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HOW MUCH DOES ECONOMIC CRISIS AFFECT SUSTAINABILITY TRANSITIONS? A SOCIAL NETWORK ANALYSIS OF THE ITALIAN BIOFUEL SECTOR¹

The present paper investigates the impact of the current economic crisis on the process of sustainability transitions by exploring the case of a green niche, namely the biofuel sector. From a methodological point of view, we employ a social network analysis aimed at comparing the Italian biofuel niche in two different time periods, specifically before and during the crisis. Our findings provide evidence that biofuel actors are

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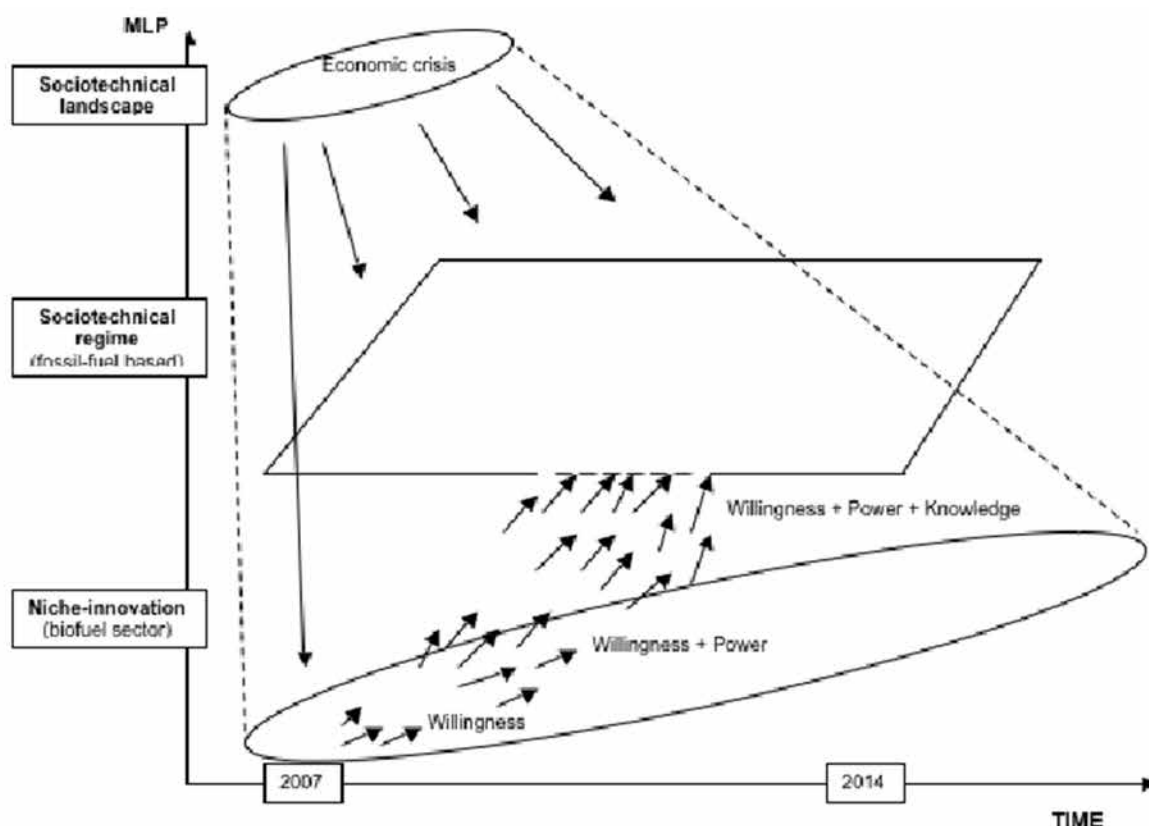
responding to the economic crisis by raising the degree of their knowledge exchange. At the same time, they are exhibiting a general scepticism about the future development of the niche, showing a lower level of expectations compared to that of 2007 (i.e. before the crisis). These results suggest that the economic crisis is concretely hindering the transition towards a biofuel-based regime by affecting the degree of maturity of the niche.

Keywords: economic crisis, sociotechnical transitions, sustainability, social networks analysis, biofuel

1. Introduction

In the framework of the socio-technical transition approach, economic crises can represent an important opportunity for transition pathways to occur by contributing to move towards more sustainable regimes (Loorbach and Lijnis Huffenreuter, 2013). While on the one hand, economic crises can reinforce the lock-in of incumbent regime structures, on the other they can pave the way to sustainability transitions by creating favourable conditions for a paradigmatic shift towards new green patterns of consumption and production (Geels, 2013; Antal and van den Bergh, 2013). On these grounds, the present article investigates the impact of the ongoing economic crisis on the sociotechnical transitions, by following a multi-level perspective (MLP) based on three interrelated levels: (i) the socio-technical

regime, (ii) the socio-technical landscape, and (iii) the niche-innovations (Geels, 2002; Raven, 2006; Geels and Schot, 2007; Van Bree et al., 2010). The socio-technical regime is the meso-level unit of analysis and represents a relatively stable configuration of institutions, techniques, artefacts, rules, practices and networks that determine the normal development and use of technologies (Rip and Kemp, 1998). The socio-technical landscape is the macro-level unit of analysis and represents the context for interactions of actors. It is composed of the set of material infrastructure, political culture, social values, paradigms, natural environment, etc. that go beyond the direct influence of regime actors (Geels, 2002). Finally, the niche-innovations is the micro-level unit of analysis and represent protected spaces for the de-



Exogenous shocks (e.g. economic crises) at landscape level put pressures on existing niche-innovations by influencing willingness, power, and knowledge within the niche and creating thus windows of opportunities for novelties in the regime

Source: own elaboration.

Fig. 1. Biofuel niche sector struggling against dimensions of the existing regime in the context of influences from the current economic crisis

velopment and use of promising technologies by means of experimentation (Berkhout et al., 2004). A socio-technical transition is the outcome of the co-evolutionary dynamics of these three levels and occurs when a niche-technology adequately developed receives enough pressure from the landscape level (Fig. 1).

From this perspective, the ultimate success of a new technology crucially depends on the niche readiness and on a set of other external-to-the-niche conditions that develop at the landscape level. Specifically, we focus on three key niche mechanisms: (i) expectations, (ii) learning process and (iii) network formation (see Lopolito et al. 2011; Kemp et al. 1998). For a transition to occur an innovation niche has to be sufficiently developed, which will take place only if the three mentioned mechanisms have reached a sufficient degree of maturity.

In this context, the present article investigates whether the ongoing economic crisis is concretely providing opportunities towards a more sustainable regime by adding a threefold contribution to the existing literature. First, it tests the impact of the economic crisis on socio-technical transition by focusing on a green niche that we believe is sufficiently developed, namely the biofuel industry. Second, it employs original data collected from producers, providers, distributors, institutions, and associations that operate in the Italian biofuel industry. Third, it adopts an innovative social network analysis strategy based on a comparison between the current status quo of the Italian biofuel sector and that before the crisis.

The article is structured as follows: section 2 describes materials and methods; section 3 reports the results achieved from the case study; section 4 ends with some concluding remarks.

2. Data and methodology

In order to analyze the impact that the current economic crisis is exerting on the Italian biofuels niche, we employ social network theory, which consists of a “finite set or sets of actors and the relation or relations defined on them” (Wasserman and Faust, 1994: 20). The social network analysis (SNA) method provides an explicit methodical way of measuring social structural properties by modeling the relationships among a set of actors to describe the structure of the group (Mitchell, 1969). The effect of the ongoing economic crisis is then assessed within the framework of the strategic niche management, looking at the architectural characteristics of the network before and after the pressure at the landscape level (i.e. the economic crisis) has been exerted. Specifically, we

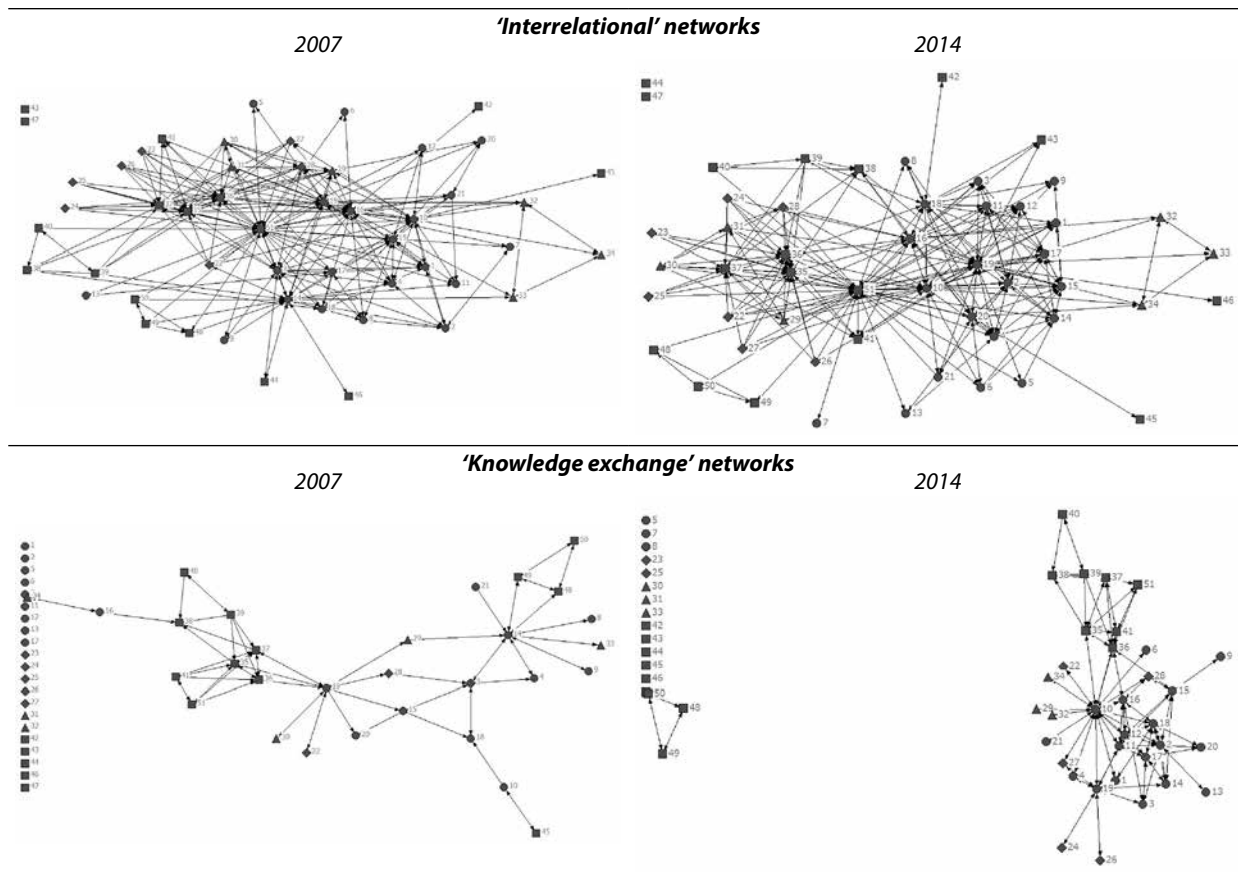
investigate the extent to which the three aforementioned key niche mechanisms, i.e. (i) expectations, (ii) learning process and (iii) network formation, have been affected by the economic crisis.

To identify all the potential kinds of relations among actors involved in the Italian biofuels niche, we adopted a snowball sampling methodology. Looking at the Italian Biofuels Association's members, we obtained the full list of biofuel producers. Any producer was then surveyed by means of an ad hoc questionnaire administered following the CAWI (Computer-Assisted Web Interview) technique. The snowball methodology allowed producers to reveal further actors that were not originally comprised in the network, enabling us to increase the network size slightly. In this way, starting from 49 originally listed actors (i.e. 21 biofuel producers, 6 suppliers, 7 distributors, and 15 institutions such as national authorities, universities, NGOs, etc.) we were able to include 2 more institutions. Following Morone et al. (2014), we defined the following two types of networks: (1) ‘interrelational’ network and (2) ‘knowledge exchange’ network. The first solely describes potential or generic forms of interactions by dealing with any kind of mutual interface among actors, and is not specifically restrained to biofuel-related interactions. The second is more relevant when it comes to assessing the impact of the network architecture in boosting expectations' convergence and learning processes, which are necessary for a niche to develop and succeed. More specifically, respondents were asked to specify how the above network relations have changed since prior to and during the crisis (i.e. in 2007 and 2014).

3. Results achieved

All gathered network data have been organized in the form of full structural network adjacency matrices and processed with the UCINET 6 software package. We carried out our analysis at two levels: First, we analyzed the two networks mentioned above by looking at their evolutions when moving from the ‘interrelational network’ to the ‘knowledge exchange network’. Subsequently, we focused on the ‘knowledge exchange’ network, by exploring three network attributes; types of actors, expectations, and knowledge. Fig. 2 reports the sociograms of both the networks analyzed for 2007 and 2014 (i.e. before and during the crisis).

The significant decrease in network density, both in 2007 and in 2014, as we move from the ‘interrelational’ to the ‘knowledge exchange’ network, seems to suggest that only a small portion of all possible connections is actually employed to exchange knowledge directly related to biofuel



Legend: Circles = Producers; Diamonds = Distributors; Up triangles = Providers; Squares = Institutions.

Source: own elaboration

Fig. 2. Sociograms before (2007) and during (2014) the crisis

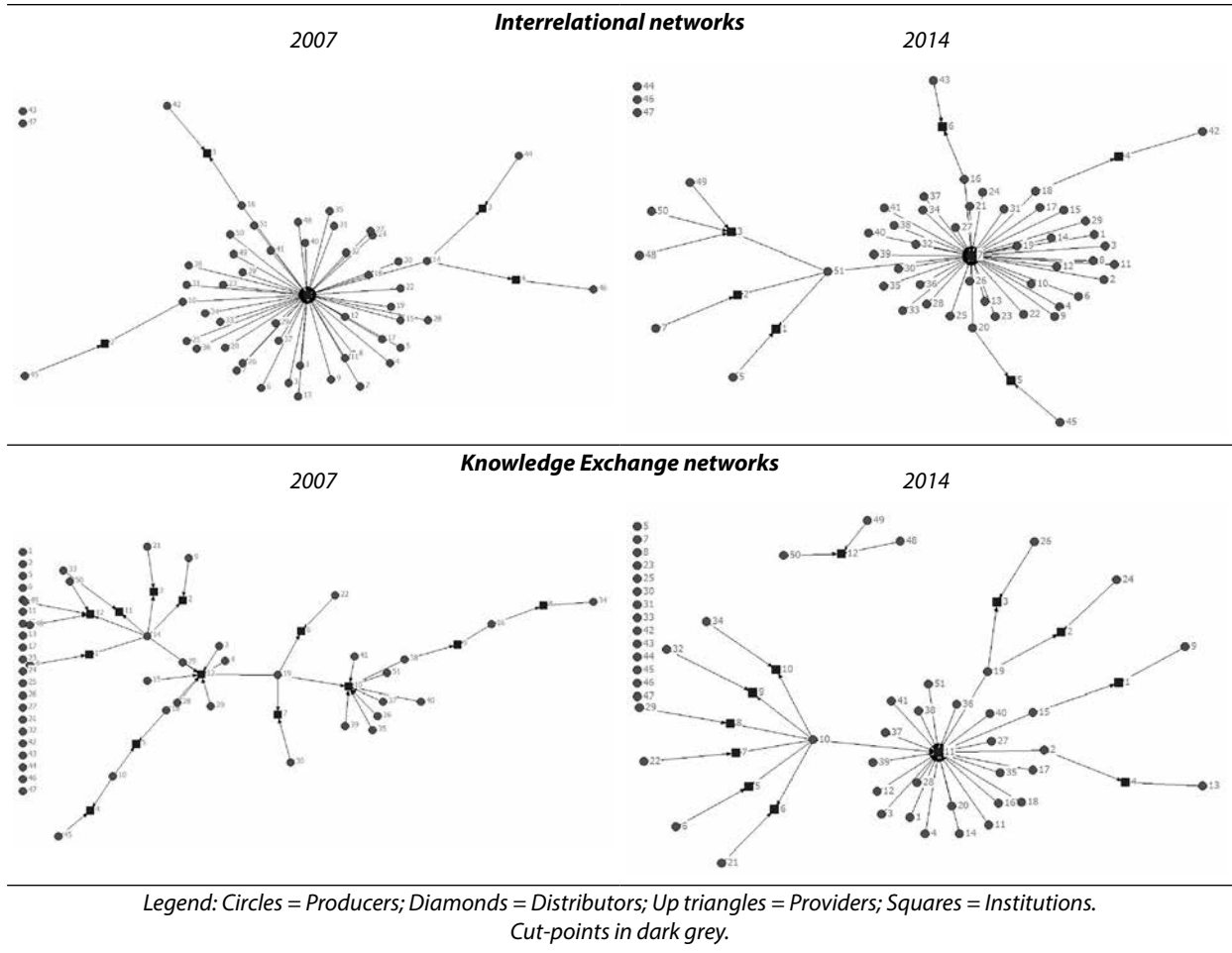
production, implying that there is an unexploited potential for a larger number of interactions. Moreover, the architectural features of the system change when considering the 'knowledge exchange' network where, in 2014, the overall structure became more connected and clustered. This finding could suggest that actors involved in the biofuel sector are reacting to the economic crisis by increasing their clustering level, thus making the knowledge exchange easier than 2007. We also performed a cut point analysis in order to investigate the existence of bottlenecks through which the attributes must flow to reach a specific portion of the social network (Scott, 1991) (Fig 3).

Findings exhibit the presence of a number of cut points (both in 2007 and 2014), two of which (one for each network) are particularly crucial since they are central and, consequently, knowledge exchange among actors are significantly dependent upon them. Moreover, by looking at 'knowledge exchange' networks we can identify 'Assocostieri' (biofuel trade association) as the only actor that has gained a central role in 2014 in the flow of knowledge about biofuels. This seems to suggest that the current economic crisis is causing actors to concentrate on their trade associa-

tion, whose role in channeling knowledge within the network is becoming significant for the future development of the biofuel niche.

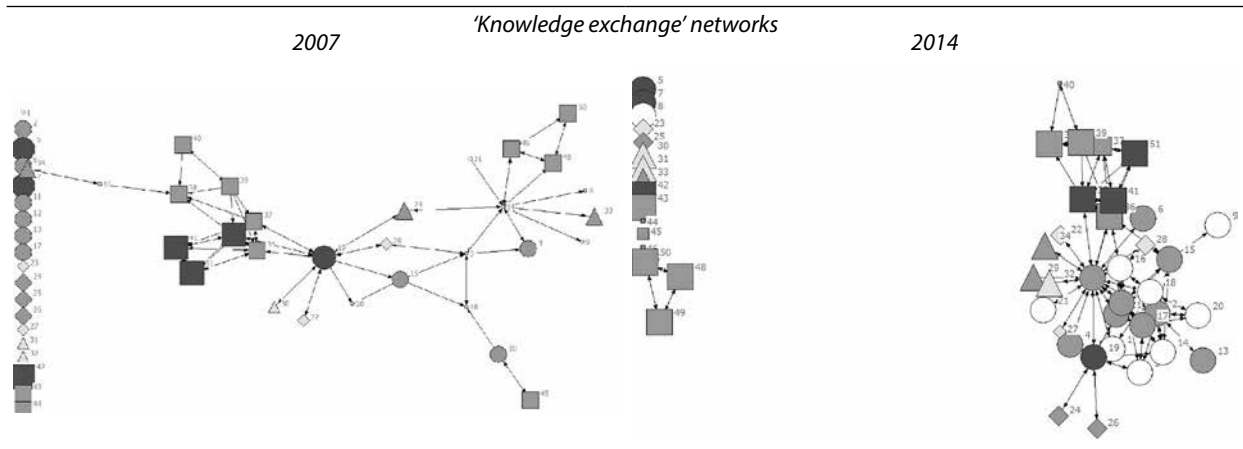
Given the importance of knowledge in boosting learning processes, we report in Fig. 4 the comparative analysis (before and during the crisis) of the "knowledge exchange" networks related to both expectations and knowledge attributes.

At first glance, when making observations from 2007 to 2014, we notice a general increase in the level of knowledge about biofuel, but we can also observe a decrease in the average level of expectations, despite the increase of a number of 'white' actors (i.e. with very low expectations), occupying a very central position in the network. Moreover, in 2014, the network now exhibits a number of highly knowledgeable actors that are disconnected from the main component. These findings could suggest that the economic crisis is seriously hindering the full development of the biofuel niche, jeopardizing its possibility to fully replace the dominant sociotechnical regime, given, on the one hand, the presence of knowledgeable central actors with low expectations, and, on the other, some 'misplaced' unexploited resources that could potentially contrib-



Legend: Circles = Producers; Diamonds = Distributors; Up triangles = Providers; Squares = Institutions. Cut-points in dark grey.

Source: own elaboration
Fig. 3. Cut-points analysis (Interrelational and knowledge exchange networks — 2007 and 2014)



Legend: Shape represents actors (Circles = Producers; Diamonds = Distributors; Up triangles = Providers; Squares = Institutions); Colour represents Expectations (Dark grey = High level; Mid grey = Medium level; Light grey = Low level; White = Very low level); Size represents Knowledge (the greater size, the more knowledge)

Source: own elaboration
Fig. 4. 'Knowledge Exchange' networks with knowledge and expectations attributes

ute to the niche development, but who are, for some reason, impeded in their actions by the architectural characteristics of the social network.

4. Conclusions

The present article provides evidence about the impact of the ongoing economic crisis on sustainable transitions by analysing the case of the Italian

biofuel niche. By means of an ad hoc designed questionnaire, we collected data from producers, providers, distributors, institutions, and associations operating in the Italian biofuel sector. Data were employed to compare the current status quo of the Italian biofuel sector and that before the crisis through an innovative social network analysis. In particular, we investigated the biofuel niche development based on three interlinked key mechanisms: (i) learning, (ii) expectations, and (iii) networking. Specifically, learning and expectations rely on networking since the emergence of a sufficiently interconnected network seems to be a necessary condition for an effective learning process and an upward convergence of expectations. With this insight, the SNA carried out provides us with the following findings:

1. The architectural structure of the network in question offers great opportunities for the technological niche development.

2. Actors are overall knowledgeable and can contribute to the learning mechanism also given the increased level of clustering the index during the crisis

3. The weakest feature of the system relates to expectations (2014), which are generally low for those agents (sceptical actors) occupying central positions in the network.

4. Critical problems arise from the cut-point analysis.

5. Despite the lower level of expectations (2014), actors that still rely on the future development of the biofuel sector are those which are experiencing not exclusively negative impacts from the economic crisis.

These findings would suggest that the architectural structure of the network offers great opportunities for further technological niche development, some of which are not yet fully exploited. Actors are knowledgeable and can contribute to the learning mechanism given the increased level of clustering during the crisis. This could imply that actors involved in the Italian biofuel sector have reacted to the economic crisis by increasing their relations, thus making the mutual exchange of knowledge easier than in 2007. The weakest feature of the system is the low level of expectations brought on by the on-going crisis. More critically, expectations are low for those agents occupying central positions in the network, which could seriously jeopardize the niche development process. Therefore, the ongoing economic crisis seems to have severely affected the sociotechnical transition towards a more sustainable regime: a sustainability transition can happen only if technological niches are sufficiently developed in terms of learning, expectation, and networking, and, from this point of view, the Italian biofuel network seems to be still very fragile given the low level of actors' expectations. In this framework, a possible way to replace the current unsustainable fossil-based regime could be raising actors' expectations in the biofuel niche. To this end, policymakers can play a key role in supporting the niche development by means of tax relief and/or subsidies which could be able to trigger private investments in new plants and lead to new jobs, increasing thus the possibility for such a transition to occur.

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