How complex is agricultural economics?

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Abstract

Recognition that an economy is complex is not new. Frederick von Hayek, for example, made explicit that markets are complex systems in the 1960s. Contemporary proponents of complexity, movement across the sciences including economics, argue that an economy is a complex system in which economic agents (whether consumers, banks, firms or farmers) continually adjust and react to market behaviour of others. A major claim by these proponents is that economics is going through its most profound change in over a hundred years. A further claim is that the neoclassical era in economics, upon which many agricultural economics principles are grounded, is being replaced by the complexity era. Indeed, is there some evidence that concepts such as agent-based modelling path dependency, self-organisation and network analysis used by the complexity movement are making inroads into agricultural economics research? This paper through a survey of literature of leading agricultural economic journals and the online repository, AgEcon Search, seeks to understand the degree that concepts from the complexity movement are emerging in agricultural economics research. Are they merely an adjunct to standard economic modelling or does it represent a more profound change in the way of analysing an economy?

Keywords Agricultural Economics, Complexity Theory; Complex Adaptive Systems; Agent-Based Modelling; Literature Survey

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Introduction

The recognition that an economy is complex is not new. Norgaard (2015) asserts that "economics provides multiple approaches to complexity – partial and general equilibrium theories of markets, growth models, macroeconomics, and monetary theories, as well as newer options such as ecological, evolutionary, and behavioural economics." Is an alternative perspective of agricultural economics required as North (1990) suggests – a complex systems perspective? Noell (2006, 2007) is certainly one proponent who questions whether a modern complex systems theory is a relevant and useful tool for agricultural economics.

Contemporary proponents of complexity, a movement across the sciences including economics, argue that an economy is a complex system in which economic agents (whether consumers, banks, firms, or farmers, for example) continually adjust and react to market behaviour of others (Arthur, 2015; Holland, 2014). Juxtaposed against mainstream (neoclassical) economics and incorporating ideas from complexity requires a radical remaking of economics (Beinhocker, 2006). Are we entering a complexity era as Holt and colleagues suggest? (Holt et al., 2011). If so, this has implications of for the principles of agricultural economics which is often based on mainstream economic thought (for example, see Hill, 2014).

There may be some evidence that concepts used by the complexity movement, such as agent-based modelling, path dependence, self-organisation and network analysis, are making inroads into agricultural economic research. This paper, through a survey of literature in leading agricultural economic journals and the online repository of AgEcon seeks to understand the degree that concepts and tools from the complexity movement are emerging in agricultural economics research. Furthermore, it examines whether tools that attempt to capture complexity, such as agent-based modelling and network analysis, are merely an adjunct to standard economic modelling or represent a more profound change in ways of analysing agricultural economic phenomena.

What is complexity?

Complexity as a concept has many definitions that widely vary (Arthur, 1999). Lloyd (2001) identified over 40 definitions with a multitude of characteristics that reflects the inability of researchers to capture what is meant by complexity, although a collection of definitions may be necessary to convey the essence of the term. Holland (1988) instead uses the term 'adaptive nonlinear networks' that exhibit certain properties regarding the multiplicity of potential patterns, coherence or propagation of substructures that are said to be complex.

Complexity theory is a movement that has grown in the sciences over the past 30 years or so (Schneider and Somers, 2006). Of central importance has been the Santa Fe Institute. In 1984, collaboration between different academic disciplines – physics, biology, computation and social sciences began to study the principles of complexity, which later became known as complexity science (German, 2016). As such, complexity theory encompasses biology to physics to economic sociology and provides a relatively loose set of themes and techniques to study complex systems rather than being a single entity; it is work in progress (Beinhocker, 2006; Miller, 2016; Mitchell, 2009).

Complexity theory as applied to economics challenges the neoclassical underpinnings of mainstream economic theory. However, it is not the intention of this paper to explicitly critique orthodox economic doctrine, this has been done more elegantly elsewhere – see

Beinhocker (2006), Elsner (2012) or Helbing and Kirman (2013) for example. Instead, this paper may implicitly portray the limitation of mainstream economic theory through discussion of tools and processes adopted from the movement of complexity theory when applied to study agricultural economic phenomena.

From the perspective of complexity, an economy is often described as a vast and complicated set of arrangements and actions in which agents[1] buy and sell, trade, speculate, produce, offer services, invest, strategise, forecast, learn, adapt and innovate (Arthur, 2015). Thus, the economy can be conceptualised as a complex adaptive system (CAS). In the systems, agents adapt by changing their strategies as they gain experience and may employ a diverse range of actions (Holland, 2014). Furthermore, agents do not necessarily act rationally and do not possess omnipotence abilities (Beinhocker, 2006; Holland, 2014).

Arthur et al., (1997) argue that complexity within an economy has six key features: dispersed interaction, no global controller, crosscutting hierarchical organisation, continual adaption, perpetual novelty, and out of equilibrium dynamics (Box 1). However, to analyse complexity using mathematical procedures that underpin mainstream economics is problematic (Arthur et al., 1997). This has required the adoption and adaption of tools or the creation of new tools to understand complexity within an economy. These include techniques such as agent-based modelling, network analysis and evolutionary game theory. Noell (2007) suggests that while methods to analyse complexity perhaps exhibit the characteristics of being theoretically complicated, their analytical demand may be relatively moderate.

Box 1: Describing complexity within an economy

Dispersed interaction An economy is dispersed interaction that considers the interaction of many dispersed agents acting in parallel. The agents may be heterogeneous and the actions of one agent may be dependent on the anticipated action of a limited number of others (Arthur et al., 1997). As such, an agent interacts in a network or contact structure such as a geographic space, the market or a computer network (Page, 2011).
No global controller An economy is steered by mechanisms of competition and coordination between the dispersed agents with legal institutions, assigned roles and shifted associations that mediate the economic actions of agents.

[1] Agents are consumers, firms, farmers, banks, investors, governmental and non-governmental organisations, for example.

Cross cutting hierarchical organisations Hierarchical theory identifies a system of behavioural interconnections in which the higher levels of the hierarchy constrain c the lower ones to various degrees (Allen and Starr, 1982). As such, at any given level the behaviours, actions, strategies and products typically serve as building blocks for constructing the next higher level (Arthur et al., 1997). Furthermore, actions occur at different spatiotemporal scales (Wolf and Allen, 1995) as organisations contains tangled interactions that are not scale dependent but instead cross-levels (Wolf and Allen, 1995; Arthur et al., 1997; Butler, 2000).
Continuing adaption and evolution As an agent accumulates experience, the agent's behaviour, actions, strategies, and products continually adapt (Arthur et al., 1997). This accumulation of experience and knowledge may be shared and the co-operation between agents with different experiences and knowledge can create innovations (Hidalgo, 2014). Importantly, adaption occurs at an individual level or through a network of individuals whereas the system itself does not adapt (Page, 2011).
Perpetual novelty This process of continual adaption exploits and creates new niches through new markets, new technologies, new institutions or new behaviours and the very act of fulfilling new niches provides further new niches (Arthur et al., 1997; Holland and Miller, 1991).
Out-of-Equilibrium dynamics The dynamic process of agents continually adapt and the related process of niche creation means an economy operates far from any optimum or global equilibrium (Arthur et al., 1997). Helbing and Kirman (2013) suggest that economic systems spend long periods of time out-of-equilibrium, assuming that a single equilibrium exists. As such, a complex economic system may have multiple equilibria that are unstable.

Connecting complexity and agricultural economics

In the agricultural economics literature, there is little evidence that conceptually, complexity is making inroads. Noell (2007) is a notable exception. Batie (2008) also considered complexity theory as part of her presidential address to the American Agricultural Economics Association on 'wicked' problems that focused on the use of sustainability science. Noell (2006, 2007) argues that economic systems are self-organising, sharing similar characteristics as other complex systems and this has consequences for agricultural economics, in understanding the internal dynamics of the systems. Furthermore, Batie

(2008) contends that normal science assumptions and approaches are inadequate for dealing with the complexities associated with many of the problems in agricultural and applied economists study. Furthermore, she suggests that complexity economics that focuses on CAS in pursuit of “real-world” relevancy is a form of post normal science that may be necessary to apply in trying to understand what she termed as ‘wicked problems’.[2] Finally, Noell rightly points out that not all economic phenomena need to be studied through the lens of theories and methods from complexity concluding that “the larger an economic system gets and the longer the analytical time horizon is, the more advantages complexity offers for deeper insights in its structure and behaviour.” (Noell, 2007, p.234).

Method

Peer-reviewed journal articles from January 2006 to March 2016 were included in the review. The period was kept to just over the last ten years (i) to keep the potential quantity of articles manageable; and (ii) to capture any potential growing interest in complexity theory. Papers included empirical (qualitative and/or quantitative) as well as theoretical articles. For inclusion in the survey of literature, papers needed to focus on some aspect of the complexity theory or methods applied to agricultural economic research. Narrowing down the systematic review to articles published in agricultural economic journals and databases had the advantage of specifying a focused study. However, the disadvantage of this was that potential existed to omit articles relevant to agricultural economics but which were instead published in broader economic journals or journals from sister branches of economics, such as ecological economics, behavioural economics or complexity economics, for example.

To identify the most influential agricultural economics journals, a tripartite approach was conducted. Firstly, use was made of the American Economic Association (AEA) list of journals indexed in EconLit[3] to identify agricultural economics journals. Secondly, metrics for agricultural economics journals were analysed. While citation and impact metrics have their shortcomings (for example, see Herrmann et al., 2011), they provide a guide to the most

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[2]Batie (2008) also suggests ecological economics and sustainability science as two further postnormal sciences. Citing Batie (2008, p.1176), “Wicked problems, which are sometimes called social messes or untamed problems, are dynamically complex, ill-structured, public problems. The causes and effects of the problem are extremely difficult to identify and model; wicked problems tend to be intractable and elusive because they are influenced by many dynamic social and political factors as well as biophysical complexities (Rittel and Webber 1973).”

[3] Journals indexed in EconLit can be found at: https://www.aeaweb.org/econlit/journal_list.php

influential journals. Three rankings were considered: Thomson's Journal Citation Report for 2014; the median for SCImago Journal Rank (JCR) between 2006 and 2014; and the median CiteFactor Impact between 2009 and 2014. And thirdly, to target journals linked to agricultural economics associations. This tripartite approach was designed to delineate the scale of the literature survey to a more manageable level.[4]

In addition to the peer-reviewed literature, scholarly research submitted to AgEcon Search database,[5,6] which is a collection of working papers, conference papers, and articles from less highly ranked agricultural economics journals were also examined. The rationale for including these articles was that this database potentially includes researchers at different levels of their career, for example, PhD candidates presenting conference papers, which might be researching agricultural economics from the lens of complexity. The inclusion of the AgEcon Search database in the literature survey was also designed to counter potential geographical and development bias as peer-reviewed journals tend to be dominated by those published in developed economies Articles and journals covered by the AgEcon Search database have a much wider geographical spread.

To determine whether an article should be included within the literature survey, a search for key terms regarding either complexity theory or methods used to understand complexity in agricultural economic systems was conducted. To gauge the level of engagement with the concept of complexity, frequently used terms in complexity theory literature included 'complexity theory', 'complex system', 'complex adaptive', 'emergent properties', 'self-organisation', 'path depend*', and 'nonlinear dynamics'. Common tools used to analyse complexity included 'network analysis', 'agent-based' and 'game theory'. For articles to be included in the survey, it was necessary that the key term resided in the title, abstract or the keywords sections of the relevant databases. Furthermore, it was necessary for the term to be used in the correct context. For example, searching for a term such as 'network analysis', it was important to establish that this was connected to understanding complex economic

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[4] In addition, the journal Eurochoices is not included since this was not covered by all metrics.

[5] "*AgEcon Search: Research in Agricultural and Applied Economics* collects, indexes, and electronically distributes full text copies of scholarly research in the broadly defined field of agricultural economics including sub disciplines such as agribusiness, food supply, natural resource economics, environmental economics, policy issues, agricultural trade, and economic development." http://ageconsearch.umn.edu/about.jsp

[6] The Journal of Agricultural and Resource Economics is included in the AgEcon Search database.

relationships rather than it referring to a 'network' and 'analysis' that had little or no relation to each other.

Finally, it was necessary to ensure consistency in searching for the term in different journal and article databases (for example, Oxford Journals, Wiley, Cambridge Journals, etc.).[7] As such, quotation marks were used where possible. Alternatively, as in the case of the AgEcon Search database, abstracts and keywords were examined to ensure the context of the search term was correct. In addition, only articles published in English were included from AgEcon Search. While this reduced the number of articles covered, this only accounted for a 6% reduction in the potential number reviewed. This is a caveat of the literature survey, as it is not known how many of these would have been relevant.

Results

The EconLit list details in excess of 1,800 economic or economic related journals, past and present. From this list, 21, journals were currently in publication and focused on agricultural economic studies. Examining the citation metrics for these journals resulted in the emergence of a consensus of the major agricultural economics journals (Table 1). By connecting journals with their related associations, more multidisciplinary journals, such as 'Food Policy', do not feature in the table. Arguably, while multidisciplinary journals except articles that are connected to agricultural economics, the main focus of this research paper was to examine ideas and methods from complexity within the agricultural economic discipline. In addition, from Table 1, it is possible to conclude that most journals with the exception of 'Agrekon' and 'China Agricultural Economic Review' are from developed economies.

[7] Both English and American English spellings were used, although the search engines of the databases recognised different spellings regardless of the version of English used.

Table 1: Agricultural economics journals ranked according to the average of the three metrics

Journal	Association	Thomson Reuters JCR 2014	SCImago Journal Rank Median (2006 to 2014)	CiteFactor Impact Factor Median (2009-2014)
American Journal of Agricultural Economics (AJAE)	Agricultural and Applied Economics Association	1.327	1.309	1.108
Journal of Agricultural Economics (JAE)	The Agricultural Economics Society	1.278	0.953	1.213
European Review of Agricultural Economics (ERAE)	The European Association of Agricultural Economists	1.271	0.915	1.224
Applied Economic Perspectives and Policy (AEPP)	Agricultural and Applied Economics Association	1.203	0.776	1.587
Australian Journal of Agricultural and Resource Economics (AJARE)	Australian Agricultural and Resource Economics Society Inc.	1.067	0.807	1.063
Agricultural Economics (AE)	International Association of Agricultural Economists	1.193	0.656	0.769
Canadian Journal of Agricultural Economics (CJAE)	Canadian Agricultural Economics Society	0.855	0.421	0.658
Journal of Agricultural and Resource Economics (JARE)	Western Agricultural Economics Association	0.526	0.567	0.573
China Agricultural Economic Review (CAER)	China Agricultural University and Chinese Association for Agricultural Economics	0.898	0.356	0.476
Agrekon	The Agricultural Economics Association of South Africa	0.183	0.233	0.377

In total, 76 articles from the ten agricultural economics journals and 284 from AgEcon Search database were arguably connected to understanding complexity in economic systems between 2006 and March 2016 (Table 2). This represents a very small fraction – between 0.2% and 4.0% – of the total number of articles published during this period. The highest proportion was in the CJAE, which was undoubtedly boosted by a special addition in 2009 on computational modelling in agricultural and resource economics, which included agent-based modelling (see Nolan et al., 2009).

Table 2: Articles identified with complexity

Journal	**Total number of articles between 2006-2016**	**Total number of articles identified with complexity between 2006-2016**	**Percentage of articles identified with complexity between 2006-2016**
AJAE	1,403	10	0.7
JAE	495	9	1.8
ERAE	318	4	1.3
AEPP	415	9	2.2
AJARE	438	1	0.2
AE	790	21	2.7
CJAE	354	14	4.0
JARE*		(2)	
CAER	258	4	1.6
Agrekon	153	4	2.6
Total	4,624	76	1.6
AgEcon Search	40,350	284	0.6

*JARE is included as part of AgEcon Search. Only two articles were identified with complexity in economics

In considering the number of articles connected to each specific search term, Table 3 shows the frequency of each term. It is evident that three terms – 'agent-based', 'game theory' and ‘network analysis’ – were most frequent, although when the term 'evolutionary game theory', was searched in the AgEcon database, which is perhaps more useful to understanding complex relationships, only seven articles were recorded since 2006. Of the three techniques, agent-based modelling accounted for almost one-third of all journal articles that attempted to explain the complex economic relationship. Furthermore, these three terms accounted for two-thirds of all articles identified by the survey of literature. It is not surprising that these three are most frequent as they represent tools that can be readily applied to agricultural economic problems.

Table 3: Frequency of search terms used in survey of literature

	Journal Articles		AgEcon Search		Total	
Search terms	Number	Percentage	Number	Percentage	Number	Percentage
Agent-based	25	32.9	76	26.8	101	28.1
Complex adaptive	2	2.6	8	2.8	10	2.8
Complex system	6	7.9	34	12.0	40	11.1
Complexity theory	1	1.3	0	0.0	1	0.3
Emergent properties	1	1.3	5	1.8	6	1.7
Game Theory	10	13.2	70	24.6	80	22.2
Network Analysis	15	19.7	44	15.5	59	16.4
Nonlinear dynamics	9	11.8	12	4.2	21	5.8
Path depend*	5	6.6	31	10.9	36	10.0
Self-organization	2	2.6	4	1.4	6	1.7
Total	76	100.0	284	100.0	360	100.0

Conceptual terms, such as ‘complexity theory’, ‘complex systems’ and ‘complex adaptive’ only accounted for 14% of the literature identified in the survey. The majority of these articles were connected to the economic analysis of complex systems. A marginally larger frequency of articles, 19%, focused on the processes or properties of complexity.

In analysing some of the literature, some articles considered complex systems without explicitly referring to complexity theory. However, a common theme makes a link between ecological, economic and social systems arguing that they form a complex system or CAS that should be modelled accordingly (Targetti et al., 2014; Xepapadeas, 2009). However, modelling CAS, while capturing complexity itself, creates complicated models that may reduce the possibility of obtaining general and analytical results (Xepapadeas, 2009). In some ways, this reinforces Noell's (2007) observations that the application of complexity theory to the analysis of economic systems will depend on its spatiotemporal dimension. Recognition that economic systems are complex can also be a limiting factor for agricultural economic research. For example, (Kozicka et al., 2015) suggest that to model the complexity of differences in commodity-specific wholesale prices between different Indian would result in a lack transparency. Finally, in its weakest use, a complex system is conceived as a backdrop to a particular issue of concern rather than any meaningful engagement its conceptual theory.

The use of tools that perhaps explain complexity in economic systems – agent-based modelling and network analysis and evolutionary game theory – also suggest a mixed picture of application in the literature. Here we focus on Agent-based modelling (ABM) and network analysis as they contrast the level of depth in which the engage with complexity.

ABM is defined as "computational method that enables researchers to create, analyse, and experiment with models composed of agents that interact within an environment" (Gilbert, 2008, p.2). It emerged from research on non-linear dynamics and artificial intelligence evolving as a research tool through the growth of personal computing in the 1980s and 1990s (Hamill and Gilbert, 2016). ABM has the potential to understanding economic complexity through 'growing' artificial societies, such as Sugarscape, from the bottom-up as in the seminal work of Epstein and Axtell (1996).

Typically, ABM use agents to represent individuals, households or firms (and sometimes nations). These agents have a unique set of characteristics and behavioural rules to their heterogeneity (Epstein, 2006; Hamill and Gilbert, 2016). For the researcher, ABM enables social scientists, such as agricultural economists, to mimic the cognitive and social characteristics of real-world actors creating an ontological correspondence between the model and the real world (Squazzoni, 2010). Often the researcher models agents across a representative landscape or network that may bounded or unbounded (Epstein, 2006; Hamill and Gilbert, 2016). A further characteristic is that ABM allows researchers to study local and micro-mechanisms that are responsible for macro outcomes, which can often be difficult to capture (Squazzoni, 2010).

In the agricultural economics literature, a number of papers use the AgriPoliS agent-based model to simulate a virtual world of an agricultural region. It builds upon the work of Balmann (1997)[8] on the use of cellular automata to understand path dependence of structural change in agriculture. From this the AgriPoliS agent-based model emerged (Happe et al., 2006)[9] in response to criticisms that the modelling of agricultural sector neglected key characteristics such as immobility of land, interaction between farms, heterogeneity of farms, dynamic adjustments resulting from structural change. As such, the central tenant of the AgriPoliS agent-based model is to model the complexity of the agricultural sector. Since 2004, the applications of the model, and it updates, have focused on structural change within agriculture regarding reform of the common agricultural policy; the effect of biogas on farm; structure capital and credit restrictions on the structural development of agricultural regions; structural change from the abolition of milk quotas, and the dynamics of land markets on agricultural structural change (Appel et al., 2010, 2015; Kellermann and Balmann, 2006; Kellermann et al., 2008, 2009; Ostermeyer and Schonau, 2012; Ostermeyer et al., 2010; Oudendag et al., 2014; Sahrbacher, 2011; Sahrbacher et al., 2008, 2013, 2014).

An alternative agent-based model used to study agricultural economics phenomena is the Regional Multi-Agent Simulator (RegMAS). It was designed to address concerns of the transparency and reproducibility of experiments with the academic community (Lobianco, 2008; Lobianco and Esposti, 2008), although its take up in the literature survey is much less, perhaps since it is a younger tool. Berger and Troost (2014) and Calabrese and Mark (2011) are notable exceptions.

In some of the literature, links between agent-based models and genetic algorithms[10] are made (Soman et al., 2008; Graubner et al., 2011). Genetic algorithms, which are important to evolutionary game theory (Weibull, 1995); belong to a broader class of evolutionary algorithms that are inspired by fitness through evolutionary processes (Holland, 1975). The use of genetic algorithms enable agents to operate with only limited information,

[8] Balmann (1997) on the use of cellular automata to analyse spatial and dynamic structural changes within agriculture and how these are related to path dependency.
[9] Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO).
[10] GAs are algorithms that belong to a broader class of evolutionary algorithms that are inspired by fitness through evolutionary processes (Holland, 1975).

remembering a fraction of past plays to enable the formation of future subjective probabilities (Bullock and Mittenzwei, 2005).

Unlike ABM, network analysis is much more disconnected from trying to understand complexity within agricultural economic papers. The exception was Armendàriz et al.'s (2015) exploration of complex food systems, which also examined ABM and a system dynamics approach.[11] Instead, researchers explore complexity of a particular process rather than of economic systems. For example, Banovic et al. (2015) were interested in the complexity succession, inheritance and retirement process on the decision-making of farm families. In this case, neural network analysis provided a tool to analyse the process. Alternatively, Schaller et al., (2014) examined the complex relationship between the valorisation of landscape and the socio-economic benefits using social network analysis (SNA).

Most articles surveyed use SNA, typically to evaluate socioeconomic phenomena such as friendship networks, stakeholder networks or rural development networks (Dougill et al., 2006; Fang, 2014; Pisani et al., 2014; Schaller, et al., 2014). Other SNA articles focused on agriculture and food including the adoption of new technology, or standards; evolutionary growth of specific agricultural sectors; supply chains; or understanding the transmission of livestock diseases (Abdirahman et al., 2011; Goswami and Basu, 2010; Lichoti et al., 2013; Magnan et al., 2015; Mueller et al., 2008; Mequaninte and Müller, 2013; Plakias, 2014).

Discussion and conclusions

This survey of the agricultural economics literature clearly suggests that the so-called 'complexity era' is only making slow inroads into the discipline. There may be a number of reasons for this. One is that economic problems that do not exhibit complexity do not require or justify the application of complex methods (Beinhocker, 2006; Noell, 2009). If an economic phenomenon does not exhibit properties of a complex system then it may not be necessary or applicable to analyse it through the lens of complexity (Noell, 2007).

[11] System dynamics, pioneered by Jay Forrester in the 1950s is a technique that attempts to represent the real world through accepting complexity, nonlinearity, and positive and negative feedback loop structures that are inherent in social and physical systems (Forrester, 1994).

While the number of articles connected with economic complexity is small, the diversity of agricultural economics as a discipline has enabled some penetration of the concepts, but few connect directly to the complexity theory movement. Tools, such as ABM and network analysis (and to a lesser degree evolutional game theory), are making inroads in agricultural economics research. It is likely, that the applied nature of these tools, their applicability to certain economic phenomena and their relatively moderate analytical demands are some of the reasons. However, while ABM is often used in the context of understanding complex systems, examining the literature for network analysis, particularly SNA, suggests that this tool is much more detached and amenable to analysing specific economic relationships. As such, many applications of SNA, in the context of agricultural economics research, tend only to reflect limited knowledge of formal complexity theory although often retaining intellectual rigour as a research tool.

That numbers of articles connected with economic complexity are small in the agricultural economics literature may also be a consequence of the transdisciplinary nature of the subject. Therefore, the application of ABM and network analysis have been applied to agricultural economic situations are perhaps published outwith the disciplines journals. For example, Happe et al., (2006, 2008, 2011) using the AgriPoliS agent-based model and Butler et al., (2007, 2008) examining social networks of farmers were published in non-agricultural economics journals. There may be clear academic reasons for this but in terms of the literature survey it highlights an important caveat. The premise of this paper was to examine how concepts, processes and methods of complexity are emerging in agricultural economic research but the survey points only to limited evidence. It is likely that articles analysing economic complexity in agricultural systems published elsewhere suggest that concepts, processes and methods of complexity are perhaps more readily accepted. Importantly, however, to test this assertion requires a much more extensive literature survey targeting journals from alternative orthodox and heterodox economics sub-disciplines.

"Complexity theory should be considered as a valuable supplement to the existing analytical toolbox" (Noell, 2007, pp.219). This research paper is a first exploration to understand if and how complexity theory has or is becoming part of the agricultural economics researchers' toolbox. The increasing popularity of ABM and to a lesser extent, network analysis as it is presently applied, are tools that could potentially explain complexity within agricultural economics. However, other tools such as evolutionary game theory or other innovative techniques to understand the properties of complex agricultural systems may be required.

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