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Complex Individuals: The Individual in Non-Euclidian Space

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INTRODUCTION – THE RECENT CHANGE IN ECONOMICS

Economics is widely seen as neoclassical economics, whose core is the idea of rational self-interested individuals interacting in markets. Yet when one conducts a census of kinds of research being published in 'leading' economics journals over the last three decades one find considerable *prima facie* evidence that a not insignificant share of this work employs non-neoclassical types of theorizing, tools and methods of empirical analysis, whereas in the first three postwar decades that share was far smaller. If one extends this empirical investigation to journal births in the last three decades, one finds evidence that non-neoclassical journal births significantly exceed neoclassical journal births, implying (with far fewer journal deaths over the same period) that non-neoclassical research appears to be a rising share of what is being published in economics journals as a whole. Further, conceptual evaluation of much of this recent non-neoclassical research indicates that it has origins outside of economics in other sciences, and thus it imports into economics assumptions from these other sciences about the nature of scientific explanation and about how to conceive the object of investigation in economics that depart from what underlies conventional neoclassical views (Davis, 2006b). While it is possible that this process might ultimately eliminate economics as a distinct domain of investigation in the future, the more likely possibility given economics' historical ability to absorb other science contents in the past (Mirowski, 1989; Blaug, 2003), is that economics' shape and objectives will be transformed, but that it will broadly remain a science of human interaction, production and exchange.

Yet under this very general description a wide range of frameworks can be imagined, and this invites us to ask how the new approaches now being pursued in economics target the fundamental assumptions of standard theory.

Indeed many of these assumptions, long taken for granted and thus rarely examined, are cast into stark relief in arguments that begin with different starting points in the new approaches. Arguably as fundamental as any of these assumptions in standard theory are those regarding the nature of economic agents, who are conventionally taken to be human individuals all of essentially the same kind of make-up, and who are thus all taken to behave in essentially the same way across their many different possible forms of interaction. This dual conception – like individuals and like forms of interaction – is challenged in many recent evolutionary-complexity-computational accounts of the economy that alternatively suppose that individual economic agents and their forms of interaction are inescapably heterogeneous. Indeed for some the stimulus for this different view of individuals lies in their perception that replacing the standard conception of the individual is key to developing new economic understanding. For example, Kirman (1997) traces the breakdown of axiomatic general equilibrium theory, particularly as associated with the Sonnenschein-Mantel-Debreu results, to the standard view of the individual, and argues for a new approach to individuals as central to new forms of economic theory. What then might be the basis of such an alternative dual conception of individuals?

One explanation of the heterogeneity of agents and interaction advanced in evolutionary-complexity-computational approaches derives from an alternative conception of space that rejects the classical view of space as a real field that operates in neoclassicism. The standard real field or Euclidian view treats space as undifferentiated except by arithmetic measure. Non-Euclidian views of space, particularly as developed for economics and social science (see Frenken, 2006), are often elaborated using alternative mathematical methods such as graph theory to investigate structures of network relationships between agents, thus further differentiating space by identifying positions specific to particular networks and according to specific structural relationships between networks. In contrast to the standard real field view of space in which you can always go from one point to another with the only issue being the arithmetic distance between those points, in non-real space one often cannot get from one point to another, because connections or pathways do not exist for doing so between different structural locations. This introduces 'irreversibilities' into the actions of agents, and more generally makes it possible to treat agents and their interactions as heterogeneous by virtue of their different locations and correspondingly different opportunities for interaction. One question it raises is whether this is enough to explain individuals as heterogeneous and non-atomistic. Another question it raises is whether an evolutionary-complexity-computational view of the world is possible without a non-atomistic account of individuals.

This chapter discusses the differences between neoclassical and evolutionary-complexity-computational views of individuals and their interaction in terms of their different underlying accounts of space. The two contrasting accounts of the individual are termed the atomistic view and the relational views. The second section of the chapter begins by further distinguishing the field and non-field concepts of space, comments on how they figure in recent debates in evolutionary biology in terms of competing interpretations of the idea of a fitness landscape, and then ties this to recent evolutionary-complexity-computational approaches' somewhat mixed rejection of the classical view of space as a field. The third section argues that this alternative understanding of space implies a relational conception of the individual, and that the standard atomistic individual conception employs a Euclidian understanding of space. I characterize the individual in the relational conception as a complex individual. The fourth section introduces the evolutionary-complexity-computational approach to individuals known as agent-based modelling, and then critically evaluates the interpretation of this approach. Potts (2000) provides attempts to combine non-Euclidian geometries of space with a conception of individuals as heterogeneous. I argue that, despite his non-Euclidian turn, he still treats individuals as homogeneous, thus showing that escaping the atomistic conception requires tying the heterogeneity of individuals directly to their relations to one another rather than to such things as path-dependence and their different locations in a differentiated space. The fifth section uses an identity analysis to further explain complex individuals, distinguishing between individual identity and personal identity, tying the former concept to how individuals are changed by social interaction and the latter concept to their being self-organizing, reflexive agents. This overall view of individuals is applied to Mirowski's (2007) 'markomata' computational view of markets, and it is argued that together they provide an understanding of markets and individuals as interlinked and everywhere complex and diverse. The sixth section closes with brief comments about social economic policy towards individuals on this understanding.

TWO GEOMETRIES OF SPACE

Complexity economics is the investigation of non-linear dynamics of economic systems made up of heterogeneous agents exhibiting co-evolving expectations. Mirowski (2007) traces the origins of complexity-computational approaches in economics to the gradual abandonment of physics as the chief model for scientific explanation in economics, and the emergence of the sciences of computation and evolutionary biology as

alternative models for economic explanation. Early neoclassical utility theory was modelled on Euclidian field theory and the energy metaphor of late nineteenth century classical mechanics, and has largely sustained this image for a century (Mirowski, 1989). Fundamental to this conception is the idea of real space, R^n , understood as a well-defined given field or metric in which any one point can be related to any other, such as embodied in the standard neoclassical notion of the economy as a homogeneous, continuous commodity space in which individual agents have demands and supplies for all goods whatsoever, and no part of the economy is partitioned off, inaccessible, or can be said to be near or distant.¹ While the real field concept of space is intuitive and familiar in mathematics as the generalization of arithmetic, algebra, and as the foundation of the integral and differential calculus, it is hardly the only concept or geometry of space or understanding of economic space. Graph theory (see Ellerman, 1984; Kirman, 1987; Mirowski, 1994) offers an alternative geometry of space based on the idea that systems can be conceived of in terms of set of elements (or vertices) and different combinations of connections (or edges) between them that make it possible to speak of 'neighborhoods' of elements. Since all neighborhoods are not connected to one other, neither are all their elements. Varying degrees of inaccessibility from any given point to particular neighborhoods accordingly makes it possible to explain space in terms of the concepts of nearness and distance. Further, adding hierarchies of neighborhoods generates higher-level systems (hyperstructures or systems of systems) that extend this basic idea by representing systems themselves as the elements having different connections to one another, as illustrated in Simon's decomposable modular decision-making systems for organizations (Simon, 1962).

Arguably the analogue of real space in evolutionary biology is the idea of a fitness landscape defined independently of the evolutionary processes that occur within it, which thus lacks 'neighborhoods' or other asymmetries that reflect particular evolutionary processes ongoing in that given space, seen as if it were a neutral container. Similarly, in standard economics, that all goods are substitutable for one another in agent choice means that neighborhoods do not exist in real commodity space. In contrast, the idea of there being 'neighborhoods' in which mutation and selection occur effectively defines space in terms of these evolutionary processes. Thus a number of recent contributors to evolutionary biology begin from the idea that the concept of space is inseparable from the concept of behavior, is therefore structured according to the distribution of different types of behavioral agents, and then examines how the processes of mutation and selection operate along pathways which are irreversible and unique, reflecting the existence of 'neighborhoods' in which different kinds of agents happen to be located

(Fontana, 2003).

Many recent evolutionary-complexity-computational approaches draw in one way or another on evolutionary metaphors, but do so with differing degrees of sensitivity to the difference between Euclidian and non-Euclidian concepts of space. Even in accounts that emphasize that space is heterogeneous and differentiated, there is still often a tendency to think of this 'non-Euclidian' space as a given space in the form of a 'social economic' fitness landscape. I suggest that one possible reason for this mixed understanding lies in a vestigial attachment to the atomistic conception of the individual. Most approaches replace the standard preference conception of the individual with a characterization of the individual in terms of search algorithms, in order to explain behavior as involving travel across a heterogeneous landscape. This appears to involve a non-subjectivist sort of characterization of individuals – thus a non-atomistic one – but the idea of search is easily associated with the idea of search across a given landscape, albeit a differentiated one. That is, the idea that the space and the behavior of agents is jointly constituting is missing also, implying that not only is space not a given (in whatever form), but that neither are the characteristics of the individual. I attempt to make this point clearer in the next section's comparison of the atomistic conception of the individual with what I take to be its genuine alternative, a relational conception.

TWO CONCEPTIONS OF THE INDIVIDUAL

The two geometries of space, the Euclidian and non-Euclidian, I argue, imply two different conceptions of individuals. The classic Euclidian field concept of real space supports an atomistic conception of the individual, whereas the various possible non-Euclidian concepts of space support a relational conception of the individual. In the case of the field concept, since space is homogeneous and continuous, no place within it can be distinguished from any other, except by being arithmetically distant from some arbitrarily given point. The character of space, then, does not itself distinguish entities of any kind from one another, so that they cannot but be defined both strictly in terms of themselves and also in the same way – or as indistinguishable atoms. Non-Euclidian space, in contrast, is differentiated by virtue of patterns of connections between sets of elements, so that these elements, or whatever types of entities they may be, must differ in kind according the different combinations of connections they have to other elements. Entities in non-Euclidian space, that is, are complex in virtue of having different kinds of relations to other entities, which are themselves similarly complex. Such entities cannot therefore be self-contained atoms, and are thus neither defined

strictly in terms of themselves nor all in the same way.

In the atomistic conception, since atoms are essentially self-contained entities that are complete in themselves, individuals thus understood are analogously defined strictly in terms of their own characteristics and all in terms of the same kinds of characteristics. Accordingly the dominant interpretation of the individual in economics – the neoclassical atomistic conception – defines all individuals solely in terms of their own preferences (whether defined in psychological terms in the classical cardinal and ordinal utility tradition or more formally in Samuelsonian revealed preference terms as a binary relationship between ranking systems) and their own (Savage-based) subjective expectations, both of which constitute characteristics of the individual that require no reference to other individuals. As the familiar fable has it, Robinson Crusoe was a complete man on his desert island before Friday arrived, would have remained one had Friday never arrived, and indeed remained one after he did.

In contrast to this and other atomistic conceptions of the individual, relational conceptions of the individual define individuals in terms of their relationships to and communication with other individuals, or more accurately in terms of their different sets of relationships to and different forms of communication with other individuals. Indeed, on the relational conception individuals cannot be defined in isolation without undermining their characterization as individuals.² Intuitively, the simple idea underlying the relational conception is that something cannot be attributed the status of being an entity or individual unless it can be shown to be distinct from a like thing; that is, it is 'individuated' by comparison to a like thing. In non-Euclidian space, this simple point is compounded, as it were, since individuals are positioned in space by virtue of having connections to many individuals who they are like in different ways. Consequently their individuality is the result of their being individuated in different ways. But as their different connections to others are a function of individuals being differently positioned in space, their different connections to others are generally incommensurable. Individuals thus understood must be complex in that – despite being unitary entities – they are made up of incommensurable characteristics. Accordingly the relational conception of individuals must be an account of *complex individuals*.

One example of a relational conception of the individual is the collective intentionality account of individuals, which treats the individual's capacity for forming shared we-intentions as an individuating characteristic of individuals that can be exercised in multiple contexts (see Gilbert, 1989; Tuomela, 1995; Davis, 2003). The simple principle of individuation it employs is that individuals are individuated relative to others they are like in virtue of the belief they have that a possible we-intention is shared.³ But the

abundance of forms and occasions in which we-intentions are expressed differentiates individuals from other individuals in multiple ways. Though proponents of collective intentionality theory do not explicitly employ any particular conception of space, their conception of individuals cannot but be complex in light of the heterogeneous nature of we-intentions. What, then, of Robinson Crusoe? In this particular relational conception, since individuals are understood to have a capacity for forming we-intentions, Crusoe can only be an individual, because Friday is possible, whether Friday ever arrives on the island, since Crusoe needs the possibility of Friday, or rather many Fridays, to be able to form we-intentions. Crusoe, then, is a complex individual, not a simple, self-contained individual, because he is made up of relations to many different Fridays.

The contrast between the atomistic and relational conceptions of the individual can be made sharper by comparing their respective treatments of differences between individuals. In the atomistic conception, though individuals can be different in having different preferences and expectations, nothing in this conception requires it, so that they can in principle all have identical preferences and expectations. Are they still distinct individuals? Representative agent models effectively use this identity to treat many individuals as one individual, implying that the differences between individuals are irrelevant. But such models can be shown to be really one-agent models (Kirman, 1992). In the argument here, they are not even that. Since in the relational conception individuals must be different from sets of other like individuals to exist as individuals, the solitary representative individual by definition cannot even exist as an individual, but rather operates as a *faux* construct for the underlying neoclassical model (and close kin to another mythical agent, the Walrasian auctioneer). This all raises an interesting question: if individuals in the relational conception are seen as complex individuals who are all different from one another, is it possible to say *anything* about them in general other than that they are all different from one another? I will argue that there is indeed one important thing we can say, namely, that they are reflexive entities. But before doing so, and for purposes of contrast, in the next section I review Potts (2000) agent-based modeling account of individuals, and argue that, despite his intention to break with the atomistic individual conception, he still ends up treating individuals as homogeneous and undifferentiated.

NEO-EUCLIDIAN AGENT BASED MODELING

Agent-based modeling, as a part of agent-based computational economics, consists of a variety of computational methods used to simulate and

investigate the properties of dynamic systems of different kinds of autonomous agents who interact according to different sets of decision rules (see Tesfatsion, 2006). Whereas in traditional general equilibrium models agent interaction is indirect, and is mediated by a price coordination process that operates through the artificial device of a Walrasian auctioneer, in agent-based models individuals interact directly with one another according to how, for example, their rules for acquiring and supplying goods match up. Agents are also seen to learn from their interactions with others, and then change their decision rules according to simple revision procedures, such as reinforcement learning. Because systems of such agents exhibit emergent properties that are not properties of the agents themselves, they are known as complex adaptive systems. Agent-based computational economics and agent-based modeling have accordingly often been characterized as a 'bottom-up' or 'culture dish' approach, since all aggregate patterns of behavior are explained in terms of individual interactions. At the same time, the emergent properties of complex adaptive systems also produce feedback effects on individual behavior, so that micro behavior and macro system or aggregate regularities operate as a two-way street.

Agent-based modeling is formulated in terms of non-Euclidian space in virtue of its representation of agents as directly interacting with one another. In standard equilibrium models, the existence of the Walrasian auctioneer creates a real space in which all agents' demands and supplies are related to one another through the medium of the equilibrium price vector. Minus the auctioneer, individuals and their demands and supplies are no longer all related to one another, so that which individuals they are modeled as directly interacting with effectively creates the space in which they act – a space which is accordingly differentiated and uneven. This non-Euclidian view of the space of agent interactions when understood dynamically requires that the paths individuals take across a sequence of interactions be seen as heterogeneous as well. Thus individuals, it follows, must also be heterogeneous. In effect, path-dependency, as an aspect of modeling agent behavior in non-Euclidian space, explains the nature of individuals.

Potts adopts this general framework, argues explicitly for abandoning Euclidian real space as necessary for progress in economics, and regards the agent-based computational conception of the individual as an advance on the atomistic conception. He formulates his view using graph theory, as developed by 'theoretical biologists and systems ecologists,' and considers it a method of analysis able to provide a 'universal framework for the study of complex systems' (Potts, 2000, 55ff), citing Kauffman, a theoretical biologist attached to the Santa Fe Institute, and author of the influential *The Origins of Order: Self-Organization and Selection in Evolution* (1993), as a key contributor. The main implication of this approach for our thinking about

individuals, Potts argues, is that individuals need to be treated as heterogeneous, and indeed he recommends we adopt the label of *Hetero economicus* for his agent-based modeling conception of the individual. But is the sense in which Potts understands individuals to be heterogeneous sufficient to distinguish his view of the individual from the atomistic view? What we find, it turns out, is that despite the fact that graph theory allows us to look upon entities as related to other entities in neighborhoods and networks, Potts does not employ a relational conception of the individual, and indeed goes on to define individuals atomistically entirely in isolation from all other individuals, remarkably even employing the traditional image of Robinson Crusoe to motivate his 'new' type of understanding.

We begin with just a single agent in an environment stocked with resources (a Robinson Crusoe formulation, as such). The model is then initially of two sets – an environment state V and an agent resource set V – where we shall initially define V as an infinite set of elements in the environment from which we draw a subset as the resource elements held by the agent (Potts, 2000, 114).

The set V represents all 'nature's endowments' from which the agent resource set V for our 'Robinson Crusoe ... might represent clams, rocks, firewood, coconuts and suchlike' (114). Crusoe's problem, then, is to 'find the good combinations' of these resources by engaging in a process of 'experimentation by combination, searching through the space of possibilities for useful combinations' – or a 'search in state-space' (115). How are the different combinations evaluated as 'good' or not? 'We may ... suppose that the agent's rankings of these technologies is an expression of the agent's preferences,' which we learn 'are engaged only after all technologies have been sampled' (116). Thus, Potts's argument is that since different Crusoes have different locations in space, and since non-Euclidian space is differentiated, agents are heterogeneous in having different locations. But this does not tell us that they are different in any important respect in themselves, and indeed Potts treats individuals – albeit in their different locations – as being all essentially the same type of agents. That is, they are homogeneous agents who appear to be different by being located in different places.

Potts makes this clear when he gives us the definition of *Hetero economicus* as an algorithmic man, meaning an agent that employs a sequential set of operations or rules as a decision algorithm, 'which we may suppose to be an innate property of an autonomous agent' that can be formally represented as (117):

$\langle Y \rangle = \langle \text{LIST: CONSTRUCT: RANK: SELECT} \rangle$ (Potts, 2000, 117).

More generally, the agent is defined as a set of resources, a set of behavioral algorithms, and a selected set of technologies. The agent is indeed a boundedly rational agent in the tradition of Simon (1959) and more recently Holland (1995), because abandoning Euclidianism implies that the reach of agent behavior no longer extends to resources at any point in space. Individuals are boundedly rational, because their cognitive abilities only operate on objects in their immediate neighborhoods. Bounded rationality, however, is not actually a property of individuals on this interpretation, but rather a property of the locations that individuals occupy – a bounded view or perspective – in a differentiated and asymmetric space. The same thing can be said about the ways in which individuals revise and adopt their different decision rules as they travel through differentiated space. Different rules are adopted as the result of traveling through specific sequences of locations in space, not because of inherent limitations of individuals, but because they only encounter specific locations. Thus any agent who travels a given path would adopt the same decision rules, and accordingly all individuals are the same type of homogeneous agents who each exhibit the same 'innate property of an autonomous agent.'

Note, then, that in Potts's account thus far Friday has yet to arrive on the scene. How will things be influenced by Friday's arrival? Nothing, we unfortunately learn, is really changed by the addition of other individuals, and in fact other individuals turn out to simply be opportunities for Crusoe to locate new sets of resources that were previously inaccessible to him. As Potts (2000) says,

The problem that agents now face is the decision of which other agent to interact with. It seems reasonable to presume that interaction between agents will be engaged according to the same logic by which the agent interacts with the environment. (125)

More fully, now 'the agent's environment [also] consists of the resources and technology sets of other agents,' which when somehow displayed to our Crusoes on the occasions of their interaction, trigger them to record the locations of these other resources (following the analysis of Holland) with 'tags' given to each other. Should any Crusoe's tags match tags created by other Crusoes, then an exchange of resources becomes possible that increases the resources available to all (126). That is, all Crusoe's Fridays are but occasions for new combinations of 'clams, rocks, firewood, coconuts and suchlike,' as well as application of the new technologies different Fridays have for their combination. In such circumstances, Potts tells us, a 'multiagent' can be formed, such as is understood as a firm or a household in standard economics (129), which if stable, merges the preferences of the different individuals into 'a single schematic preference' (130). This re-

produces *Hetero economicus* on a more general level as a complex system, but except for the added tagging system as an account of agent interaction, there is nothing really different in this view of the agent from our original Crusoe. All agents are homogeneous as sets of resources, algorithms, and (now) tags, and differ merely by having different combinations of these, which is the result of their different paths through a differentiated space. That is, there is nothing in the appearance of Friday as another individual that changes Crusoe (or Friday).

Non-Euclidian space and path-dependence, therefore, are not sufficient to produce real agent heterogeneity. Potts's Crusoes are not only defined all in the same way, but their contact with their Fridays does not change their nature. Indeed Potts's Crusoe does not meet a Friday as a different type of individual, but just another Crusoe. Individuals are still all defined in terms of their own characteristics, or atomistically, demonstrating that a non-Euclidian space joined to a standard view of the individual only ends up producing an essentially neo-Euclidian understanding of social space. I suggest, then, that if we are to develop a genuinely evolutionary-complexity-computational approach to social space and an adequate understanding of individuals as heterogeneous beings, we need to begin with the individual, and specifically with a relational conception of the individual. I further develop this conception in the following section by introducing an identity analysis of complex individuals which emphasizes how they are and are not affected by social interaction.

THE IDENTITY OF COMPLEX INDIVIDUALS

Since the relational conception defines individuals in terms of their relations to others, and since individuals have many different kinds of relations to others, they are complex in the first instance in virtue of having many different kinds of (incommensurable) connections to others, whether these connections are market relations, organizational ties, social relationships, etc. Individuals thus understood might be said to have multiple selves, a concept that was originally developed in connection with the atomistic individual conception and the idea that solitary individuals could conceivably have multiple utility functions (for example Elster, 1979; compare Davis, 2003, ch. 4). If we give up the utility function idea, and re-appropriate the multiple selves concept for the relational conception, individuals would then be understood to have multiple selves in virtue of their having multiple connections to others. This alternative understanding treats individuals' connections to others as connections they have to social groups, so that their multiple selves are then associated with their different social identities, thus

linking their locations in different social networks to their being members of different social groups. Of course there are limitations to seeing individuals' social network locations as social group affiliations, and indeed also limitations to the idea of a social group itself, reflecting problems involved in determining what constitutes a social group and what constitutes membership in a social group. But I put these problems aside here to focus on how individuals having different social identities make them complex individuals.⁴

The idea of a 'social group' itself is a classification category differentially constructed in social science, public administration, and popular discourse, framed in third person object language, which orders individuals by sets of characteristics interpreted as shared, and which ascribes to individuals seen as having the characteristics appropriate to particular social groups the status of having membership in those groups. The idea of 'group membership', then, is simply that of being an item in a set or being an object with a certain characteristic that causes it and all other things having that same characteristic to belong to that set. Thus individuals' multiple selves understood as their social identities constitute different 'object characterizations' of individuals that on the relational conception of individuals must be part of their general definition as individuals. But it is also part of the idea of an individual that individuals are not only objects, but are in some undefined sense 'agents' as well, so that on the relational conception an individual is complex not just in having many social identities and relations to others, but also in being both an agent and an object (or an object in as many senses as the individual has social identities). I distinguish these two aspects of complex individuals in terms of the two ways the concept of identity can be applied to them.

The individual's object characterization as a group member – or object identity – as is reflected in all the different ways in which individuals are classified in social group taxonomies by social scientists, public authorities, and in the many forms of social discourse – thus rather their many object identities – may be referred to as a person's set of *individual identities*. The social grounds for the constitution of a person's different individual identities in the contemporary world are familiar and numerous: tax and social contribution requirements, legal responsibility determination, market contract compliance, pension and social services delivery, medical treatment, credit rating, rights elaboration, education and training evaluation, birth and death verification, experimental investigation, and so on in an essentially unbounded list. All explain individual identity (in different and often essentially incommensurate ways) by ascribing to individuals membership in categories constructed to represent different social group aggregates. Corresponding to these different forms of individual identity, moreover, there

exists a variety of 'continuity' tracking technologies used to operationalize these different individual identities in the face of constant change in individual characteristics: names, number assignments, individualized records of all kinds, family descent, curriculum vitae, photographs, biometric measures (fingerprints, DNA identification, dental records, brain scans, iris scans), surveillance, and incarceration or institutionalization. As social group categories are tools designed for the management of heterogeneous populations of individuals according to functional relationships believed to obtain between them, the use of these tools requires there be practical working systems for their consistent application. Consistency in this regard is a matter of being able to continue applying a given category to individuals as long as they satisfy its requirements, especially when there is change in their other characteristics.

Discussions of individual identity in philosophy (traditionally thought to be the subject domain in which identity questions particularly concerning individuals are systematically investigated) usually explain the concept of individual continuity in terms of characteristics of ahistorical, socially isolated individuals (for example, continuity of psychological states), and not surprisingly frame this as a question of 'personal' identity. However, the relational conception of the individual, as formulated in terms of individuals having many social identities, naturally turns our attention to the numerous practical systems for addressing continuity of individual identity that have long been in place in the world. Here we find not only an established general principle for explaining individual identity as continuity through change, namely, sustained membership in a group that can be represented by a social category, but also a rich variety of social practices have been developed to operationalize this principle. Thus, in modern history at least, the origins of the concept of individual identity appear historically prior to the origins of the concept of personal identity. Indeed philosophers generally date the origin of 'personal identity' as a distinct question of investigation to the late seventeenth century work of John Locke, who is said to have given the first systematic account of personal identity (see Noonan, 1989; Locke 1975 [1694]). Thus, if we follow this historical progression, and emphasize the social practices model for labeling, categorizing, and tracking individuals, we ought to investigate and explain the concept of personal identity as an extension and development of the concept of individual identity.

How, then, should the concept of personal identity be understood? If we assume that there is something more to individuals than just their many individual or object identities, given the discussion above, we might take it to arise in the form of personal principles of individual continuity which individuals themselves seek to implement as analogues to the tracking practices and individual identity categories they see applied to themselves in

social group classification systems. From this perspective, the concept of *personal identity* emerges as a category that individuals themselves manage when there already exist systems of social categories constructed for managing people's various individual identities. A concern with personal identity is thus a relatively recent historical development that reflects the emergence of individual identity systems and their tracking technologies. But whereas social tracking technologies have multiplied, and have now become increasingly sophisticated, it is hard to say what tracking technologies analogous personal principles of individual continuity or personal identity might attempt to employ. Indeed individuals generally use social tracking technologies (their names, their family descent, curriculum vitae, etc.) to represent their personal identities or 'who' they think they are. Following Clark (1997), individuals appear to rely on these social tracking technologies as external scaffolding that they use to manage their personal identities. That is, they recognize the concept of their personal identity as distinct from their various individual identities, but they lack means of operationalizing the concept.⁵

What does this leave us to say, then, about how individuals manage their own personal identities? One thing that *seems* clear is that, if the concept of personal identity is taken to be an historical analogue to socially constituted individual identity systems, then it may also be distinguished from these systems by its being a self-referencing or reflexive type of activity. Social systems that manage different individual identities treat them as object identities distinct from the processes involved in the categorization, labeling, and tracking of individuals. In contrast, individuals who manage their personal identities treat these identities as identical with themselves, that is, as their 'own' personal identities that are different in their view from the individual identities that others create for them. More fully, the activity individuals engage in when managing their personal identities might be seen as a *self-organizing* or *self-reproducing activity*. Indeed, since the social practices that classify individuals into social groups fragment them as single individuals, the task of individuals if they are to act on a concept of themselves is to produce that concept for themselves. We may take this idea also to underlie the standard characterization of individuals as 'agents'. Agents are usually defined as entities whose behavior determines events rather than is determined by events. Since reflexive entities are in some sense self-determining, they cannot be fully determined by events, and this allows for the possibility (if does not guarantee) that their behavior determines events. Thus we may also associate the idea of the individual being an active agent with the historic emergence of the personal identity concept.

Individuals, then, organize their own personal identities, using tracking technologies that derive from different social constructions of their individual identities. To express this in terms of the relational conception of the individual set forth above, consider the market as one basis for the social construction of individual identities in terms of the individual identity categorizations assigned to market participants. In neoclassical economics, markets are everywhere the same as a single supply-and-demand process, and market participants are accordingly frozen in a single individual identity which the theory constructs in the atomistic terms it assigns to isolated rational maximizers. In contrast, consider Mirowski's evolutionary-complexity-computational approach to markets, the *markomata* conception (Mirowski, 2007). Since markets as *markomata* are everywhere diverse and complex, market participants – or the individual identities that participation in markets thus understood entails – must also be everywhere different and heterogeneous. Markets as *markomata* are linked and interrelated by the different kinds of information they accept from other markets as computational inputs, so that markets constitute nodes of a complex informational network that can be characterized in terms of different overlapping and hierarchical relationships. Accordingly individual market participants, or their individual identities, must also be related to one another in a complex informational network similarly characterized by different sets of overlapping and hierarchical relationships to other individuals. This is the same respect in which individuals are characterized as complex on the relational conception of the individual as set out above.

But if this provides an evolutionary-complexity-computational understanding of the individual identities of market participants, how do we understand the personal identity of market participants seen as what they themselves manage and produce? Note first that from the neoclassical view this question does not arise, because individuals are explained entirely in terms of their individual object identities. Since there is but one individual identity for market participants in but one kind of market form (the supply-and-demand model), there is no question of organizing a collection of plural individual identities for the individual to address. This is consistent with what I have previously argued on this subject (Davis, 2003), namely, that personal identity cannot be explained in neoclassical economics, either in terms of its earlier subjectivist individual conception or in terms of what later replaced that conception, the abstract individual conception. The abstract individual conception can be applied equally to individuals, groups of individuals, the different selves of individuals, animals, and non-living entities; thus it cannot refer to the single individual, and its adoption effectively eliminates the individual from economic theory.⁶ In terms of the treatment of identity here, then, the only account of individuals neoclassical theory possesses is its

individual object identity characterization of market participants.

However, the markomata evolutionary-complexity-computational view does provide an understanding of personal identity as a self-organizing or self-reproducing kind of activity in which individuals engage as an analogue to the market social process that continually constructs individual identities for them as market participants. That is, as markets proliferate, and as this social process multiplies market participants' individual identities, so individuals have an ever more tangible problem of constructing their personal identities. From Mirowski's view, markets as markomata are understood as a form of automata, as in von Neumann's theory of automata, where automata are self-reproducing entities whose evolution can generate more complex forms of themselves in terms of possessing greater computational capacity (see Mirowski, 2002). Parallel to this, individuals' self-organizing activity seen particularly in the sense of a self-reproducing kind of activity mimics and reinforces the self-reproduction process of markets, since an increasing complexity of markets in terms of greater computational capacity needs to be accompanied by an increasing capacity for complexity on the part of individuals as market participants able to self-organize themselves in such a market system. This is not to say that individuals in their personal identity construction processes are to be taken as Turing Machines or other types of artificial intelligence systems. As Clark (2005, 27) says, 'we shouldn't be fooled into mistaking the basic apparatus of the Turing Machine for an explanation (at any useful level of abstraction) of the way biological brains support rational thought'. Indeed, on the evolutionary understanding here of individuals and markets, both have essentially open-ended capacities for self-reproduction made additionally complex by their co-evolution.

This evolutionary-complexity-computational relational conception of the individual can be compared to Potts's view. Potts explains the heterogeneity of individuals in terms of the differentiated character of a non-Euclidian space, so that there is nothing in the interactions between individuals that contributes to their heterogeneity, and they are thus only incidentally differentiated from one another, and not differentiated in terms of their own characteristics. From this view, however, individuals' different interactions in markets produce different individual identities as market participants, which generate different self-organizing/self-reproducing activities in different individuals. Individuals are consequently different in themselves in a non-incidental sense. I have termed this conception a complex individual conception, because the characteristics that constitute different individuals are incommensurate and cannot be reduced to one another. Though individuals share a personal identity principle, it lacks a single content across individuals that would allow us to describe individuals all in the same way. This complex individual conception, I suggest, is the conception appropriate

to a non-Euclidian view of space and an evolutionary-complexity-computational approach to individuals. Potts indeed reasons in terms of non-Euclidian space, but his adoption of an atomistic individual conception produces what might be termed a neo-Euclidianism that emphasizes path-dependency of well-formed atoms — a modest change in dynamical thinking that lacks real novelty and emergence.

COMMENTS ON SOCIAL ECONOMIC POLICY TOWARDS INDIVIDUALS

Here I make one comment regarding normative implications of the complex individuals conception. Just as the traditional atomistic individual conception supports a set of normative arguments, especially as associated with efficiency judgments, so the complex individuals conception supports a set of normative arguments, though ones that involve an altogether different conception of individual well-being. From the standard viewpoint, changes in markets are recommended that increase efficiency by enabling individuals to achieve higher levels of utility. This view is often associated with the idea that atomistic individuals possess determinate utility functions with which they are identified. In the complex individuals conception, however, individuals do not have given utility functions. At a given point in time and from the perspective of a particular individual identity, one might approximate individuals' interests with some such functional representation, but this would produce a partial representation of the individual better characterized as one of an individual's multiple selves. Yet as the multiple selves problem seen as a multiple utility function problem cannot be resolved in the standard framework, even partial representations of individuals in utility function terms are to be avoided.

The complex individuals account here represents individuals in terms of their self-organizing/self-reproducing activity. This 'production' understanding of the individual does not lend itself to the idea of satisfying some functional state, but rather underlies the idea of individuals as agents. What view of individual well-being does this then support? Since individuals are inescapably heterogeneous from this viewpoint, I suggest that it supports treating diversity and difference as a normative ideal along side other measures of well-being associated with fairness and equality as apply to shared individual identities. The social systems that categorize individuals in terms of their membership in social groups have as implicit normative principles equal and fair treatment of all individuals who fall within an established category. By its very nature, this object identity bureaucratization principle disregards differences between individuals. Moreover, as social

categorization systems are often loosely integrated, there are few normative principles that apply to individuals across their multiple individual identities. As a principle of this sort falls outside the individual identity system, and is associated with individuals' analogue self-organizing concerns, it seems it accordingly constitutes a principle that makes individual diversity and difference a normative ideal.

Note that recent evolutionary-complexity-computational thinking in economics has yet to do much to formulate normative concepts and policy prescriptions. Indeed, that simulation methods create so many different possible world scenarios seems to undercut the entire idea of a normative stance toward the economy. At the same time, a principle of individual diversity and difference as an ideal plays no role elsewhere in contemporary economics. Oddly, outside of economics, diversity of individuals as a normative ideal is commonly defended. This chapter suggests that this ideal can play a role in economics in an evolutionary-complexity-computational type of approach that differentiates the different aspects of the identity of individuals, and recognizes personal identity as a central component of any account of individuals.

NOTES

¹ Debreu's (1959) assumption of a complete set of forward markets for all time is a paradigmatic expression of this. But others careful about their axiomatic foundations are also explicit about the real field as the space in which economic explanations occur. See the current leading advanced microeconomic text, Mas-Colell (1985, xiv-xvi).

² I argue in Davis (2003) that the neoclassical atomist conception of the individual does not satisfy reasonable criteria needed to identify individuals as distinct and relatively enduring entities, and accordingly fails as a conception of an individual.

³ This is the normal or main case as exhibited in speech act behavior. Duplicious we-intentions, in which the individual privately denies the shared quality of an expressed or known we-intention, are derivative from and depend on the existence of the main case.

⁴ For three quite different ways in which the concept of social identity has been introduced into economic models, see Davis (2006a).

⁵ Here I do not attempt to explain this apparent lacuna other than to say that it might be argued that first person singular speech, which is appropriate to a personal identity discourse, lacks the same systematic elaboration afforded by third person speech used to characterize individual identity.

⁶ This conception of the individual is anticipated in prewar operations research theory, a mixed collection of decision-making tools meant to be used by experts in a wide range of applications that involve complex strategic coordination problems (see Mirowski, 2002, ch. 4).

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