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Regional Systems of Innovations as Social Fields

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ABSTRACT The world today is subject to ambiguous, complex and mutually reinforcing global trends. The same could be said for the adaptations of social settings to these global trends. As a consequence, societies attempt to develop various increasingly sophisticated and complex systems of innovations, with all its material, social and cognitive consequences. In this article we consider systems of innovations as special type of social fields influenced by three social forces: institutions, networks and cognitive frames. Through the fuzzy-set analysis, we are examining whether these are necessary and sufficient conditions of successful adaptation to global trends via increasing innovative performance. We need a combination of at least two, but best if three, social forces to structure the social field in order to exhibit positive adaptation to global trends. This implies that the ability of social settings to meet challenges posed by global trends can indeed be a subject of rational action.

Key words: social fields, social forces, regional innovation systems, fuzzy-set analysis

1. Introduction: Innovations as Adjustment Tool

The world is in flux. It is subject to ambiguous, complex and mutually reinforcing global trends. This situation is often described as 'out of control' and leads to eschatological visions. However, this is not a new situation of the world. Sociology as a science was intended to become an academic response to the demand for analysis of immense social changes stemming from the industrial revolution. It was provoked by innovations which permeated all areas of social life and fundamentally transformed societies in the second half of the 19th century. The changes shaped the early sociological imaginaries and provoked Alvion Small to announce the 'era of sociology' (Small, 1895.).

However, this does not imply that we are dealing today with old wine in new bottles. The extent and speed of globalization introduced a new dimension to the dynamics of contemporary societal changes by blurring the boundaries between local and global. Global conditions influence localities all over the world (Pikalo and Trdina, 2009.:45). On the other hand, even relatively minor local innovations become "more and more part and parcel of global ones" (Genov, 1997.:410). The recent economic crisis confirmed the view that the best way to deal with the challenges posed by the global trends is by enhancing innovative performance in all areas of social life.

Global trends are multifold. So are the adaptations of social settings to global trends. In the following we shall focus on the trend of *spreading of instrumental activism* marked by the never ending attempts to efficiently coordinate goals and means of action in market competition (Genov, 1997.:412 f.). It always requires the animating culture of entrepreneurship and innovation. Ironically, attempts to reduce complexity only contribute to 'hyper-complexity' (Luhmann, 1995.:471), making the task even harder. As a consequence, societies attempt to develop various increasingly sophisticated and complex systems of innovations, with all its material, social and cognitive consequences.

The question is what can a nation, region, locality or organization do to adjust successfully to global challenges by managing technological innovations? There are indeed no clear-cut prescriptions for adjustment processes (Golob, 2009.). Successful adaptation is multidimensional since different structural levels have to achieve synchronization in the 'social becoming' (Sztompka, 1991.). *First*, at macro-level, societies have to develop adaptive mechanisms for steering the increasing complexity. This context renders obsolete old debates on the most appropriate modes of coordination of markets, states and networks and encourages the search for new concepts which explain countries' ability to carefully combine traditional modes of governance in direction of context-specific forms of 'meta-governance' (Jessop, 2002.; 2007.). *Secondly*, at meso-level the adjustment provokes questions about the ability of a social setting to continuously (re)produce technological and social innovations. Hence, this is fundamentally the issue of managing systems of innovation as social fields. They can be studied as 'arenas of social interaction for the exchange of goods and services' (Beckert, 2010.:609). *Third*, at micro-level individuals and groups have to find the way to actively adjust to the 'invisible set of forces' (Fourcade, 2007.:1022) influencing the emergence of local orders of technological innovation.

2. Societal Changes in the Conditions of Complexity and Technological Innovations

The crucial discussions referring to the macro-level are focused on the question whether societal development could be subject to planned activity. This simple question might seem to be by and large rendered obsolete by changes in social

research and social management. But the issue of macro-social steering remains as relevant as ever. It touches upon the very core of research on the ability of present day societies to adapt to global trends by managing technological innovations.

From the perspective of the research on this topic, two interrelated recent intellectual developments are especially relevant. The first one concerns the rise of complexity in social life. When trying to contextualize the changes in the social environment, most authors are more and more often focusing on the mutual influence of *globalizing processes* and *technological development* (Castells, 1996.; Urry, 2003.) in increasing social complexity. The process has already reach the point "when, because of imminent constraints in the element's connective capacity, it is no longer possible at any moment to connect every element with every other element" (Luhmann, 1995.:24). Etzioni describes the same situation as 'the rise of social options' (Etzioni, 1968.:5). Taylor insists that "the condition of complexity is irreducible and is as it is inescapable" (Taylor, 2001.:3). This gave rise to a very structured and technical analysis of completely social processes (see Arsham, 2005.; Damij and Damij, 2005.; Damij et al., 2008.).

The second development concerns the shift from primacy of the state towards multi-level responsibility for social and economic policies. This change was especially visible in the societies in transition which implemented major public administration reforms (Vukovič et al., 2008.), but was also widely present in all developed societies. The process has been described as "post-national relativization of scale" and as a shift from state interventionism towards various forms of self-organizing governance mechanisms in "networked economy" (Jessop, 2002.:248). The shift rendered obsolete hierarchies vs. market debates, which pervaded traditional discussions. Highly developed and complex societies have to focus on the systemic competitiveness (Esser et al., 1996.) as well as on the generation of resources and mobilization of competencies (Karnøe et al., 1996.).

The networks of governance seem to be best for resolving this task since they imply self-organization and mutual coordination among autonomous actors. Some authors see networks as a new paradigm for understanding the "architecture of complexity" (Kenis and Schneider, 1991.:25). However, superiority of networks cannot be taken for granted, as networks are also prone to failure (Jessop, 2002.:236). According to Castells, networks can have "considerable difficulties in coordinating functions, in focusing resources on specific goals, in managing the complexity of a given task beyond a certain size of network" (Castells, 1996: 15). Nevertheless, he claims that the development of information and communication technology can render these weaknesses of networks obsolete, but it is unlikely that networks would completely replace traditional modes of governance. Consequently, networks could be considered as a third mode of governance (Jessop 2002.:237). We have to look for theoretical and practical solutions in the emergence of a fourth, 'umbrella' type of meta-governance, which involves "rearticulating and collibrating different modes of governance" (ibid: 241). In some cases meta-governance can solve problems which cannot be solved by other modes of governance, especially focusing on jointly defined goals and ensuring effective implementation.

Some social settings are able to handle problems of adaptation to global trends and others fail (Genov, 2007.). Some adjust quickly to the demand for new complex forms of governance, others fail. The difference lies in the ability to actively grasp the situation. The active society is not *adapted*, but *adaptable* (Parsons, 1966.; Boulding, 1978.). Active orientation implies for individual or collective actor to stand above and beyond the ongoing processes. "To be active is to be in charge. To be passive is to be under control, be it of natural processes, of social waves and streams, or – of active others" (Etzioni, 1968.:4). The active orientation has three major components which help to solve governance failures. *First*, individual or collective actors have to be self-conscious and knowing. *Second*, actors are committed to realize one or more clearly defined goals. *Third*, they need to have access to levers (or power) which may allow the resetting of the social arrangements (Etzioni, 1968.:xx).

Resetting the social arrangements is the key issue for several reasons. Alternative institutional arrangements are very often the background of the difference between economic growth, stagnation and recession (North, 1990.; Nee, 1998.). This implies that a social setting that is not conducive to technological innovations has to reset relevant institutional arrangements. Social actors are usually acting in the context of incomplete information and mental models, which contributes to transaction costs (Nee, 1998.:1). As transaction costs are important part of costs of production and exchange in contemporary economies, they hinder the change in institutional arrangements. Finally, actors usually make 'choices within constraints' (see, for example, Adam et al., 2009.; Šušteršič, 2009.). A number of formal and informal constraints are shaping the selection of options (Nee, 1998.:8). This hinders the ability to react positively to global trends, implying path-dependency of strategic choices. The social forces structuring the social fields (institutions, networks or cognitive frames) have to change in order to create a new path. The sequence of events influences new events in a way that developmental trajectories limit the set of options for future trajectories (Kay, 2003.:2).

Nevertheless, 'choice within constraints' also implies 'path-shaping'. Changes take place even in well-established arrangements with high levels of legitimacy. Policy-makers and other stakeholders have to take complex constellations of interests into account (Torfing, 2001.). Hence, policy path can be defined as a relatively stable way to structure a certain social field. Policy path is a discursive terrain in which relevant social forces are mutually structuring themselves (Torfing, 2001.:286-287).

3. Systems of Technological Innovation are Social Systems

The meso-level of technological innovations is where social settings exhibit their ability – or lack thereof – to adjust to global trends by continuously (re)producing technological and social innovations. Basic factors of production and investment are no longer the key factors of competitiveness of the most developed localities. Instead, it is the innovativeness and sophistication of products and services (Porter, 1990.; 2001.). This implies that we are dealing with context-specific processes in

which the key role is played by unique and locally embedded knowledge. Differences between the most competitive localities are getting smaller and smaller but at the same time these small differences have a growing importance. This has since long been acknowledged for the high-tech sector (Garnsey, 1998.). The role of localized learning is perhaps even more important for medium- and low-tech sectors, where continuous improvements are the only key to success and survival, especially in areas with very high costs which do not allow for strategies of cost competitiveness (Lorenzen, 1998.). The typical examples are Scandinavian countries. They proved that low-tech activities can prosper also in such areas (Maskell et al., 1998.).

To understand this phenomenon, we have to broaden our understanding of innovation. The dominant classical definition of innovation is that of Schumpeter (1934.). He understands innovation as new combinations of production factors: production of new goods, introduction of new processes, opening of new markets, access to new sources of raw materials and intermediates, re-organization of an industry, etc. Schumpeter's conceptualization is focused on technical innovations but implies the broader notion of innovation process. Ironically, in order to achieve technological innovations, non-technological processes seem even more important than the technological ones (Lundvall, 1992.; Edquist, 2000.).

Even when dealing with technological innovations, we have to distinguish between different types of them. Not only radically new innovations in global context are important (de Propris, 2001.). Different types of innovations imply differences in the structuration of relationship between relevant actors. In the medium- and low-tech sectors non-radical types of innovation seem to be much more important, especially when the structure of the business sector is not very supportive to research and technological development activities. This might be due to the small size of the company and its rather limited resources. Nevertheless, such companies can show very high levels of innovativeness in products, production processes and organization. In such case, the dominant type of innovation is the local incremental adaptation which is the result of continuous processes of cognitive and social learning.

This implies a new conceptualization of innovative processes which is taking interactions between actors into account (Lundvall, 2002.:3). Development and dissemination of knowledge is a social process implying inter-organizational learning and communication. Innovation is therefore process rather than structure (De la Mothe and Paquet, 1998.). Knowledge is stored in the cognitive space between actors of innovative process and organizations which differ in their ability to detect and absorb the knowledge (see e.g. Likar et al., 2006.). In order to understand innovative processes we have to identify broader social processes and understand how they are influenced by relationship between actors in the innovation.

Therefore, the system of technological innovations is primarily a social system. Learning and knowledge are central to innovation processes and involve interactions between different actors in markets as fields where knowledgeable actors

meet (Meeus et al., 1999.; Beckert, 2010.). We can interpret systems of innovation as social fields influenced by three social forces: institutions, networks and cognitive frames. Key processes in this social field are the (re)production, transfer and diffusion of knowledge and technology. The social field can be defined as infrastructure of knowledge-based enterprises, universities, research and development institutions, supply of highly qualified labour and infrastructure of business support institutions. Another dimension of the process is the network of intermediary institutions (liaison offices, technology transfer offices etc.) or their functional substitutes (e.g. think-tanks) which foster formal and informal interactions and dissemination of cognitive frames (Welter et al., 2009.).

The formation and functioning of systems of innovation is context-specific. Empirical evidence from international reports on competitiveness demonstrates that the formation of developmental coalitions differs among nations, regions and localities within the same countries. Italy is a typical example of such differences. Some regions in the north of the country belong to the archetype of vibrant and propulsive entrepreneurial regions with abundance of successful business clusters. Regions in the south are typical examples of 'amoral familism' (Banfield, 1958.), weak social capital and inability to engage in heterarchical network-type of inter-organizational linkages (Putnam 1993.). Note that the relevance of social capital is especially important (Adam, 2011.).

Hence, the options for formulating generally valid theories and relevant policy measures are limited. The solution is to develop context-specific analysis of social fields. This analysis in itself is rather complex as we are dealing with "networked polity", where the unit of planning and leadership is not a single organization, but a "multi-organizational project team" (Ansell, 2000.:309). This implies that we cannot focus only on a single organization or sector. Instead, we have to take into account all relevant stakeholders, as well as the infrastructure for (re)production of knowledge, intermediary organizations and relevant NGOs. Actors are vertically and horizontally disaggregated, but are engaged in continuous process of coordination. There is a continuous interaction and mutual influence between forces structuring the social field. Systems of innovations are a special type of social fields where numerous formal and informal interactions between members of the system are taking place. Innovative processes are social processes and the social field can be structured to enable or prevent positive responses to global challenges. The systems of innovation are social infrastructures. Societies can employ them to adapt to global trends by (re)producing technological innovations.

4. Towards Social Fields Definition of Systems of Innovation

The success or failure of a specific social setting to adjust to global trends essentially depends on its ability to arrange social forces operating at micro level. Institutions, social networks and cognitive frames have in the past been repeatedly confirmed as relevant in determining the rich variety of outcomes (Fligstein and

Dauter, 2007.:106-107; Beckert, 2010.:605) concerning competitiveness of economies (Hall and Soskice, 2001.), formation of prices (Uzzi and Lancaster, 2004.), levels of inward foreign direct investments (Bandelj, 2008.), access to labour market (Granovetter 1995.), etc. These three forces are forming the relational topography of a social field of technological innovation by making it more or less conducive to successful adaptation to global trends. Social fields of innovations are continuously "being structured by social forces that increase stability in social interaction" (Beckert, 2010.:609). The social fields of technological innovation are not determined by geography, but are culturally, socially and politically established (Scott, 1994.:206). This is not only a theoretical assumption, but serves also as an analytical tool for the analysis of regional systems of innovation.

How do social forces shape specific social fields of innovation? *First*, institutions exert their influence by limiting the scope of actions, encouraging some and discouraging others. For example, governmental intervention for establishing new firms and generating spin-offs, support services for innovations, networks of technology parks and technology transfer entities, or top-quality universities is generally supportive to adapting to global trends by generating high innovation performance. *Secondly*, social networks position individuals and collectives in the social space thus limiting ties with specific nodes and encouraging others. In functioning systems of innovation we can identify high levels of university-industry cooperation, inter- and intra-regional cooperation of producers with customers, and mutual trust. Social networks are 'lubricating' project-based organizations thus resulting in higher innovative performances. *Third*, cognitive frames provide the necessary mental tool-kit which allows interpreting relevant strategies such as introduction and nurturing of firm-based innovation systems, absorption of new knowledge and expenditure for research and technological development. These interpretations are highly relevant because in complex environments we cannot foresee all possible combinations and formalize them as rules. These scripts contribute to the desired structuring of social fields by suggesting social action in spite of uncertainty of outcome (Beckert, 2010.:610).

We can empirically verify the point that institutions, social networks and cognitive frames structure technological innovations understood as social fields in a way supporting or discouraging their adaptation to global trends. For the purpose of this analysis we will apply comparative fuzzy-set analysis of regional systems of innovation. We shall try to determine whether the social forces under scrutiny are necessary and sufficient conditions for successful innovative performance of selected regions. Fuzzy-set analysis is a very recently introduced and rapidly developing method of comparative social research (Ragin, 2000.; 2008.) enabling particularly strong dialogue between theory and empirical evidence and is, importantly, an appropriate analytical technique for comparing factors of developmental performance (Adam et al., 2005.).

The first step in fuzzy set analysis is determining relevant domains. For the purpose of this paper, we will conduct comparative analyses of several regional sys-

tems of innovation. Note that the concept of region is a blurred one. It might refer to a territory in a state. We can also interpret it in the sense of functional regions (Andresson and Karlsson, 2004.). Cultural or geo-regional aspects can be also pointed out. Hence, the issue of the empirical representation of regional systems of innovation is one of the most discussed (Doloroux and Parto, 2004.). We conceptualize the region as a framework in which technological innovations occur. Thus we see regions as meeting points where initiatives and stimuli come both from above (from the national government or global trends) as well as from below (actors in the local setting) (Heidenreich, 2004.).

We will draw data from seven regions. The first two (Silicon Valley and Stockholm) are clear success stories. They seem to demonstrate the ability to adapt to global trends, thus we could describe them as both active (Etzioni, 1968.) and thus also of being adaptable (Parsons, 1968.; Boulding, 1978.). The cases of Valencia and Shenzhen represent what Rodriguez-Pose and Crescenzi (2008.) described as 'mountains in a flat world'. They distinguish themselves from their surroundings and the national system of innovations. The case of Agder is in a way similar to the above cases but it is particularly interesting because of the small size of the region (Tödtling and Trippl, 2005.). At the end we have the relatively unsuccessful stories of Slovenia and Lodz.

The so-called 'regional advantage of Silicon Valley' is a highly intriguing case since it exemplifies the major difference between EU and USA due to the higher mobility of capital, population and knowledge in the USA (Crezcenci et al., 2007.). There were two locations in the USA where specific attention was paid to innovations in the regional development. These locations were Route 128 and Silicon Valley. While first was in decline already by 1980's, the second one is still running high in the world of innovations. How did this become possible? Some argue that the distinction of this region is not just the focus on scientific advances or technological breakthroughs. Instead, the cutting edge derives from the 'habitat', the liberal 'air' and the fast changing relationships of the actors inside the Silicon Valley itself (Rowen et al., 2000.).

The second case is of a new social field of innovation systems. It refers to the metropolitan region of Stockholm in one of Europe's most innovative countries (EIS 2009.). Sweden's business sector is the driving force behind the successful R&D. The idea of metropolitan innovation systems arises from the notion that metropolitan regions have high innovation potentials (Revilla Diez, 2002.). The data on five biggest Swedish cities account for 80% of all new processes and products in Sweden (Andersson and Karlsson, 2004.).

We may call our third case of Valencia 'the Spanish slow tiger'. Spain itself and its regional innovation policies have a surprisingly long tradition (Cooke, 2008.). The majority of Spanish regions are in the group of so-called medium low innovators. However, the region of Valencia has improved significantly its standing since 2004. and sprung to the group of average innovators (Regional Innovation Scoreboard,

2009.), although its economy is based on traditional sectors and high-tech companies are rare. Nevertheless, Valencia's RIS is still being described as weak. Some authors are skeptical if one may even speak of a regional system of innovation in Valencia (Fernandez de Lucio et al., 2008.; Zabala-Iturriagagoitia et al., 2008.).

The fourth example brings us to a regional system of innovation embedded in the Chinese innovation *millieux*. We could ask ourselves here whether there are Argonauts at work in China's Shenzhen (Saxenian, 2006.). The question is well in place given the fact that Shenzhen was designed on the model of Silicon Valey. The general debates in China turned towards stronger emphasis on innovation, whereby one of the focuses is on reshaping the interaction between producers and users of knowledge. The goal of the reforms was to push the R&D institutes to produce outputs directly useful for the market (Gu and Lundvall, 2006.). The weaknesses of the system are its weak absorptive capacity and the underdeveloped social capital. The so-called industrial cities like Shenzhen stand in the forefront of the new development (Sigurdson, 2004.; Zhang et al., 2010.).

The small scale example concerns Agder with around 200,000 inhabitants and consisting of West and East Agder. It is described as a "dual society" and its innovation system as "fairly week" by Asheim (2009.:76, 262). However, the Regional Innovation Scoreboard (2009.) shows that together with Rogaland the region is one of the medium high innovators in a country which in overall belongs to the moderate innovators category (EIS 2009.). The region is relatively wealthy with entrepreneurial traditions and with a combination of high technology industries, traditional industries and emerging branches (Teräs 2009.). It has a competitive large industry (Asheim, 2009.:272). Even small regions like Agder may suffer from all of the innovation barriers presented by Tödtling et Trippl (2005.) since the Agder region is in risk of lock-in and faces the problem of fragmentation (Teräs, 2009.:233).

The next case concerns 'the fallen region' of Lodz. Contrary to Valencia it descended on the RIS ranking (2009.). The region of Lodz is embedded in the Polish innovation system that has not shown significant results due to highly centralized policies, relatively low R&D expenditure, poor cooperation of R&D units with industry, weak intermediary institutions, low awareness of the role of innovations and entrepreneurship in economic development, low focus on the implementation of new solutions, lack of proper coordination of actions by government agencies and low percentage of high-tech products in export (Stawasz et al., 2007.). In other words, the region is lagging behind in the majority of key knowledge society indicators (Walendowski, 2006.:3). The development of regional innovation strategies in Poland has only started recently (Rogut and Piasecki, 2006.).The LORIS Innovation Strategy directly refers to the Lodz Region. However, the regional innovation system shows pretty much the same weaknesses as the national innovation system (Stawasz et al., 2007.).

The last case is Slovenia, where we will take a broader approach because of the small size of the country and the lack of meso-level of administration. Slovenia

belongs to the group of innovation followers (EIS 2009.). There is a separation of firms from innovative activities and self-sufficiency of academia in the country (Adam and Makarovič, 2002.a; Adam and Makarovič, 2002.b). The transitional process was neither focused on enhancing the relations between economy and academy nor on enhancing the importance of innovations as a whole. The shift towards flexibility and innovation as adaptation to global trends has been implemented on a theoretical level. There has been a lot more emphasis on macro-economic factors and less has been done in the areas of political and organizational culture, social capital development (Kos, 2009.:23) and law enforcement. Thus, the fact that Slovenia is involved in major innovation and globalization trends notwithstanding, its success remains less than optimal.

The second step in our analysis is determining relevant fuzzy-sets, i.e. variables to be analysed. This selection is to be theoretically informed. The foundation for our selection is in the theory of social fields outlined above. Hence, in our fuzzy-set analysis we focus on the role of the three social forces influencing the outcome, system of innovation's innovative performance.

The next step is to construct fuzzy-set database on the basis of available empirical evidence. We constructed a fuzzy-set database on the basis of a two-stage procedure. First, we identified five variables to measure each social force and three variables to measure the outcome, system's innovative performance. Variables INS 1-5 are proxies measuring performance of relevant institutions, NET 1-5 are proxies for the structuring force of social networks, CFR 1-5 are the proxies measuring relevant cognitive frames and OUTCOME 1-3 are measuring innovative performance. Second column of table 1 shows which aspects of regional system of innovation are included in our analysis. When assigning fuzzy-set membership we decided to use three anchors. This is necessary because in our case data cannot be easily calibrated. Namely, fuzzy-set membership is estimated on the basis of analysis of secondary data gathered from variety of sources. Firstly we employed data sources (of quantitative nature) from the Regional Innovation Scoreboard, OECD Regional Database, World Values Survey, EPO/WIPO databases and Academic Ranking of World Universities database. We also included data from various reports on the (regional) innovation systems of the selected regions, since the case studies approach is very common in the innovation studies, which are however generally providing descriptive values (qualitative data), though some numerical values were also found and used (for e.g. Kroll, 2010. or Schaaper, 2009.).

The scores in Table 1 were designated by the authors of this paper, whereby both the quantitative and qualitative data has been translated into a common basis by forming our anchor values of 0, 0.5 and 1, thereby preparing it for the fuzzy-set analysis. In Table 1 features whose values were derived from numerical data only are marked with (*). For the rest qualitative data has been used as the basis for determining the anchor values. You can see the anchors, their verbal labels and sources of data in the Appendix 1.

Table 1.
Regional systems of innovation in seven regions

Type	Features of regions	Valencia (Spain)	Silicon Valley (USA)	Stockholm (Sweden)	Shenzhen (China)	Agder (Norway)	Lodz (Poland)	Slovenia
INS 1	Supportive government regulation for new firms or/and IPR/ spin-offs	0,5	1	1	1	1	0,5	0,5
INS 2	Support services	0,5	1	1	1	1	0.5	0,5
INS 3	Density of technology parks and technology transfer entities	0,5	1	1	1	0,5	0,5	0,5
INS 4	Regional entity (-ies) for innovation support	1	1	1	1	1	0.5	0.5
INS 5	Top universities*	0,5	1	1	0	0	0	0,5
NET 1	Trust/social capital*	0,5	1	1	0,5	1	0,5	0,5
NET 2	Universities-industry cooperation	0,5	1	1	1	0.5	0	0,5
NET 3	Intraregional collaboration of firms	0,5	1	1	0,5	0,5	0	0,5
NET 4	Interregional collaboration of firms	0	1	1	1	0,5	0	0
NET 5	Cooperation with customers	0	1	1	0	1	0	0
CFR 1	Firm based innovation system	0.5	1	1	0,5	1	0	0
CFR 2	Presence of science based industry	0,5	1	1	0,5	0,5	0	0,5
CFR 3	Skilled work force*	0,5	1	1	0,5	1	0	0,5
CFR 4	Knowledge absorption capacity	0,5	1	1	0,5	0,5	0,5	0,5
CFR 5	Business R&D expenditures*	0,5	1	1	0,5	0,5	0	0,5
OUTCOME 1	Number of patents*	0,5	1	1	0,5	0,5	0	0,5
OUTCOME 2	High-tech items in export*	0,5	1	1	1	1	0	0
OUTCOME 3	General innovation performance*	0,5	1	1	0,5	0,5	0	0,5

The second step was to calculate average value of fuzzy-set membership for each social force and for the outcome of system of innovation. These values are presented in table 2 as INS for relevant institutions, NET for social networks, CFR for cognitive frames and OUTCOME for system's innovative performance. This is the database which we use in our analysis.

Table 2.
Fuzzy-set database

Fuzzy-set	Valencia (Spain)	Silicon Valley (USA)	Stockholm (Sweden)	Shenzen (China)	Agder (Norway)	Lodz (Poland)	Slovenia
INS	0.6	1	1	0.8	0.7	0.4	0.5
NET	0.3	1	1	0.6	0.6	0.1	0.3
CFR	0.5	1	1	0.5	0.6	0.1	0.4
OUTCOME	0.5	1	1	0.67	0.67	0.0	0.33

We conducted analysis of the necessary conditions for each of the three social forces constituting social systems of innovation. The results shown in Table 3 indicate high level of consistency and of coverage for each of the social forces under scrutiny. This would imply that institutions, social networks and cognitive frames are necessary conditions of high levels of innovative performance. In all cases the relevant statistics showed in the table 3 testify high empirical relevance of consistent subsets.

Table 3.
Results of necessary conditions analysis

Analysis of Necessary Conditions		
Outcome variable: OUTCOME		
Conditions tested	Consistency	Coverage
INS	1.000000	0.834000
NET	0.911271	0.974359
CFR	0.942446	0.958537

We also conducted subset/superset analysis on our data. Table 4 shows the results. The consistency of all possible solutions is well above the usually requested threshold of 0.75. The combination of consistency and raw coverage is high in all three relevant cases. It is still satisfactory at comparative level if we take each of the three combinations of two social forces. However, it is well below the threshold for each of the individual social forces. This can be interpreted in a way that an individual social force does not have enough explanatory power to account for the outcome. The

policy of supporting the development of a single force could not yield the expected outcome of increase in innovative performance. We need a combination of at least two, but best if three, social forces to structure the social field in order to exhibit positive adaptation to global trends. This result is consistent with the outcomes of our previous study of factors of developmental performance. It clearly indicated that in order to achieve significant results the developmental policies have to be complex and supporting all necessary and sufficient factors (Adam et al., 2005.).

Table 4.
Results of subset/superset analysis

Outcome: OUTCOME			
Subset tested	Consistency	Raw coverage	Combined
INS*NET*CFR	0.973684	0.887290	0.957709
INS*NET	0.974359	0.911271	0.844106
INS*CFR	0.958537	0.942446	0.853624
NET*CFR	0.973684	0.887290	0.836636
INS	0.834000	1.000000	0.661911
NET	0.974359	0.911271	0.669968
CFR	0.958537	0.942446	0.677522

Finally, we conducted a study of necessary and sufficient conditions by 'truth tree' method, by applying Quine-McCluskey algorithm. We tested the following model:

Model: OUTCOME = f(INS, NET, CFR)

The results show that the complex and intermediate solutions are identical as shown in Table 5. The coverage and consistency of solution are very high. This verifies the point that institutions, networks and cognitive frames are necessary and sufficient conditions of successful adaptation to global trends via increasing innovative performance.

Table 5.
Results of truth tree analysis

Frequency cutoff: 1.000000			
Consistency cutoff: 0.973684			
Condition tested	Raw coverage	Unique coverage	Consistency
INS*NET*CFR	0.887290	0.887290	0.973684
Solution coverage	0.887290		
Solution consistency	0.973684		

5. Conclusions: What Lies Ahead?

We are dealing with a situation in which nobody can escape the challenges posed by the global environment. Everybody has the option to adapt to it and thrive, or fail. Social settings like nation states, regions, localities and even the smallest organizations have the possibility to influence their economic and social situation in the long run. Internal social, economic, and political institutions, networks and cognitive frames become vital factors in development (van Rossem, 1996.:524). The basic preconditions for this adaptation process are endogenous in their nature (Adam et al., 2005.). Thus, the best way to adapt to global trends is by enhancing innovative performance in all areas of social life. In this paper we were able to theoretically ground and empirically verify the influence of three social forces of institutions, networks and cognitive frames on social fields of technological innovations. This implies that the ability of social settings to meet challenges posed by global trends can indeed be a subject of rational action.

The sociological analysis of social systems of innovation is still underdeveloped. Economics, economic and regional geography and political science are in the forefront of this strand of research. However, analyzing systems of innovation as social fields constituted by social forces, sociology has much to offer in the analysis of institutions (Dobbin, 1994.; Fligstein, 1990.; DiMaggio and Powell, 1991.). The analysis of social networks might be helpful as well (Burt, 1992., 2001.; Granovetter, 1973.; White, 1981., 2002.). Finally, sociology of culture provides us with theoretically informed accounts of cognitive frames' role in influencing social action (Swidler, 1986.).

Future research on the topic will most probably expand in two interconnected directions. There is a need for continuous institutional and network analysis of specific social fields of technological innovations. However, the focus on the difference of particular cases is in itself "theoretically unsatisfactory, empirically unhelpful and not constructive for policy." (Lorentzen, 2009.). Therefore, the search for theoretical and policy solutions will have to be oriented towards conceptual syntheses based on historically informed comparative analyses as well as on the triangulation of qualitative and quantitative empirical evidence.

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Appendix 1.
Fuzzy-sets, anchor values and data sources

Fuzzy-sets	Features/Regions	Anchor values and verbal labels	Source
INS 1	Supportive government regulation for new firms or/and IPR/spin-offs	0: practically non existent 0,5: existent, but not entirely effective 1: existent and effective (with the result of high percentage of spin offs in region etc.)	various system of innovation reports
INS 2	Support services	0: practically inexistent support services 0,5: existent , but ineffective support services 1: existent and effective support services	various system of innovation reports
INS 3	Density of technology parks and technology transfer entities	0: no technology parks and/or other technology transfer entities 0,5: some existent technology parks and/or technology transfer entities, but their effect remains below optimum 1: technology parks and/or technology transfer entities are important actors in the IS	various system of innovation reports
INS 4	Regional entity (-ies) for innovation support	0: no such explicit entities 0,5: entities who also provide the service of innovation support 1: existence of entities for innovation support – one or a series of diverse entities	various system of innovation reports
INS 5	Top universities	0: no universities in the top 500 listing in the Academic Ranking of World Universities 0,5: at least one university in top 500 in the Academic Ranking of World Universities 1: at least one university among top 100 in the Academic Ranking of World Universities	Academic ranking of world universities report http://www.arwu.org/
NET 1	Trust/social capital	0: low social capital is a distinctive figure/low indicators for (Olsen group and Putnam group) participation + trust + density of networks +altruism) 0,5: low or medium high social capital/medium high indicators for (Olsen group and Putnam group) participation + trust + density of networks + altruism 1: high social capital and trust are distinctive figures/ high indicators for (Olsen group and Putnam group) participation + trust + density of networks +altruism	World Values Survey data
NET 2	Universities-industry cooperation	0: very low cooperation between universities and research institutes 0,5: emerging and to some extent efficient cooperation 1: efficient cooperation between universities and research institutes	various system of innovation reports
NET 3	Intraregional collaboration of firms	0: the collaboration of firms inside the region is poor 0,5: collaboration of firms inside regions is usual, however not very strong 1: strong intraregional cooperation of firms is a distinctive feature of the IS	various system of innovation reports and OECD Regional Database
NET 4	Interregional collaboration of firms	0: the collaboration of firms outside its own region (other regions in the same state or regions in other states) is poor 0,5: collaboration of firms outside its own region (other regions in the same state or regions in other states) is usual, however not very strong 1: strong interregional collaboration is a distinctive feature of the IS	various system of innovation reports and OECD Regional Database

NET 5	Cooperation with customers	0: low cooperation with customers/not a customer oriented IS 0,5: medium cooperation with customers/customer orientation is one of the features of the IS 1 customer oriented IS	various system of innovation reports
CFR 1	Firm based innovation system	0: firms are not at the centre of the IS 0,5: one of the general orientations of the IS is firm based IS 1: the existence of firm based innovation system	various system of innovation reports
CFR 2	Presence of science based industry	0: the majority of industry is non science based (distinctive prevalence of traditional industries) 0,5: some science based industry or science based industry on the rise 1: strong science based industry	various system of innovation reports, OECD Regional Database, Kroll, 2010
CFR 3	Skilled work force	0: low percentages of employment in medium-high and high tech manufacturing and in knowledge intensive industries 0,5: medium or medium high employment in medium-high and high tech manufacturing and in knowledge intensive industries 1: high percentages of employment in medium-high and high tech manufacturing and in knowledge intensive industries	Regional Innovation Scoreboard, OECD Regional Database, Kroll, 2010
CFR 4	Knowledge absorption capacity	0: low absorption capacity is one of the major lacks of the IS 0,5: the absorption capacity is low, but there have been some advancements in the area 1: high absorption capacity as a distinctive feature of the IS	various system of innovation reports
CFR 5	Business R&D expenditures	0: business R&D expenditure under score 100 on the OECD Regional Database or the equivalent according to Kroll 2010 0,5: business expenditures between 101 and 1000 on the OECD Regional Database or the equivalent according to Kroll 2010 1: business expenditures more then 1000 on the OECD Regional Database or the equivalent according to Kroll 2010	OECD Regional Database, Kroll, 2010
OUTCOME 1	Number of patents	0: low on rankings of EPO, WIPO and national patents 0,5: medium high and medium on rankings of EPO, WIPO and national patents 1: high on rankings of EPO, WIPO and national patents	European Patent Office data, World Intellectual Property Organization, various system of innovation reports
OUTCOME 2	High-tech items in export	0: low level of high-tech items in export (approx. 5%) 0,5: medium levels of high-tech exports (approx. 10%) 1: significant levels of high-tech export (approx. 15%)	various system of innovation reports
OUTCOME 3	General innovation performance	0: general innovation indicators as a whole are very low 0,5: average or medium high innovation indicators as a whole 1: high innovation indicators as a whole	Regional Innovation Scoreboard, OECD Regional database, various system of innovation reports

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Regionalni sustavi inovacija kao društvena polja

Sažetak

Današnji svijet postao je predmetom dvoznačnih, kompleksnih i uzajamno podržavajućih globalnih trendova. Isto se može reći i za socijalno okruženje koje se adaptira tim globalnim trendovima. Posljedično, društva nastoje razviti različite sustave inovacija koji postaju sve sofisticiranijima i kompleksnijima, uključujući i njihove materijalne, društvene i kognitivne posljedice. U ovom članku bavimo se sustavima inovacija kao posebnim društvenim područjima koja su pod utjecajem triju društvenih sila: institucija, mreža i kognitivnih okvira. Fuzzy-set analizom ispitujemo jesu li ovo nužni i dostatni uvjeti uspješne adaptacije globalnim trendovima kroz povećanje inovativne performanse. Potrebna nam je kombinacija barem dviju, a najbolje triju društvenih sila koje bi strukturirale društveno područje kako bi pokazali pozitivnu prilagodbu globalnim trendovima. To znači da sposobnost socijalnog okruženja da se suoči s izazovima globalnih trendova može biti predmetom racionalnog djelovanja.

Ključne riječi: društvena područja; društvene sile; regionalni inovacijski sustav, fuzzy-set analiza