup>. However, major proponents of the ontological camp, such as Barkley Rosser Jr., Herbert Gintis and Alan Kirman, openly display their esteem for heterodox economics by engaging in academic exchanges with them, and arguing about the compatibility of complexity economics with heterodox schools of thought such as Post Keynesian Economics (see e.g. Rosser 1998, Rosser 2006)<sup>16</sup>. Therefore, it seems appropriate to rate the ontological camp of complexity economics as heterodox and dub them heterodox complexity economics (HCE; see tab. 2). This assessment is

<sup>15</sup> Kirman (2016: 544ff.) argues that Walras did not establish a coherent mechanism that would bring an out-of-equilibrium economy back to a general-equilibrium-state. Yet, it remains unclear whether this involves the rejection of Walras' law or, merely, that Walras' law may be compatible with lasting partial disequilibria.

<sup>16</sup> Herbert Gintis even started off his academic career as heterodox (radical) economist (see Katzner 2011: 12ff.).

supported by the fact that HCE proponents (are only allowed to) publish – except for particular journals specializing in features of economic formation - mainly in heterodox journals such as the *Journal of Post Keynesian Economics*, *the Review of Political Economy* or the *Cambridge Journal of Economics*.

## VI. MCE, HCE and the future of economics

David Colander and Roland Kupers (2014) use the picture of the one or two mountains to tackle the question about the novelty of complexity economics: either complexity economists climb the same mountain as orthodox neoclassical economists but take a different route or, alternatively, they abandon the mountain the neoclassical economists try to climb and turn instead towards another mountain which appears more appropriate. This picture fits our analysis well: the proponents of MCE climb the neoclassical mountain (yet use a different methodical route), while the HCE proponents turn towards another mountain. So, as with the Keynesians, there is a mainstream and a heterodox camp of complexity economists.

How does this assessment impact on the future of the economic discipline? Primarily, one may argue that complexity economics stands a good chance of having a considerable effect: 1) Cries for a ‘new economic thinking’ are today louder than ever – last, but not least, the recent global financial crisis can be understood as the empirical anomaly which pushed neoclassical economics into a state of crisis, and complexity economics can be seen as a potential alternative (see e.g. Colander et al 2009; Kirman 2010); 2) complexity economics is a ‘sister science’ to complexity theories in other disciplines including the natural sciences (and some Nobel laureats) – this lends considerable ‘natural authority’ to this approach; 3) during the advancement of a scientific discipline, the degree of complexity (in common parlance) becomes higher – complexity science seems to be the next step in this direction in the domain of economics (but not only economics); 4) complexity economics is a highly formalized approach satisfying demands for accuracy and professionalism. Moreover, since the bigger and more influential camp – MCE – does not claim to oppose neoclassical economics<sup>17</sup>, resistance from the ranks of the orthodoxy with respect to access to economic, social and cultural capital in the field – i.e. professorships, grants, journal space, respected positions outside academia etc. – will be low.

But what does this imply for HCE and heterodox economics in general? On the one hand, it appears most likely that HCE will not succeed in truly kicking off a paradigmatic revolution in economics. At best, it will not be strictly separated from MCE and, therefore, may also secure access to the aforementioned kinds of capital. ‘Family resemblance’ may be as helpful in this respect as the professional cooperation of proponents of both complexity economics camps<sup>18</sup>. On the other hand, from the perspective of heterodox economics, not much can be hoped for: even if complexity economics were to rise to the state of a ‘normal science’ in economics, this would only pluralise the

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<sup>17</sup> Fontana (2008) rates the methodical impact of complexity economics as revolutionary – yet, this does not make for a paradigmatic revolution (‘climbing no other mountain’) as long as there is no ontological opposition to orthodox neoclassical economics.

<sup>18</sup> Proponents of MCE and HCE, for example, often co-author articles or co-edit books. In this respect, both complexity economics camps alongside the orthodoxy/heterodoxy divide are much more friendly than the two Keynesian camps on that divide (neo-Keynesianism and Post Keynesianism), which either ignore or outrightly combat each other.

paradigmatic pathways with respect to the ontological dimension, once the formation perspective of complexity economics and the allocation perspective of neoclassical economics is broadened by a social provisioning perspective of heterodox economics. After all, there are some indications (see e.g. Colander/Holt/Rosser 2010; Roos 2015) that HCE (and, to a lesser extent even MCE) is tolerant and open-minded in this respect.

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