Towards a Theory of Structural Change in Agriculture: Just Economics?

ALFONS BALMANN, VLADISLAV VALENTINOV[1]

Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle (Saale), Germany; Contact: balmann@iamo.de; Tel: +49 345 2928300

Paper prepared for presentation at the 149th EAAE Seminar 'Structural change in agri-food chains: new relations between farm sector, food industry and retail sector' Rennes, France, October 27-28, 2016

[1] The authors want to thank Franziska Appel, Lioudmila Chatalova, Taras Gagalyuk, Frans Hermans, Franziska Schaft, Daniel Müller and Zhanli Sun for valuable comments and contributions to earlier collaborative work.

Abstract

Though structural change in the agricultural sector has huge merits for economic development, the public opinion on structural change is quite negative. On the one hand, structural change does hardly lead to Pareto superior outcomes. On the other hand, there are concerns that structural change may go along with negative social externalities which may result from more industrialised forms of agriculture. This paper argues that addressing these concerns by agricultural economic research requires a systems perspective which goes far beyond traditional economic and reductionist perspectives. Conceptual approaches can for instance be found in the research on complex systems as well as in Luhmannian systems theory. Therefore, collaboration across disciplines is essential to develop a better theoretical understanding of structural change.

1. Introduction

Over the past centuries, the agricultural sector in developed economies has contributed substantially to economic development. Ever increasing productivity of agriculture allowed more production and consumers to spend lower and lower shares of their income for food. Moreover, the increased productivity allowed to release agricultural labour force that was needed by other sectors in the economy. Productivity increases as well as economic development went along with structural changes in the whole economy as well as within the agricultural sector. Within the agricultural sector, structural change was and is driven by many factors like technological progress, changing product and factor price relations, institutional and policy changes, as well as reduced transaction costs within the value chain and within farms.

Considering these hardly disputed facts, it may be surprising that structural change in agriculture has usually a very negative connotation in public debates. Looking at the public debates on agricultural structural change, at least two types of concerns can be differentiated. The first of them relates to the view that farmers are often considered a disadvantaged group and that structural change affects particularly poor farmers negativly. This view is for instance expressed by the German term “Bauernsterben” (dying peasants). There may be several explanations for this type of concern. One is that, in general, the process of structural change hardly leads to Pareto-superior states. Every innovation threads existing technologies, routines and actors. This mechanism is particularly highlighted by the notion of “creative destruction” coined by the Austrian economist Joseph A. Schumpeter (2005 [1942]) and with regard to the agricultural sector by the notion of the “technological treadmill” (Cochrane 1958). Cochrane argued that productivity gains in agriculture are benefitting only a few innovative agricultural producers while the majority of producers suffers the consequences of the following drop in prices. Particularly small farms using outdated technologies and operating at suboptimal sizes lose competitiveness and profitability. Either they are able to adopt the new technologies without substantial perspectives for profits or they need to quit production. Accordingly, structural changes may have social and distributional implications which are hardly addressed by economic concepts. Another, but related reason which may also foster social concerns about structural change is loss aversion in the sense of Kahneman and Tversky (1984). Even if most individuals benefit from structural change, those who lose may feel far more uncomfortable with their losses than the potential winners appreciate their gains.

A second type of public concerns on structural change is related to criticisms about a tendency of moving away from peasant farming towards some kind of "factory farming". Indeed, modern agriculture is becoming increasingly industrial with an enormous capital and knowledge intensity. Boehlje (1999) coined even the term "biological manufacturing" and argued that modern farming is increasingly based on science and less on art. Moreover, he argues that agriculture is increasingly integrated into value chains in which key actors in the value chain like large retailers define how farmers have to produce. This view contradicts with traditional views on agriculture which often glorified peasant farming like Jefferson (1785) who argued that "(t)hose who labour in the earth are the chosen people of God (...) Corruption of morals in the mass of cultivators is a phenomenon of which no age nor nation has furnished an example." An alternative argument was provided by Alexander V. Chayanov who argued that peasant farms' production is motivated by subsistence needs of the family and is based on self-exploitation of the family labour. Both views deviate substantially from the economic notion of profit maximisation which may provoke the suspicion that profit oriented farmers may operate in unsustainable ways if there is no correction of potential externalities (Čajanov 1923).

Both types of concerns are not new and are often used as arguments in favour of political protection and regulation of the agricultural sector like in the EU Common Agricultural Policy (CAP). On the other hand, many agricultural economists repeatedly criticised over the past decades the CAP as inefficient and ineffective with regard to the official policy goals and societal goals. Although there may be good reasons why policies do not always follow scientific advice, such as rent-seeking behaviour, opportunism and specific mental models, there may also be deficits of (agricultural) economists in adequately understanding and addressing the above mentioned public concerns about structural change and in developing concepts which allow adequate economic advice and generate the necessary trust in this advice. In order to overcome these deficits, traditional economic interpretations and projections of structural changes may benefit from being accomplished with insights from other disciplines. Moreover, it may be necessary that analyses of structural change go beyond reductionist and partial economic analyses by following more holistic approaches.

Instead of providing extensive lists of potential economic shortcomings or to list up potential enhancements, the remainder of this contribution highlights a few rather conceptual views. In particular, these views follow a systems' perspective building on the Luhmannian distinction between the "part-whole" and "system-environment" approaches. Regarding part-whole approaches this paper highlights ongoing research on complex systems as these may provide a deeper understanding on the adaptability of the agricultural sector and existing internal concerns of the agricultural sector. Regarding the system-environment problem, concepts related to the social systems theory in the tradition of Niklas Luhmann are highlighted as these address external concerns.

2. Complex systems

The research on complex systems studies particularly the dynamics and patterns of systems consisting of many interacting particles. As there are many disciplines involved in this kind of research like computer science, physics, chemistry, biology, ecology, history, psychology, sociology and economics, it is difficult to set up a unique and general definition of complex systems. Specific and common issues of complex systems are however so called

"emergent properties" which mean that one can find on the macro-level of the system outcomes which cannot be derived directly from studying the individual parts on the micro-level. In economics and social sciences, ideas on emergent phenomena have been particularly highlighted by Hayek (1963) arguing that market economies rely on self-organisation and spontaneous order. A prominent example in social science is also provided by Schelling (1978) who showed in his book *Micromotives and Macrobehavior* how social segregation may result from simple unconscious interactions of individuals.

A substantial part of the research on complex systems is based on the use of so-called agent-based models (ABM) respectively multi-agent models, which nowadays are quite prominent in the field of agricultural economics. Examples can be found in, e.g., Balmann (1997), Berger (2001) or Happe, Kellermann et al. (2006). ABM are explicitly able to generate emergent properties and thus they may be well suited to study characteristics of structural change which are related to the public concerns mentioned above.

While there are many potentially interesting emergent phenomena related to the complexity of structural change, two specific phenomena are illustrated in the following: path dependence and heterogeneity.

2.1. Path dependence

Farming systems in reality are not necessarily those which are optimal. One type of reasons results from externalities. If the benefits and costs of certain farming systems differ between farmers and society, farmers favour those systems which mainly fit their own interests instead of societal needs – at least, as long as there are no effective regulations or incentives for farmers to adjust towards socially optimal behaviour. Another type of suboptimality can result from path dependencies. For instance, Cowan and Gunby (1996) argue theoretically and empirically that farmers may not adopt integrated pest management (IPM) despite of its superiority. Latacz-Lohmann, Recke et al. (2001) show a similar mechanism preventing conventional farmers from switching towards organic farming. In both cases, the obstacle that prevents an optimal solution is seen in path dependences. Path dependence means that inferior regimes may emerge and persist (Arthur 1989). The reasons for such path dependences are seen by Arthur (1989) in self-reinforcing mechanisms. Translated to the farm level, one can argue that farmers learn to use and optimise a certain farming system. If they would switch to a more superior system this would require additional investments and learning costs. Balmann, Odening et al. (1996) show that the complementarity of investments with sunk costs, such as investments in specific assets and/or human capital, can cause a permanent lock-in of a firm to an inferior state. Such sunk costs and complementarities can explain why certain farming types are showing an enormous inertia and persistence despite of a low productivity and profitability compared to other farm types.

Farm structures are path dependent too (Balmann 1995). Even within and between regions with similar agricultural conditions (climatic, soil, infrastructural, economic, social), farm structures can be very heterogeneous. Agricultural structures are shaped by historical events and previous pathways. They often tend to be locked in certain regimes and evolve at a rather slow speed. This inertia is caused on the individual farm level by long investment cycles, slow changes in human and financial capital, and on the aggregate level by persistent institutions, frictions on land markets, specific mental models of the actors and state conserving agricultural policies. For instance, sunk costs of assets and human capital on a

farm cause high shadow prices for complementary inputs like land and quotas which are required by other farms which intend to grow. As a result, also agricultural structures respond inert and ponderous to external changes even if from an economic point of view substantial deficits with regard to productivity, efficiency and profitability exist.

Path dependent structural change results moreover from path dependences in its environment. Within a supply chain path dependences may emerge because the potential providers of new agricultural technologies face substantial costs for research and development as well as the risk that farmers hesitate to adopt the new technology. The same holds for processors which may not invest into new technologies as long as they do not expect that farmers are not providing the required qualities and quantities. Morgan and Murdoch (2000) illustrate such mechanisms comparing conventional and organic supply chains.

Also policies can be path dependent. Kay (2003) addresses the path dependence of the EU CAP evolution. If policy makers aim to support farmers, they may rather address the concerns of current farmers than those of potential future farmers. Vice versa, farmers adjust rather to current policies than uncertain future policies.

Path dependence is however not absolutely perpetual. Under certain conditions, farm structures and related farming systems may be subject to abrupt changes. Such changes can be considered as structural transitions or regime shifts (Mueller, Sun et al. 2014). On the one hand, these changes can be triggered by pull factors such as path breaking and path creating activities of certain actors or by new opportunities resulting from new technologies or markets. Wiskerke and Roep (2007) suggest such an approach for reforming the pork supply chain in the Netherlands. Ostermeyer (2015) finds that after the abolishment of the milk quota some dairy farmers may be able to establish a large dairy production even in regions which were previously dominated by rather small farms. Even though the number of such path braking farms may be small, their share in total production may be substantial. On the other hand, a path dependence may also be overcome by push factors such as changing environmental conditions (natural, economic, institutional) which erode the preconditions of the previous farming structures and systems. An erosion of preconditions may also result from an unsustainability of the existing system. An example may be seen in the abolishment of battery cages for laying hens in the EU which provided huge opportunities to establish alternative production systems within a few years. Often, pull and push factors complement each other for a transition.

2.2. Heterogeneity

A specific issue which is related path dependence of structural change is heterogeneity within the agricultural sector. This heterogeneity can at least partly be seen as a result of the path dependent development of farms. Farms differ in many respects, among them are organisational form, specialisation, and size with regard to used inputs, production capacities, and output. Popular indicators for farm size are the numbers of hectares, cows, pigs, labour units or within the EU the “Standard Output” describing the average monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock.[2] An interesting phenomenon that describes the heterogeneity of farms regarding size indi-

[2] Cf. http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Standard_output_(SO)

cators is the validity of the "Pareto principle" saying that approximately the largest or richest 20 percent own 80 percent while the other 80 percent own just 20 percent (Pareto 1911). In the end, the Pareto principle represents a kind of power law which is related to Gibrat's law (cf. Fujiwara, Guilmi et al. (2003), Castaldi, Dosi et al. (2007)). Though the Pareto principle is not met by all size distribution, there are however quite some prominent examples within the agricultural sector. For instance, the European Commission found that in 2009 within the EU 15 as well as within the EU 12 countries some 80 percent of direct payments were received by the largest 20 percent of the (EC 2011).[3] Background of this distribution is the distribution of agricultural land for which the direct payments are paid. Based on the Pareto distribution of direct payments, the European Commission argued that there would be a need to introduce a redistributive mechanism like a capping of payments per farm for large recipients. This proposal led to substantial disputes among countries. Particularly representatives of regions with large farms intervened against this proposal. Sahrbacher, Balmann et al. (2015) explain the resistance of the German government against this proposal with the fact that the very large farms in the eastern parts of Germany show on average very high employment figures. Thus, the redistributive measures may negatively affect the job security of farm workers with low wealth.

If agricultural policies aim to support farms sustainably, the policies should also be evaluated regarding their impacts on current as well as on future farms. If the long-run impacts are not considered, there is a risk that future farms suffer from well-meant policies that support current farms and that in the end the sector suffers a kind of subsidy trap (Balmann, Dautzenberg et al. 2006). Balmann, Sahrbacher et al. (2014) analyse the long-term implications of redistributive payments and support for young farmers for several German regions by using the agent-based model AgriPoliS. A key finding of these analyses is that in regions where almost all farms are small there is a substantially higher inflow of subsidies and on average, incomes may increase. However, the incomes of those farms which gain are in the very most cases unsatisfactory and do not improve substantially in the long run. In the end, the farms cannot increase their relative competitiveness compared to other farms which are usually in the same situation and a substantial share of the extra payments will translate into higher rental prices for land.

According to Balmann, Sahrbacher et al. (2014) also the results for regions with rather mixed farm sizes including small and medium-sized farms are interesting. In such regions, the extra payments slow down structural adjustments and the benefits for the small farms come at the expense of development perspectives of medium-sized farms. These farms cannot develop their land base which prevents them from realising economies of size. Moreover, in both types of regions, the small benefits remain only as long as extra-payments continue. As soon as these extra-payments disappear, small farms suffer substantially and many of them have to exit. These adjustments provide for some medium-sized farms improved development perspectives, though with a time-lag of quite a number of years. In quite some cases this time-lag means missed opportunities. I.e., the technological treadmill is temporally slowed down and runs afterwards even faster.

Balmann, Sahrbacher et al. (2014) conclude that the additional support for small and young farmers creates some policy paradoxes. First, the extra payments do rather harm medium-

[3] Cf. http://ec.europa.eu/agriculture/rica/pdf/PO0202_direct_payments.pdf

sized farms in the neighbourhood of small farms than large farms in other regions – even if the subsidies are redistributed between the regions. Second, the particular support for small farms and young farmers creates vested rights and dependencies on the subsidies which leads in the end not just to a path dependence of farms and regional farm structures, but likely also to a path dependence in the evolution of agricultural policies which have to fix the problems created before (Kay 2003). Third, though small farms in regions like southern Germany suffer from low income, they are still quite wealthy because their land is very valuable. Therefore, within Germany, the redistributional payments transfer taxpayers' money from rather poor regions into wealthy regions.

What to learn from these issues related to complexity in general as well as path dependence and heterogeneity in particular? In principle, many of the issues discussed above have an economic background and can be captured by economic reasoning. Common to these issues is however, that many implications of policies can only be understood if the complexity of the systems is properly considered. This requires to analyse the system at the micro-level as well as the macro-level including the interdependencies between micro and macro level. In particular, the emergent properties of the system have to be considered such as path dependence and Pareto distributions. That means at the same time to be aware that complex systems like farm structures cannot be assumed to fulfil traditional economic assumptions like equilibrium conditions or homogeneity, convexity and rationality assumptions.

Beyond the evaluation of policies, a systems perspective may also allow to identify potential solutions for specific problems. Before fundamental structural changes occur, some specific additional facilitators or catalysts of change may be necessary. One reason is that a "valley of tears" might have to be overcome or is assumed by the actors as too huge before they may adjust. Understanding this valley of tears may also be a prerequisite to address the public concerns about changes.

3. A Luhmannian systems theory perspective

Another systems perspective that addresses public concerns can be found in the tradition of the Luhmannian systems-theoretic analysis tracing the relevant discontinuities to the systemic differentiation of social reality. Luhmann argued that in the modern society, social systems serve the primary purpose of complexity reduction, i.e., relieving individuals of the intolerable cognitive burdens linked to the processing of civilizational complexity. Social systems, according to Luhmann, are highly selective in registering the happenings in the environment. While the complexity of these happenings is potentially infinite, systems deal with this complexity by ignoring the bulk of it. Against this backdrop, it is a kind of wonder that individuals participating in social systems tend to develop stable mental models that are insensitive toward a large share of environmental happenings. A systems-theoretic perspective would explain the pervasiveness of mental models in terms of the pervasiveness of systems that reduce, or externalise, environmental complexity.

The centrality of insensitivity to environment in this exposition of social systems suggests that the Luhmannian approach is markedly different from the open systems perspective espoused by Ludwig von Bertalanffy (1968). To make the case for the systemic insensitiv-

ity to environment, Luhmann drew upon the Maturana and Varela's (1980) concept of operational closure. Systems exhibiting operational closure "produce not only their structures, but also the elements of which they consist in the network of these same elements. The elements … have no independent existence. They do not simply come together. They are not simply connected. It is only in the system that they are produced" (Luhmann 2012, p. 32). The idea of the operationally closed system indeed presents a striking contrast to that of the open system maintaining the "exchange of matter with its environment, presenting import and export, building-up and breaking-down of its material components" (Bertalanffy 1968, p. 141).

Valentinov and Chatalova (2016) propose to see the conceptual chasm between the open and closed systems theories not as a purely theoretical conundrum but rather as a way to analyse a broad range of sustainability problems and social dilemmas endemic to the modern society. These problems and dilemmas are illuminated by Valentinov's (2014a, p. 18) two principles summarising the Luhmannian vision of system-environment relations. The complexity reduction principle "posits that systems increase their complexity by becoming increasingly insensitive to the complexity of the environment" (ibid); the critical dependence principle associates "the increasing complexity of systems … with their growing dependence on environmental complexity" (ibid). The two principles explain the inevitable tension between systemic complexity and sustainability. In Luhmann's (Luhmann 2012, p. 76) own words, through operational closure, systems develop own "degrees of freedom, which they [i.e., systems] exploit as long as possible; in other words, as long as the environment tolerates it… [T]he overall effect [of operational closure] is not adaptation, but greater deviation".

In Luhmann's work, the paradigmatic illustration of the tension between complexity and sustainability is what he called "the ecological degradation" which is induced by the insensitivity of social systems, especially the economic system, to the complexity of the natural environment. Commenting on the insensitivity of the economic system, Luhmann located "the key to the ecological problems… in the language of prices. This language filters in advance everything that occurs in the economy when prices change or do not change. The economy cannot react to disturbances that are not expressed in this language" (1989, p. 62). In addition, the idea of the insensitivity of the economic system has much to offer in the way of explaining heterogeneous farm structures and path dependence in agriculture, especially given that agriculture presents a setting where the relevant social systems, such as the economic system, exhibit heightened metabolic dependencies on their natural environment. Following Valentinov and Chatalova (2016), these heightened dependencies must exacerbate sustainability problems and social dilemmas arising in the process of agricultural structural change.

The role of environmental dependencies acquires special significance in the light of the institutional economics perspectives on the nature of the modern corporation and the firm more generally. In various ways, economists as diverse as Boulding (1984), Schumpeter (1950), Galbraith (1967), and Hodgson (2005) acknowledged that the attainment of technological excellence can only occur within a protected enclave sufficiently decoupled from the erratic market environment. These authors saw the meaning of the corporation in providing this enclave, and justified this meaning by the growing complexity of the modern

technology. The Luhmannian dictum of the "complexity increase through complexity reduction" allows to apply this vision, in inverted form, to the structural change in agriculture.

From the Luhmannian perspective, it may be plausible to conjecture that the heightened environmental dependence prevents at least some farm structures from developing effective complexity reduction strategies. This is probably the case with small-scale family farming which is traditionally associated with the high dependence of agricultural production on natural contingencies (Valentinov 2007). The low complexity reduction potential of small-scale agricultural producers does not allow them to control their technological interdependence at a level that would be sufficient for escaping the special kind of social dilemma like the agricultural treadmill (Cochrane 1958). Furthermore, being entrapped in the agricultural treadmill lowers the ability of these producers to assume corporate social responsibility, thus deepening the cultural rifts between agriculture and broader society (Balmann et al. 2016). Path dependence of structural change presents another dilemmatic situation in which agricultural producers collectively fail to choose superior technological solutions. A likely systems-theoretic explanation for this dilemma is the inability of the concerned enterprises to mobilise sufficient internal complexity in view of their constrained complexity reduction potential. Path dependence can be further reinforced by rigid mental models that are in turn shaped by systemic affiliations of the concerned actors. Finally, the often constrained complexity reduction potential notwithstanding, agricultural enterprises externalise the complexity of their societal and natural environment in such a way as to generate social costs that are shifted to rural population and other stakeholders. This problem is especially characteristic for agricultural enterprises of larger scale (Valentinov 2014b).

The issue of social costs acquires a further moral dimension against the backdrop of the tendency of agricultural structural change to generate losers, or victimise a certain share of its participants. Technically, the sheer existence of multiple equilibria makes it impossible to pass from one optimum to another without crossing a "a valley of tears", i.e., without some kind of damage that must be imposed on someone. This damage certainly poses a challenge for ethical theory which has to establish whether the damage is morally acceptable or legitimate. Luhmann advances two interesting arguments bearing on this issue. First, he decouples moral legitimacy of systemic happenings from the individual consent to them; to him, legitimacy means individual acceptance of these happenings independently of whether the affected individuals approve them (Luhmann 1993). This understanding is radically different from the Habermasian idea of legitimation through discourse but is perfectly aligned with the fact that structural change is almost never Pareto-optimal. Second, Luhmann held moral communication to be dysfunctional in view of its tendency to provoke conflict (cf. Kneer and Nassehi 2000, p. 181; Luhmann 1993, p. 368ff.). It is clearly true that agricultural structural change periodically generates rising tides of conflictual moral communication, not least in the mass media. Furthermore, Luhmann is probably right to point out that this communication creates more conflicts than it solves, for it seeks to ascribe responsibility to individuals rather than to acknowledge the emergent character of systemic phenomena.

On reflection, the societal resistance to the structural change in agriculture presents a manifestation of the so-called "institutionalist dichotomy", known as a key analytical tool of

the old, or original, institutional economics (cf. Munkirs 1988). The dichotomy differentiates between the dynamic progressive technology and its institutional embedding which is necessarily static, ceremonial, past-binding, and backward-looking. Given that the structural change in agriculture is technologically induced, the dichotomy offers a ready explanation why it becomes the object of institutional resistance. What is interesting is that today this resistance often takes the form of public discourse revolving around moral (and not infrequently emotionalized) critiques of the industrial agriculture. It is clear that from the suggested institutionalist standpoint, these critiques are reflections of the increasing inadequacy of the obsolescent institutional structure to the advancing technology (or, as Marx would put it, the inadequacy of the prevalent production relations to the state of productive forces).

The Luhmannian critique of the dysfunctional nature of moral communication subsumes this institutionalist argument by emphasizing the contrast between the emergent character of systemic phenomena and the person-centered (i.e., individual-oriented) ways of thinking. If the complexity-reducing social systems, such as the economic system, are to enjoy a fair degree of stability, they must rest on accordingly stable individual expectations, which can in turn be cognitive or normative. In contrast to cognitive expectations, normative expectations ascribe disappointment to the wrongness of the observed reality rather than to the perception of the observer, and for this reason are especially static. Disappointments of normative expectations tend to generate emotional and moralistic discourse, which, in the Luhmannian setting, is grounded in the person-centered nature of normative expectations. If the advance of technology constitutes a part of the environmental complexity processed by the economic system, then the technologically-induced disappointments of normative expectations seem inevitable. Furthermore, the discrepancy between the person-centered nature of these expectations and the emergent character of the advance of technology are likely to make the resulting moral discourse dysfunctional in the Luhmannian sense. Yet, regardless of whether the Luhmannian assessment of moral discourse is correct, his framework does concur with the institutionalist diagnosis of the inevitability of the institutionalist resistance to the "logic of technological development" (Ayres 1978).

With regard to the public concerns about structural change as well as concerns about economic analysis as well as advice, several conclusions from the Luhmannian perspective can be drawn for developing theories of structural change in agriculture. In accordance with the conclusions from the complex systems perspectives it seems to be important to take indeed a systems perspective. It may be particularly important to take a position which allows to see the whole picture and to avoid getting lost in too many details. From an economists point of view, the Luhmannian perspective provokes (at least implicitly) the concern that disciplinary approaches may get trapped in their own paradigms. Because of this specific kind of autopoiesis, there may be a good reason for the addressees of economic advice to be skeptical about disciplinary conclusions. Though these concerns may hardly be overcome, there is nevertheless a good reason for economists to stay and further develop their disciplinary insights. At least they provide a basis for advice and it has to be left to the sectoral, societal and political subsystems to use this advice.

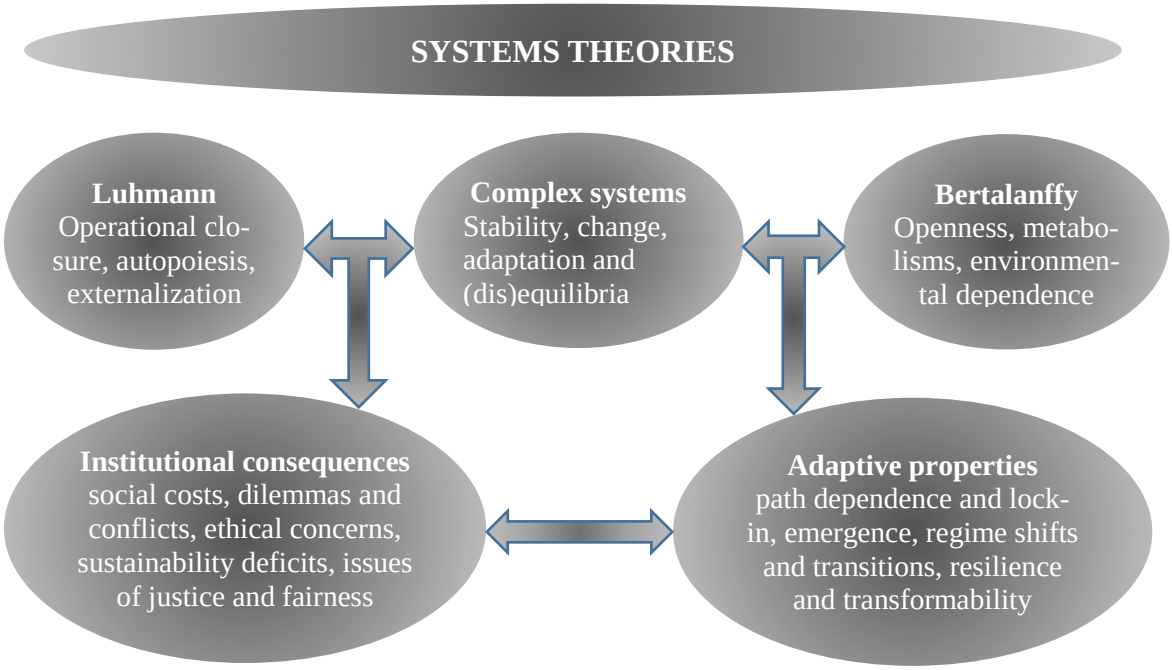
4. Concluding Remarks

Considering the fact that structural changes in the agricultural sector are driven by external framework conditions like technological progress, changes in consumer and societal expectations, institutional and political developments as well as internal mechanisms of competition and cooperation, mental models of farmers or the evolving stocks of capital, land and labour, then it is quite clear that the process of structural change is complex and can hardly be captured by any simple and reductionist theory. And even though many sophisticated economic theories and models about structural change exist, one should be aware that these hardly allow to see far more than a number of bricks of a large puzzle. Aiming to develop a more general theory of structural change requires to take a systems perspective. However, this is not for free. In the end, it requires to abstract from details on the micro-level as it is hard to consider everything at the same time.

In particular, one has to be aware that key characteristics of agricultural structural change like interactions of agents within space and time are hardly tractable by the traditional analytical toolboxes of economists like calculus and statistics. New tools like agent-based models may allow to overcome some of these limitations. However, such models come at high costs of their own. These costs include huge amounts of resources for development, calibration and validation of such models. Moreover, these models have their own limitations including the need to use simplified submodels of agents and of the interactions of agents. And last but not least, they have very quickly a black box character for the addressees of the results as well as for their users. Also recent developments in modelling human behaviour based on psychological and experimental approaches may be beneficial and important to get a better understanding of important drivers of structural changes. However, these developments also add new and additional bricks to the puzzle of structural change.

In the end, one has to be aware that the research on structural change can contribute more and more bricks to the whole puzzle and can work on putting some bricks together. Huge limitations remain. Interdisciplinary collaboration may not just add valuable insights, but rather seems to be essential for a better understanding. In particular, it will be important to collaborate in developing a more general systems perspective. This requires beyond finding joint languages also substantial engagement in structuring the challenges and identifying potential building blocks. Figure 1 illustrates exemplarily a research program which aims to structure potential conceptual building blocks and interdependences.

Figure 1: Building blocks for a systems perspective on structural change



Source: Own design based on collaboration with colleagues from IAMO.

A systems perspective allows on the one hand to develop new theoretical conceptualisations of structural change on existing concepts, tools and insights of systems theories from different disciplines and scientific communities. On the other hand, these theories allow a systematic reflection of characteristics and key issues of structural change. In particularly two fields of work should be addressed. First, it is important to get an appropriate understanding of the adaptive properties of agricultural structures including the meaning of these properties. Terms like path dependence or resilience are important notions to describe the systems characteristics. The use of such terms should however differentiate between positive, descriptive uses on the one hand and normative uses on the other hand. Second, a systems perspective can and should be used to understand the institutional consequences of structural change in order to address the ethical dimensions of structural change within the agricultural sector as well as between agriculture and society.

References

Arthur, W. B. (1989). Competing Technologies, Increasing Returns, and Lock-In by Historical Events. *The Economic Journal*, *99*(394), 116-131.

Ayres, C.E. (1978). *The Theory of Economic Progress: A Study of the Fundamentals of Economic Development and Cultural Change.* Kalamazoo: New Issues Press.

Balmann, A. (1995). *Pfadabhängigkeiten in Agrarstrukturentwicklungen - Begriff, Ursachen und Konsequenzen*. Berlin, Duncker & Humblot.

Balmann, A. (1997). Farm-based modelling of regional structural change: A cellular automata approach. *European Review of Agricultural Economics*, *24*(1), 85-108.

Balmann, A., Dautzenberg, K., Happe, K., & Kellermann, K. (2006). On the dynamics of structural change in agriculture: Internal frictions, policy threats and vertical integration. *Outlook on Agriculture*, *35*(2), 115-121.

Balmann, A., Odening, M., Weikard, H.-P., & Brandes, W. (1996). Path-dependence without increasing returns to scale and network externalities. *Journal of Economic Behavior & Organization, 29*(1), *159-172*.

Balmann, A., & Sahrbacher, C. (2014). *Structural Implications of First Hectare Payments and Young Farmer Support within the EU CAP Reform 2013: The German Case*. EAAE Congress, Ljubljana.

Berger, T. (2001). Agent-based spatial models applied to agriculture: a simulation tool for technology diffusion, resource use changes and policy analysis. *Agricultural Economics of Agricultural Economists, 25*(2): 245-260.

Bertalanffy, L von (1968). *General System Theory: Foundations, Development, Applications.* New York: George Braziller.

Boulding, K.E. (1984). *The Organizational Revolution: A Study in the Ethics of Economic Organization.* Westport, CT: Greenwood Press.

Čajanov, A. V. (1923). *Die Lehre von der baeuerlichen Wirtschaft: Versuch einer Theorie der Familienwirtschaft im Landbau*. Berlin, Parey.

Castaldi, C., Dosi, G. (2007). *The patterns of output growth of firms and countries: new evidence on scale invariances and scale specificities*.

Cowan, R. A., & Gunby, P. (1996). Sprayed to death: path dependence, lock-in and pest control strategies. *The economic journal, 106* (May): 521-542.

EC. (2011). *CAP Towards 2020 - Impact Assessment - Direct Payments*. Brussels: European Commission DG Agriculture and Rural Development. Retrieved from http://ec.europa.eu/agriculture/rica/pdf/PO0202_direct_payments.pdf.

Fujiwara, Y., Guilmi, C. D., Aoyama, H., Gallegati, M., & Souma, W.. (2003). *Do Pareto-Zipf and Gibrat laws hold true? An analysis with European Firms*. arXiv.org

Galbraith, J.K. (1967). *The New Industrial State.* Princeton: Princeton University Press.

Happe, K., Kellermann, K., & Balmann, A. (2006). Agent-based analysis of agricultural policies: an illustration of the agricultural policy simulator AgriPoliS, its adaptation and behavior. *Ecology and Society, 11*(1).

Hayek, F. A. (1963). Arten der Ordnung. *Ordo - Jahrbuch für die Ordnung von Wirtschaft und Gesellschaft, 14*.

Hodgson, G.M. (2005). *Economics and Institutions: A Manifesto for a Modern Institutional Economics.* Cambridge: Polity Press.

Jefferson, T. (1785). Notes on the State of Virginia. In A. Koch & W. Peden (Eds.), *The Life and selected Writings of Thomas Jefferson* (pp. 280-281). New York: Modern Library.

Kay, A. (2003). Path dependency and the CAP. *Journal of European Public Policy, 10*(3), 405-420.

Kneer, G., & Nassehi, A. (2000). *Niklas Luhmanns Theorie sozialer Systeme.* Paderborn: Wilhelm Fink.

Latacz-Lohmann, U., Recke, G., & Wolff, H. (2001). Schwerpunktheft: - Ökonomische Aspekte des ökologischen Landhaus - Die Wettbewerbsfähigkeit des ökologischen Landbaus: Eine Analyse mit dem Konzept der Pfadabhängigkeit. *Agrarwirtschaft - Zeitschrift für Betriebswirtschaft, Marktforschung und Agrarpolitik, 50*(7), 433-438.

Luhmann N (1989) Ecological Communication. Chicago: The University of Chicago Press.

Luhmann, N. (1993). *Gesellschaftsstruktur und Semantik,* Volume 3. Frankfurt am Main: Suhrkamp.
Luhmann, N. (2012). *The Theory of Society,* Volume 1. Stanford, CA: Stanford University Press.
Maturana, H.R., & Varela, F.J. (1980). *Autopoiesis and Cognition: The Realization of the Living.* Dordrecht et al.: Reidel Publishing Company.
Morgan, K., & Murdoch, J. (2000). Organic vs. conventional agriculture: knowledge, power and innovation in the food chain1. *Geoforum, 31*(2), 159-173.
Mueller, D., Sun, Z., Vongvisouk, T., Pflugmacher, D., Xu, J., & Mertz, O. (2014). Regime shifts limit the predictability of land-system change. *Global Environmental Change-Human and Policy Dimensions, 28*, 75-83.
Munkirs, J.R. (1988). The Dichotomy: Views of a Fifth Generation Institutionalist. *Journal of Economic Issues* 22(4): 1035-1044.
Ostermeyer, A. (2015). *Milchproduktion zwischen Pfadabhängigkeit und Pfadbrechung: Partizipative Analysen mit Hilfe des agentenbasierten Modells AgriPoliS*. Halle (Saale), Studies in the Agricultural and Food Sector in Transition Economies, 81, Leibniz Institute of Agricultural Development in Transition Economies (IAMO).
Pareto, V. (1911). *Manuale di economia politica*, Paris, Marcel Rivière. Rowman and Littlefield International, London.
Sahrbacher, A., Balmann, A., & Sahrbacher, C. (2015). The Political Economy of Capping Direct Payments: Applications in – and implications for – Germany. In J. F. M. Swinnen (Ed.), *The Political Economy of the 2014-2020 Common Agricultural Policy - An Imperfect Storm* (pp. 277-306). Brussels: Centre for European Policy Studies (CEPS).
Schelling, T. C. (1978). *Micromotives and Macrobehavior*: New York [u.a.]: Norton.
Schumpeter, J.A. (1950). *Kapitalismus, Sozialismus und Demokratie.* Tübingen: Francke Verlag.
Valentinov, V. (2007). Why Are Cooperatives Important in Agriculture? An Organizational Economics Perspective. *Journal of Institutional Economics*, 3(1), 55-69.
Valentinov, V. (2014a). The Complexity-Sustainability Trade-off in Niklas Luhmann's Social Systems Theory. *Systems Research and Behavioral Science*, 31(1), 14-22.
Valentinov, V. (2014b). K. William Kapp's Theory of Social Costs: A Luhmannian Interpretation. *Ecological Economics*, 97(1), 28-33.
Valentinov, V., & Chatalova, L. (2016). Institutional economics and social dilemmas: a systems theory perspective. *Systems Research and Behavioral Science*, 33(1), 138-149.
Wiskerke, J. S. C., & Roep, D. (2007). Constructing a Sustainable Pork Supply Chain: A Case of Techno-institutional Innovation. *Journal of Environmental Policy & Planning, 9*(1), 53-74.