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SOCIAL CAPITAL AND INSTITUTIONAL QUALITY AS FACTORS OF INNOVATION: EVIDENCE FROM EUROPE

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SOCIAL CAPITAL AND INSTITUTIONAL QUALITY AS FACTORS OF INNOVATION: EVIDENCE FROM EUROPE

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Abstract

This paper investigates how different dimensions of social capital and institutional quality are related to innovation activity and its utilisation. For reasons of data availability, previous studies have included mainly patenting data. This study complements the previous studies by analysing smaller sample, but including more indicators of innovation. Data for 29 European countries are analysed. As an alternative to usual analysing methods, cluster analysis is used to overcome the problem of small sample. First, cluster analysis is conducted to examine the similarities and differences in various aspects of innovation activity and utilisation of innovations. Next, the social capital and institutional quality are considered as possible factors of innovation next to the R&D and human capital. The findings supported the idea that different dimensions of social capital have a different impact on innovation activity; the results concerning the utilisation of innovations were mixed.

Keywords: innovation, social capital, institutional quality, Europe

JEL Classification numbers: A12, A13, O31, O4

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1. INTRODUCTION

As innovation plays an important role in economic growth and development, it is necessary to understand the factors, which determine the differences in innovation intensity across countries and regions. The purpose of this paper is to examine the relationships between different factors of innovation and alternative innovation outputs, using European countries as a sample. Two aspects of novelty should be mentioned. First, most previous studies concentrate on traditional factors of innovation like research and development (R&D) expenditures or the level of human capital. Undoubtedly, innovation requires investments in R&D, and qualified manpower is needed to create and utilise innovations. But empirical evidence shows that the same expenditures on R&D in different countries often fail to yield similar success in innovation.[4] This suggests that innovation process is additionally influenced by many other factors. The current paper includes the characteristics of the social environment, i.e. networks, norms and trust, which can be jointly referred to as social capital, and the overall institutional environment of a particular country as possible factors of innovation into analysis. Theoretically, both social capital and formal institutions could help to reduce transaction costs arising from risk and uncertainty of innovation. However, since social capital as a relevant factor of innovation have been actively dealt in the academic literature only over the last few years, there are yet not many empirical tests assessing the effect of social capital on innovation. It can be assumed that one possible reason for this lies in the complexity of the measurement of social capital, which should take into account many different dimensions of the concept.

Second, in previous studies innovations are mostly measured by the number of patent applications. However, the reliability of this measure can be questioned, as it covers only one aspect of innovation activity – mainly new-to-the-market product innovation,

[4] Furman et al (2002, p. 899) have formulated this puzzle as following: "If innovators draw on technological and scientific insights from throughout the world, why does the intensity of innovation depend on location?"

excluding, for example, new-to-the-firm product innovation or imitation, process innovation and non-technological innovation as well as the utilisation of innovations. Therefore, including other indicators of innovation into the analysis could improve the understanding of the influence of social capital and institutions on different aspects of innovation. The reason, why these indicators have not been included in the previous analyses, lies probably in the poor availability of data – for example, for Europe the indicators describing various aspects of innovation are available only at the country level, while larger regional databases cover only the patenting data. However, when using the traditional methods of testing influences of several factors on innovation, i.e. regression analysis or structural equation modelling, a larger sample than the number of European countries is necessary in order to guarantee the reliability of the results. Nevertheless, in order to complement the previous studies analysing larger sample but including only patenting data, the current study performs the analysis including more aspects of innovation and using cluster analysis as an alternative to usual analysing methods.

In all, 29 European countries are covered in the analysis, including both the old member states of the European Union (and other countries with no communist background) and transition countries. Firstly, cluster analysis is conducted to explore the similarities and differences in various aspects of innovation activity and utilisation of innovations. Then, the social capital and institutional quality are considered as possible factors of innovation next to the R&D and human capital. To measure social capital, many previous studies have used an overall index, one variable or one latent construct (see, for instance, Subramaniam and Youndt, 2005; Ackomak and ter Weel, 2005, 2006). However, it can be assumed that different dimensions of social capital may have dissimilar impacts on innovation. Therefore, this paper tests the influence of social capital on innovation by separate dimensions. Exploratory as well as confirmatory factor analysis is performed to form latent constructs from initial indicators describing possible factors of innovation. Next, the mean levels of social and institutional environment are analysed in different clusters of innovation activity and utilisation of innovations to find out whether and how the social capital and institutional quality influence innovation and

its utilisation. To shed some light on the extent of these possible influences, for comparison, the mean levels of R&D and human capital are also examined.

The paper is structured as follows. Section 2 presents the theoretical background, discussing the causal relationships between innovation, social capital, institutional quality, and other factors of innovation − R&D and human capital. Section 3 introduces the innovation data and presents the results and discussion of cluster analysis of innovation data. Section 4 deals with the measurement of possible factors of innovation. Section 5 presents the mean values of factors of innovation in different clusters, attempts to explain which factors are important for different type of innovative activity. Section 6 discusses the results on the basis of separate countries. Section 7 points out the limitations and makes recommendations for future research, while Section 8 concludes.

2. THEORETICAL BACKGROUND

Innovation is usually understood as the introduction of something new or significantly improved, including both new products and processes. As such, innovation can be broadly defined as an increase in the variety of goods, services and proceedings, rather than a purely technological advance (Unger and Zagler 2003). The involvement of a country or a region in innovative activity has two aspects: inputs and outputs (see, for instance, Nasierowski and Arcelus, 1999). The inputs include, above all, human capital, expenditures on R&D and employment in R&D, both in the government and business sector. The outputs of innovation include product innovations, process innovations and non-technological innovations that can be measured for example by the share of enterprises with different innovative activities or patent applications. Beside innovation activity, the utilisation of innovations is also important. The ability to exploit the innovations can be measured by the share of high technology exports or the share of sales of new products in turnover of the enterprises. Hereinafter, when innovation is mentioned, the outputs of innovative activity

are actually borne in mind, while the inputs of innovation activity will be considered as an influencing factor of innovation.

Traditionally, inputs of innovation can also be understood as basic determinants of innovation. In order to attain innovation outputs, investments into education system and public policy for research and development (R&D) are needed.[5] R&D as an input of innovation is unquestionably a key factor of innovation. Also, the general level of human capital of a region or a country is commonly supposed to positively influence innovation. An overview of theoretical reasoning and empirical results can be found, for instance, in Daklhi and de Clercq (2004) or Subramaniam and Youndt (2005). Shortly, the general level of human capital determines the quality of the labour force, which is employed or can potentially be employed in R&D. In addition to the direct positive influence on innovation, a higher educational level of the labour force in R&D demands lower extra expenditures on additional training, allowing more finances for other innovative activities.

Factors of innovation include the availability of financial funds for R&D activities. Innovation requires time and effort of research workers in the innovation sector, which, typically, should be rewarded financially immediately, whilst the returns from innovation will occur only after time and with unknown rate and probability. Basic alternatives for innovation financing include internal finance (out of profit) and external finance (credit-based or equity-financed systems) (Unger and Zagler 2003). Regarding internal finance, the innovation rate depends on the probability of success of innovation and on the profit share. In case of low internal funds, usually, there is a need for external finance through financial markets, where the cost of capital (and therefore the innovation rate) depends on asset prices and interest rates.

However, it could be assumed that, due to high risk and uncertainty, innovation funding only from profits and through private

[5] The effects of educational, technological and financial factors on innovation at firm and sector level are widely addressed in the literature on national innovation systems (see, for example, Dosi et al, 1990; Lundvall, 1992).

capital markets is insufficient. "Innovation … involves uncertainty, risk taking, probing and re-probing, experimenting, and testing. It is an activity in which "dry holes" and "blind alleys" are the rule, not the exception" (Jorde and Teece 1990, p. 76). As such, risks and uncertainties can be seen as defining characteristics of innovation, as technological development is full of unforeseeable contingencies. Van Waarden (2001) argues that innovation is more often characterised by uncertainty than by risk. While the probability and costs of risky transaction can be calculated, the probability of uncertain events is not known and costs cannot be calculated. Besides direct uncertainties, there are additional indirect uncertainties and risks in innovation due to the need for cooperation, information exchange and pooling resources between producers, suppliers and consumers. Although private firms usually employ different risk-reducing strategies like internal differentiation, integrating with a partner or structuring inter-firm relations (Nooteboom, 2000), these remedies tend to be insufficient. As such, formal laws and regulations introduced by the state are needed to further reduce risk and uncertainty.

The focus on institutions draws on North (1990), Olson (1982), and Williamson (1975, 1985), whose work highlights the fact that markets are not perfect but characterised by transaction costs, and formal institutions can help to correct different market failures. Institutions[6] can be defined as a set of humanly devised behavioural rules that govern and shape the interactions of human beings, by helping them to form expectations of what other people will do, and constraining possible opportunistic and erratic individual behaviour (North 1990, Kasper and Streit 1999, Lin and Nugent 1995). In order to be effective, institutions always imply some kind of sanction for rule violations. Literature usually makes distinction between formal and informal institutions, the former including rules, laws or rule systems and the latter socio–cultural

[6] When using the term "institution", distinction should be made between the "institutional arrangement" (set of behavioural rules that govern behaviour in a specified domain) and the "institutional structure" (totality of institutional arrangements in an economy) (Lin and Nugent 1995: 2307). Here the first part of this definition is considered.

beliefs and values (see Kasozi 2004). Altogether, institutions influence people's and firms' ability to cooperate for mutual benefit (Collier 1998; Knack 1999).

Theoretical opinions and empirical evidence on the effect of formal institutions on innovations is contradictory. Firstly, many economists and policy makers believe that formal regulation is bad for innovation, as it reduces the competition and freedom of firm, including freedom to innovate (van Waarden 2001). Instead, competition can provide the best incentive for economic transaction and innovation, while freedom allows for creativity and venturing. However, competition and freedom are also sources of risk and uncertainty. As such, there is always a trade-off and need for balance between freedom and competition on the one hand, and regulation and predictability on the other. Secondly, national legal systems differ in their capacity to reduce risk and uncertainty both effectively and efficiently – and curiously, some systems have themselves become new sources of uncertainty. Van Waarden (2001) has analysed both direct and indirect effects of formal regulation and litigation on innovations in U.S. and Netherlands and concluded that although one would expect economies with a legal system that is more effective in reducing risk and uncertainty to be more innovative, the opposite seems to be true. This paradox can be explained by reminding that institutions reflect cultural values of a particular society. As such, risk-averse cultures tend to have legal systems that emphasise the reduction of risk and uncertainty, and they also produce more risk-averse innovative behaviour in firms.

Norms and values, also referred as informal institutions, are largely involved in the concept of social capital. As social capital is a complex concept with many dimensions and it can be analysed at different levels, there are also many definitions of it (see, for example, Adler and Kwon (2002), Tamaschke (2003), or Leana and van Buren (1999) for exhaustive overviews of different definitions). The most famous advocate of the concept, Robert Putnam, sees social capital mainly as an attribute of a country or a region and defines it as "… features of social organisation such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit" (Putnam 1995). Different elements

of social capital included into most definitions can be divided into two aspects: structural and cognitive (Hjerppe, 2003; Chou, 2006). Cognitive social capital encompasses norms and trust, while trust in turn can be divided into general trust and the trust in different institutions like police, government, church, banks, media, etc. – also referred to as institutional trust. The structural social capital includes social networks – both informal (formed by the interpersonal relationships between friends, relatives, colleagues, neighbours, etc.) and formal (defined as participation in associations and voluntary organisations: professional, religious, cultural, etc.). In addition, civic participation is often considered as a dimension of social capital, being expressed, for example, by voting activity.

The influence of social capital on innovation can be described, first of all, as forming the innovative milieu (Daklhi and de Clercq, 2004). A good overview on the development of theories concerning social capital as a factor of innovation can be found in Landry *et al*. (2002) and Fountain (1998). Next, the impact and the influence mechanisms of social capital on innovation will be discussed, distinguishing between different dimensions of social capital.

It is generally accepted that firms do not innovate in isolation but need interaction with their environment. Hence, the structural dimension of social capital − both formal and informal networks − can be thought to be paramount for several reasons. First, innovation significantly depends on spread of information, especially in high-technological fields, where information is very specific (Fukuyama, 2000). Further specialisation and more complex technologies demand more cooperation. Networks consist of ties between individuals and through them also between firms. These ties enable, help and accelerate information exchange and also lower the costs of information search. It has been said that access to know-how can be gained with the help of know-who, that is, information about who knows what (Gregersen and Johnson, 2001; Lundvall, 2006). Often, networks may help to avoid duplication of the costly research. Second, networks have a synergy effect, bringing together complementary ideas, skills and also finance. Connecting different creative ideas and thoughts can lead to

unusual combinations and radical breakthroughs (Subramaniam and Youndt, 2005). In addition, networks not only facilitate the innovations themselves, but also help and accelerate the distribution of innovations (Abrahamson and Rosenkopf, 1997).

However, the information exchange via networks cannot work without trust (Tsai and Ghoshal, 1998). Trust can be described as confidence in the reliability of others. The trust that people have in other people in general can be referred to as generalised or general trust. In case of high trust, the expectations that others will reciprocate are high and people tend to follow the civic norms in their actions (Knack and Keefer, 1997).

Trust can influence innovation through many mechanisms. First, the higher the general trust, the lower the monitoring costs of possible malfeasance or non-compliance by partners and the smaller the need for written contracts (Knack and Keefer, 1997; Tamaschke, 2003). Hence, higher trust enables firms to spend more time and finances on other purposes, innovative activity being one of them. Second, the higher the general trust in a society, the less risk averse are its members, including investors. As a result, higher trust encourages investors to invest more in R&D projects (Ackomak and ter Weel, 2006). Third, in case of higher general trust, when workers are selected, their human capital is more important and their acquaintances are less important (Knack and Keefer, 1997). Thus, the labour force employed in R&D probably has higher skills and education that are needed for innovative activity. Fourth, as it was noted before, cooperation needs trust. Therefore, trust between firms developed by repeated cooperation may lead to riskier and more radical innovative cooperation projects (Ackomak and ter Weel, 2006). The trust in institutions like the government and legal system is also substantial. In case of a reliable legal system and effective patent registration, the motivation to innovate is higher: the innovators feel that the results of their activity and R&D expenditures are protected and they can expect their activity to pay off (Dakhli and de Clercq, 2004; Tabellini, 2006).

Trust is closely related to norms: civic norms guiding people's behaviour can be viewed as trustworthiness that increases trust in

other people. Also, the norm that voting is a civic duty may increase political participation and improve governmental performance and hence also the trust in government (Knack and Keefer, 1997). Notwithstanding, norms themselves have received less attention in the previous literature about the impacts of social capital on innovation. Dakhli and de Clercq (2004) argue that the higher the norms of civic behaviour – for instance, the norm of helping others or the norm of good citizenship – the higher the country's level of innovation. Reciprocity can be one important factor to encourage the diffusion of resources: for example, the amounts of information given to each other at a given point of time do not have to be equal – the information is expected to be returned in the future. The norm that prefers society's interests to self-interest also supports the diffusion of information. In addition, shared norms help to avoid misunderstandings and facilitate cooperation.

Although the literature on the impact of social capital on innovation has been proliferating in the last decade, to date there are only a few studies that have empirically tested this impact. Landry *et al*. (2002) analysed the effects of networks and trust on the likelihood and on the radicalness of innovation at the firm level. They found confirmation for the innovation-increasing effect of networks, but trust turned out to be insignificant in determining both likelihood and radicalness of innovation. Dakhli and de Clercq (2004) analysed the impact of networks, trust and norms on different indicators of innovation at the country level. It turned out that none of these three dimensions of social capital influence the number of patents, that higher institutional trust increases high-tech export, and unexpectedly for the authors, that higher norms of civic behaviour appear to decrease high-tech export. The authors supposed that the norms of being a good citizen are contradictory to the intentions to think differently and create new ideas.

At the same time, for example, Tsai and Ghoshal (1998) found in their firm-level analysis that both social interactions and trustworthiness increase the number of innovations via resource exchange and combination. The firm-level study by Subramaniam and Youndt (2005) showed that overall social capital influenced positively both incremental and radical innovative capabilities.

Ackomak and ter Weel (2006) analysed European regional-level data, finding that trust has a positive influence on the number of patent applications. The work of Kaasa (2007) has also shown that civic participation has strong positive effect on patenting intensity in European regions, while the impact of the other dimensions of social capital like networks, institutional trust and general trust appeared to be rather small, although also positive.

As can be seen, the results of previous empirical analyses confirm that social capital is a multidimensional concept and different dimensions have to be supposed to have different effects in innovation.

3. INNOVATION ACTIVITY AND ITS UTILISATION IN EUROPE

The innovation data used in this study were drawn from two databases: the European Innovation Scoreboard (EIS) (European…, 2007) and the Eurostat database (Eurostat, 2007). In both the EIS and Eurostat some indicators originate from Community Innovation Survey (CIS) (Eurostat, 2006), which is a survey on innovation activity in enterprises covering both EU member states, EU candidate countries, Iceland and Norway (see, for example, Eurostat (2006) for further information). The exact descriptions and sources of the innovation indicators and years included in the analysis are given in Appendix A. The study covers 29 European countries, for which the innovation data were available including 10 transition countries. However, there are also some missing values in case of some variables. The countries analysed can be seen in Appendix B. As the main principle, the latest data available were chosen. When possible, the average of two or three years was calculated to smoothen the fluctuations and to reduce the influence of possibly unusual values.

Innovation activity is measured by five aspects. First, the general innovative activity is measured by the share of enterprises with innovation activities. Then, to take different types of innovations

into account, separate indicators are included describing the share of enterprises with product innovations, the share of enterprises with process innovations, and the share of small and medium-sized enterprises (SME-s) using non-technological change. The patenting activity is described by the number of patent applications to the European Patent Office (EPO) and US Patent and Trademark Office (USPTO). In order to avoid overvaluing the patenting activity compared to other aspects, factor analysis of the two indicators was conducted using the principal components method to capture the information into one variable.[7] For the data analysis here and hereafter SPSS for Windows 11.5 were used. The results are presented in Table 1. For further analysis, here and hereafter the factor scores of latent variables were saved as variables (see Appendix B).

Table 1. Results of factor analysis of patenting activity

Indicator	Factor loadings	Variance explained (%)
USPTO patents per million population	0.998	99.63
EPO patents per million population	0.998	

Utilisation of innovations is described by three indicators. The share of high technology exports in total exports should describe the ability of a country to exploit the innovations in order to increase exports. The shares of sales of new-to-market products and new-to-firm not new-to-market products in turnover capture the aspects of utilisation of both initiation and imitation of innovations. These two indicators enable to estimate the ability of firms in the particular country to profit from the innovations made. Before further analysis, all indicators were standardised in order to prevent the influence of different scales of initial indicators on the results of cluster analysis. The standardised values of innovation indicators can be seen in Appendix B.

[7] An analogical method has been used earlier by Whiteley (2000) to create one variable describing social capital.

Next, the *k*-means clustering approach (see, for example, Statsoft, 2007) was used to group the European countries included in the analysis on the basis of both innovation activity and utilisation of innovations. In order to get adequate results, the method of running means was applied. As there were some missing values, it is reasonable to exclude cases pairwise, not listwise, in order to utilise all the information available. To test, whether this method could change the results, the cluster analysis for both innovation and its utilisation was performed first with listwise exclusion and then with pairwise exclusion. However, the cluster membership of countries with complete data did not change. Therefore, only the results obtained by pairwise exclusion are presented and discussed.

For choosing the number of clusters the following principle was used. If adding one cluster results in a new cluster significantly different from the previous clusters, it will be added. If adding one more cluster gives a new cluster quite similar to another cluster, the cluster will not be added.

In case of indicators of innovation activity it was most reasonable to divide countries into four clusters. The results of cluster analysis of innovation activity are presented in Table 2. Here and in Table 3 the numbers in table describe the means of the standardised values of variables describing innovation activity of the countries belonging to the particular cluster.

Firstly, we can see that almost all values of the innovation indicators are highest in cluster 1 and lowest in cluster 4. The only exception is process innovation which is highest in cluster 2. Further, there is clear distinction in the values of innovation factors between clusters 1–2 and 3–4, the first two having positive values and the latter negative values of indicators. The exception is again related to cluster 2, where the value of patenting is negative and even lower than in cluster 3. One possible explanation for both exceptions could be drawn from the composition of cluster 2 – it includes mainly small open economies with liberal policies, being thus more flexible compared to other countries, but having less power to protect their innovations with patents. Secondly, the distribution of countries between clusters could be expected to follow the general development level of analysed countries.

Appendix C presents the mean values of GDP per capita and Human Development Index, showing that this assumption holds in case of innovative activity.

Table 2. Results of cluster analysis of innovation of European countries

Indicators	Final cluster centres:			
	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Patenting activity	1.30	–0.51	–0.20	–0.82
Innovative enterprises (% of enterprises)	1.13	0.54	–0.55	–1.11
Product innovation (% of enterprises)	1.12	0.54	–0.58	–1.09
Process innovation (% of enterprises)	0.79	0.83	–0.36	–1.26
Non-technological innovation (% of SME-s)	0.95	0.37	–0.14	–1.44
Countries in clusters:	Austria Denmark Finland Germany Iceland Luxembourg Sweden Switzerland	Belgium Czech Republic Estonia Greece Ireland Portugal	France Italy Latvia Netherlands Norway Romania Slovenia Spain	Bulgaria Hungary Lithuania Malta Poland Slovakia Turkey

Division of countries between clusters in Table 2 is in some cases surprising and not easy to explain. Why are all Baltic countries – Estonia, Latvia and Lithuania – in different innovation clusters? Similarly, which factors separate geographically, historically and culturally similar pairs of countries like Belgium and France, Portugal and Spain into different clusters? And even more surprisingly, how can a poor country like Romania be in the same cluster with Norway and France? Further analysis should shed some light into these controversies.

Table 3 presents the results of cluster analysis of utilisation of innovations, where Malta and Switzerland turned out to be outliers. Although Malta was in the "worst" group of countries (cluster 4 in Table 2) by innovation activity, it has extremely high level of high-tech exports and it is also good in utilising initiated innovations in form of sales of new-to-market products as a share of turnover. Switzerland, which belongs to the most successful cluster of innovation activity (cluster 1 in Table 2), has also highest value of the share of sales of new-to-firm products in turnover describing utilisation of imitated innovations.

Concerning other countries, it seemed reasonable to divide them into three clusters. Altogether, indicators of utilising innovations in clusters 1–2 could be considered as "good", in clusters 3–4 as "average" and in cluster 5 as "bad". Cluster 3 is the most inconsistent – the average share of sales of new-to-market products in turnover is lower than in cluster 4 and the share of sales of new-to-firm products in turnover even lower than in cluster 5. On the other hand, it appears that clusters 3–5 all dominate by one single dimension of innovation utilisation: cluster 3 has the highest score (among these three clusters) in exporting high-tech products, cluster 4 is the most successful in utilising initiated innovations (i.e. they have higher share of sales of new-to market products in turnover), while countries in cluster 5, vice versa, are relatively better in utilising imitated rather than initiated innovations.

Concerning the mean values of GDP per capita and Human Development Index (see Appendix C) and the utilisation of innovations, it appears that higher welfare indicators associate positively with high-tech export (cluster 3) and are lowest among good imitators (cluster 4). However, the question about the direction of causality remains open. On the one hand, it is commonly accepted that innovations are an important precondition for economic growth and development. On the other hand, it could be argued that innovative activity in wealthier countries is higher because of the availability of more financial and human capital resources. To explain the differences between clusters, alternative determinants of innovation are further analysed.

Table 3. Results of cluster analysis of utilising innovation of European countries

Indicators	Final cluster centres				
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Exports of high technology products (% of total exports)	3.60	0.72	1.02	–0.34	–0.49
Sales of new-to-market products (% of turnover)	2.72	–	–0.39	0.84	–0.69
Sales of new-to-firm not new-to-market products (% of turnover)	0.58	4.05	–0.45	–0.01	–0.19
Countries in clusters:	Malta	Switzerland	France Hungary Ireland Luxembourg Netherlands	Bulgaria Czech Republic Finland Germany Poland Romania Slovakia Slovenia Sweden	Austria Belgium Denmark Estonia Greece Iceland Italy Latvia Lithuania Norway Portugal Spain Turkey

4. MEASUREMENT OF FACTORS OF INNOVATION

Due to heterogeneous character of social capital, no single indicator of social capital can be used and therefore measurement methods using many indicators have to be applied. The same holds for institutional quality. Also, these indicators cannot be found among the usual indicators published by statistical offices. Instead, special surveys have to be conducted in order to get appropriate data. In the current study, most of the data describing different dimensions of social capital were taken from the database World Values Survey (WVS) (Inglehart et al., 2004; World…, 2006). To reduce overrepresentation of some groups of respondents, the weight variable provided in the data was used when computing country-level means. The indicator of voting activity was drawn from the International IDEA Database: Voter Turnout from 1945–2001 (IDEA, 2007). The data about institutional quality came from the database Governance Matters V: Governance Indicators for 1996–2005 (Kaufmann et al., 2006). The data measuring R&D and human capital were drawn from European Innovation Scoreboard (EIS) (European…, 2007).

It makes sense to assume that innovation process takes time and thus a time lag should be considered between observations of the factors of innovation and observations of innovation. Daklhi and de Clercq (2004) and Subramaniam and Youndt (2005), for instance, use innovation data observed three years later than the factors of innovation. Yet, many studies do not use the time lag (Tsai and Ghoshal, 1998; Nasierowski and Arcelus, 1999; Landry *et al*. 2002) or use innovation data observed even earlier than the factors of innovation (Ackomack and ter Weel, 2005; Ackomack and ter Weel 2006). As the stock of social capital or the level of institutional quality does not change rapidly, it is possible that the results are not drastically influenced by the chosen time lag. Still, whenever feasible, it is reasonable to use such data about the factors of innovation that are observed before the innovation data. For this study the innovation data for years 2000-2004 and the latest data available were chosen (see Appendix A). Indicators of social capital originating from WVS pertain to 1999, except data

for Norway and Switzerland (1996), Finland and Spain (2000), and Turkey (2001). The year, when the voting activity is measured, depends on the year of elections and ranges from 1996 to 2000. The data used for describing governance, R&D and one indicator of human capital the missing data were replaced with the observations for 2001 or 2002 (if 2001 not available) (see Appendix E for further information). As the correlations of the data for 2001 and 2002 with the data for 2000 ranged from 0.98 to 0.99, the replacements presumably do not decrease the reliability of the analysis.

Regarding social capital, it is assumed that different dimensions of social capital can influence innovation in dissimilar ways. Therefore, for describing social capital, an overall index, one variable or one latent construct cannot be used. This idea is supported by the argument pointed out by Franke (2005) that grouping several dimensions of social capital into one index may eliminate the substance of the concept and its explanatory power may be lost in the analysis. The current study considers separately the following dimensions of social capital: formal and informal networks, civic participation, general trust, institutional trust and social norms. The exact descriptions of the indicators of social capital are presented in Appendix D. The scales are chosen so that larger values reflect a larger stock of social capital.

Formal networks are measured by belonging to the organisations and unpaid voluntary work for organisations. To test the argument of Knack and Keefer (1997) about the different influence of Olson-type and Putnam-type organisations,[8] the indicators of belonging to organisations and unpaid work for both types of organisations are included in the analysis. Informal networks are described by frequency of spending time with friends, importance of friends,

[8] The Olson-type organisations include professional associations, political parties and labour unions, while the Putnam-type organisations cover religious, education and cultural organisations (Knack and Keefer, 1997). It is believed that Putnam-type organisations involve more social interactions of people with varying background and help thus to build trust and cooperative norms, while the Olson-type organisations tend to be more rent-seeking.

and spending time socially with colleagues. Civic participation is also measured by three indicators: in addition to the voting activity the share of people who have attended lawful demonstrations, and signed a petition. The indicator used to measure general trust is the answer to the question about whether most people can be trusted. Institutional trust is measured by four indicators: satisfaction with the democracy, confidence in the civil service, parliament and the police. When attempting to describe and analyse norms, one has to bear in mind that the claimed norms can noticeably differ from actual behaviour. However, even the indicators of actual behaviour, if drawn from surveys, are subjective, because the respondents are likely to be reluctant to admit bad behaviour (Knack and Keefer, 1997). In this paper, norms are described by three indicators: justifiability of cheating on taxes, claiming government benefits to which one is not entitled, and accepting a bribe. Institutional quality is measured by six governance indexes: rule of law, control of corruption, government effectiveness, political stability, regulatory quality, voice and accountability (see Kaufmann et al. (2006) for further information).

R&D and human capital as commonly accepted factors of innovation are described by two or three indicators respectively. R&D is described by the R&D expenditures both in the business and government sector. Human capital – an individual's knowledge, skills and abilities that can be improved with education – can be considered at three levels: firm-specific, industry-specific as well as individual-specific human capital (Daklhi and de Clercq, 2004). The individual-specific human capital is more connected with regular education and can also be understood as the general level of human capital in a country or region, while the industry- or firm-specific human capital is more connected with lifelong learning. To cover various aspects of human capital, it is measured by the shares of population with tertiary education, new science and engineering (S&E) graduates, and the number of persons involved in life-long learning. The exact descriptions of the indicators of R&D and human capital are presented in Appendix E.

In order to capture the information of indicators of a particular dimension of social capital into one variable, it is reasonable to use factor analysis resulting in latent constructs corresponding to the

dimensions of social capital. First, an exploratory factor analysis was conducted using the principal components method with equamax[9] rotation. In order to test for stability of the results, other extraction methods (maximum likelihood, generalised least squares) and other rotation methods (varimax, quartimax) were implemented, but the pattern of loadings of indicators into factors remained the same. To decide the number of factors, the Kaiser criterion was used: only the factors with eigenvalue greater than 1 were retained (Statsoft, 2003). The results (see Appendix F) showed that the indicators of social capital clearly divided into groups describing different dimensions of social capital and every indicator corresponds to that dimension which this indicator was assumed to measure. The only exception was the indicator of general trust, which loaded into the factor describing formal networks and it did not load in a separate factor in case of more factors, either.

As the intention was to analyse general trust as a factor of innovation separately from formal networks, next, confirmatory factor analysis was performed. Factor analysis of particular indicators was conducted using the principal components method to capture the information into one variable. Each indicator was chosen to describe that dimension of social capital, with which it was most strongly related according to the exploratory factor analysis (except general trust). To differentiate between Olson-type and Putnam-type organisations, additionally, the latent factors corresponding to both types were constructed as the sub-factors of formal networks. The percentages of total variance explained are quite large, considering that only one factor was extracted. The results are presented in Table 4. In addition, the indicator of general trust was standardised in order to make it comparable with the other latent variables corresponding to different dimensions of social capital.

[9] Equamax is chosen, because it is a combination of varimax, which minimises the number of variables that have high loadings on each factor, and quartimax, which minimises the number of factors needed to explain each variable (SPSS, 2005).

Table 4. Results of factor analysis of dimensions of social capital

Latent variable/factor	Indicator	Factor loadings	Variance explained (%)
Formal networks	Belonging in Putnam-type organisations	0.86	79.96
	Belonging in Olson-type organisations	0.80	
	Unpaid work for Putnam-type organisations	0.79	
	Unpaid work for Olson-type organisations	0.75	
Putnam-type formal networks	Belonging in Putnam-type organisations	0.92	88.97
	Unpaid work for Putnam-type organisations	0.92	
Olson-type formal networks	Belonging in Olson-type organisations	0.94	94.42
	Unpaid work for Olson-type organisations	0.94	
Informal networks	Spending time with friends	0.95	67.64
	Friends important in life	0.86	
	Spending time socially with colleagues	0.62	
Civic participation	Attending lawful demonstrations	0.87	66.68
	Signing a petition	0.84	
	Voting activity	0.73	
Institutional trust	Confidence in parliament	0.91	90.52
	Confidence in the police	0.88	
	Confidence in the civil service	0.84	
	Satisfaction with the democracy	0.75	
Norms	Claiming government benefits, not justified	0.89	64.73
	Cheating on taxes, not justified	0.80	
	Someone accepting a bribe, not justified	0.72	

The factor analysis of the governance indicators was conducted analogically. All six indicators loaded into one factor (using the Kaiser criterion). The results are shown in Table 5. The results show that all aspects of governance are very closely related to each

other. Hence, the influence of institutional quality on innovation can be analysed using this single latent variable of governance. The factor scores of social capital and governance as well as standardised values of general trust are presented in Appendix G.

Table 5. Results of factor analysis of governance

Indicator	Factor loadings	Variance explained (%)
Rule of law	0.97	86.55
Control of corruption	0.96	
Government effectiveness	0.96	
Political stability	0.94	
Regulatory quality	0.90	
Voice and accountability	0.84	

At last, the latent factors of R&D and human capital were constructed in similar way. The results are shown in Table 6. The factor scores and standardised values of initial indicators are presented in Appendix H.

Table 6. Results of factor analysis of R&D and human capital

Latent variable/ factor	Indicator	Factor loadings	Variance explained (%)
R&D	Business R&D expenditures (% of GDP)	0.92	84.13
	Public R&D expenditures (% of GDP)	0.92	
Human capital	Population with tertiary education	0.87	55.02
	New S&E graduates	0.70	
	Participation in life-long learning	0.64	

The factor loadings of the R&D indicators show that the two indicators are strongly related to each other, as can also be seen from the standardised values presented in Appendix H. However,

the indicators of human capital are less closely related to each other. This can also be seen from the variance explained – the factor of human capital explains only 55% of the total variance of these three indicators. Therefore it is reasonable to study the possible relations of the shares of tertiary education and new S&E graduates, and participation in life-long learning with innovation and its utilisation separately from each other.

Next, the relationships between the factors of innovation and both innovation activity and utilisation of innovations are discussed.

5. DETERMINANTS OF INNOVATION BY DIFFERENT CLUSTERS

To shed some light to possible reasons of the differences in the levels of innovation activity, next, the mean values of factors of innovation are investigated in different clusters of innovation activity and utilisation. These mean values are presented in Tables 7 and 8.

Table 7 shows first that cluster 1 dominates by high positive values of almost all analysed determinants of innovation (except norms and new S&E graduates) and cluster 4 is characterised by lowest and negative values of innovation determinants (except in case of norms, again), but the distinction between clusters 2 and 3 is not so obvious. Looking at the differences among clusters by separate indicators, it appears that in most cases, there is a clear positive relationship between innovation activity and the determinants of innovation. More specifically, the mean values of formal and informal networks, civic participation and governance all decrease when we move from cluster 1 (composed of most actively innovating and patenting countries) towards cluster 4. This assures that at least the structural dimensions of social capital encourage innovation. However, the effect of the cognitive aspects of social capital is not so clear. Both general and institutional trust have lower values in cluster 2 compared to cluster 3. The same holds for R&D expenditures. This could be related to the fact that patenting activity was also lower in

cluster 2 (see Table 2), testifying that innovation output in the form of patents requires both high R&D expenditures and trust for cooperation between innovating firms. Further, in the current analysis there seems to be no clear pattern concerning the effect of norms on innovation – norms appear to have the same value in clusters 1 and 4, and lowest value in cluster 2.

Table 7. Mean standardised values or factor scores of social capital, governance, R&D and human capital in clusters of innovation activity

Factor of innovation	Clusters			
	1	2	3	4
Formal networks	0.87	–0.13	–0.24	–0.51
Putnam-type formal networks	0.78	–0.05	–0.16	–0.57
Olson-type formal networks	0.88	–0.21	–0.30	–0.40
Informal networks	0.38	0.18	–0.04	–0.49
Civic participation	0.47	0.18	0.12	–0.83
General trust	0.85	–0.45	0.08	–0.67
Institutional trust	1.08	–0.33	–0.29	–0.50
Norms	0.26	–0.64	0.00	0.25
Governance	1.03	0.02	–0.16	–1.01
R&D	1.16	–0.35	–0.17	–0.83
Human capital	0.66	–0.14	–0.12	–0.58
Population with tertiary education	0.51	–0.10	–0.05	–0.44
New S&E graduates	0.08	0.34	0.04	–0.43
Participation in life-long learning	1.01	–0.48	–0.21	–0.59
Countries in clusters:	Austria Denmark Finland Germany Iceland Luxembourg Sweden Switzerland	Belgium Czech Republic Estonia Greece Ireland Portugal	France Italy Latvia Netherlands Norway Romania Slovenia Spain	Bulgaria Hungary Lithuania Malta Poland Slovakia Turkey

Concerning human capital in clusters 2 and 3, indicators of tertiary education and life-long learning follow the same pattern as norms, trust and R&D: their values in cluster 2 are lower than in cluster 3. This, combined with the information in Table 2, reveals positive effect of education on patenting activity, but also its irrelevance for innovative activity itself (share of innovating enterprises). Another unexplained outcome from Table 2 – higher level of process innovation in cluster 2 compared to cluster 1 – seems again to have no good explanation concerning factors of innovation. The only indicator by which the second cluster dominates the first (and all the others) is new S&E graduates, but there is no explanation why this factor should favor process innovation more than product or non-technological innovation.

Table 8 continues to give some contradictory results. It seems that there is no explicit relationship between factors of innovation and utilisation of innovation. However, it should be taken into account that the analysis of utilisation of innovations didn't give clear order of clusters. Rather, clusters 1 and 2 appeared to include outliers, and clusters 3–5 all dominated by different aspect of innovation utilisation (see Table 3). Taking this into account, further analysis follows distinct aspects of utilising innovation separately.

Concerning outliers, the case of Malta could be compared with cluster 3 (both having high levels of high-tech exports) and cluster 4 (both being relatively good in utilising initiated innovations). It appears that civic participation, institutional trust and also Putnam-type networks are the key factors of high-tech exports, while Olson-type networks rather hamper this outcome. Cluster 3 has also the highest mean value S&E graduates, but it's improbable that this is related only to high-tech exports. Malta, unlike countries in cluster 3, has very high positive value of norms, but negative values of general trust, governance, R&D and human capital. These abnormal results remain hereby unexplained. Further, comparison of Malta and cluster 4 reveals that the only common characteristics are more Putnam-type networks and negative values of governance.

Table 8. Mean standardised values or factor scores of social capital, governance, R&D and human capital in clusters of utilisation of innovations

	Clusters				
Factor of innovation	1	2	3	4	5
Formal networks	0.04		0.03	0.18	–0.15
Putnam-type formal networks	0.17		0.31	0.09	–0.21
Olson-type formal networks	–0.07		–0.28	0.26	–0.07
Informal networks	–1.26		0.36	–0.15	0.07
Civic participation	0.55	–0.63	0.19	–0.23	0.09
General trust	–0.67	0.55	0.07	–0.07	0.03
Institutional trust	0.86		0.56	–0.40	0.00
Norms	1.82	0.17	–0.40	–0.02	0.01
Governance	–0.44	1.25	0.61	–0.34	–0.06
R&D	–1.28	0.94	0.00	0.15	–0.08
Human capital	–1.56	1.24	0.08	–0.19	0.13
Population with tertiary education	–1.61	0.52	–0.03	–0.17	0.21
New S&E graduates	–1.06	–0.52	0.56	–0.08	–0.04
Participation in life-long learning	–0.56	3.14	–0.28	–0.08	–0.04
Countries in clusters:	Malta	Switzer-land	France Hungary Ireland Luxem-bourg Nether-lands	Bulgaria Czech Republic Finland Ger-many Poland Romania Slovakia Slovenia Sweden	Austria Belgium Denmark Estonia Greece Iceland Italy Latvia Lithuania Norway Portugal Spain Turkey

Another outlier, Switzerland, had the best performance in utilising imitations, which seems to be positively related to the general trust, quality of governance, R&D and human capital, especially life-long learning. However, comparing these results with cluster 5, which was also relatively good in utilising imitations, it appears that the positive effect of tertiary education and the negative effect of formal networks (especially Putnam-type) dominate in this cluster. Unfortunately the data about formal networks were not available for Switzerland. However, comparing these results enables to suggest that different aspects of human capital can substitute each other, but the overall effect of human capital on utilising imitation is positive.

Cluster 4 as most successful in utilising initiated innovations becomes distinct from other clusters by negative values of almost all factors of innovation except formal networks (including rent-seeking Olson-type organisations) and R&D expenditures. Contrarily, cluster 5 as a relatively successful imitator shows negative values of formal networks, but small positive values of all other dimensions of social capital. As such, it could be concluded that only research financing and formal cooperation are relevant for utilising initiation of innovations, while human capital and other aspects of social and institutional environment have a rather negative impact; the opposite holds for utilising imitation.

6. DISCUSSION OF THE RESULTS: WHAT DETERMINES INNOVATION BEHAVIOUR IN DIFFERENT COUNTRIES?

As the results of previous analysis were rather contradictory, it would be interesting to compare the division of countries between different clusters simultaneously by innovation activity and utilisation of innovations (Tables 2–3), looking simultaneously at the differences in the factors of innovation as a possible explanation of such division. Further analysis is based on the individual

data of different countries (Appendixes B, G and H) and the results are shortly presented in Tables 9 and 10.

We can see that countries with highest scores on patenting activity and with good performance also in other types of innovation, like Finland, Sweden and Germany, perform also well in utilising innovations and especially in the form of the sales of new-to-market products. These countries are characterised by high levels of R&D and human capital, and positive values of most aspects of social capital (except norms that show relatively low values). However, Germany is an exception with its negative factor scores on S&E graduates, life-long learning, and all types of networks. In case of Switzerland, dissimilarly to the previous example, the very high patenting activity is associated with strikingly high value of utilising imitation (i.e. sales of new-to-firm products).[10] These outcomes are guaranteed, first of all, by high levels of life-long learning and quality of governance, but also by high business R&D expenditures. However, it should be noted that Switzerland (together with U.S.) had already since 1970s substantially higher per capita patenting level than did other advanced economies, while the international patenting levels of the other three countries started to increase since the late 1980s (Furman et al, 2002). This suggests that at best the currently analysed determinants of innovation only complement other factors. For example, the case of Switzerland, Finland, Sweden and Germany refer to importance of national innovation policy, which has probably been the basic factor behind the success in patenting, compared to the other countries with similar levels of the above-analysed innovation determinants.

Another interesting result of this comparison is that many countries which have high shares of innovating enterprises (especially concerning product and process innovation) but which are not so good in patenting belong into the "worst" cluster by utilising innovations. Among them, Austria, Denmark, Iceland and Belgium have all remarkably positive values of R&D expenditures and in most cases also positive values of human and social capital

[10] However, data about sales of new-to-market products were not available for Switzerland.

indicators, while in Greece, Portugal and Estonia most of these factors of innovation show negative values. Among other indicators of social capital, Olson-type networks show also remarkably large positive values in these countries (except in Portugal and Estonia). This confirms that possible rent-seeking behaviour (despite of relatively high norms and trust levels in most of these countries) would damage motivation for cooperation and thus retrains successful utilisation of innovations.

Table 9. Determinants of innovation by countries – successful examples

Success in innovation	Countries	Possible determinants
Successful in both innovating and utilising innovations (especially utilising initiated innovations)	Finland, Sweden	High positive values of the all analysed determinants (norms relatively lower)
	Germany	Differs from Finland and Sweden by negative values of education and networks
Actively patenting and utilising mainly imitated innovations	Switzerland	Education, governance, business R&D
Low patenting but high share of innovative firms (mainly product and process innovation) – in the same time, bad performance in utilising innovations	Austria, Denmark, Iceland, Belgium	High R&D expenditures, human capital and social capital, including Olson-type networks (also in Greece)
	Greece, Portugal, Estonia	Negative values of the above indicators
Relatively good in patenting, high share of innovative firms, success in high-tech exports	Ireland, Luxembourg	Good governance, high institutional trust, high involvement in informal and Putnam-type networks, but mostly negative values of R&D and human capital

Among the other countries, Ireland and Luxembourg stand out as relatively good in both aspects of innovation. In both countries, good results in innovating activity have transformed into success in high-tech exports. The common factors behind these results

include high quality of governance, institutional trust, informal networks and Putnam-type participation, while most indicators of R&D and human capital (except business R&D in Luxembourg and S&E graduates in Ireland) show negative values.

Table 10. Determinants of innovation by countries – unsuccessful examples

Success in innovation	Countries	Possible determinants
Bad (worst) in all aspects of innovation	Lithuania, Turkey	Strongly negative R&D, human capital and social capital. Exceptions: - Turkey has positive norms and informal networks, - Lithuania has high human capital
Worst in utilising innovations, slightly better (cluster 3) in innovation activity	Latvia, Italy	Negative R&D, human capital and social capital, but positive norms
	Spain, Norway	No clear pattern of the innovation determinants
Poor innovators, but relatively good in sales of new-to-market products	Bulgaria, Poland	Strong norms (in Bulgaria also informal networks) but nothing else
	Slovakia	Positive values of formal and civic participation
	All 3 countries have negative R&D and human capital	

Lithuania and Turkey[11] belong by both criteria into the last cluster. The common characteristics of these countries are strongly negative factor scores of R&D and social capital (still, in case of Turkey norms and informal networks had high positive values). However, unlike Turkey, Lithuania has high positive values of most human capital variables, showing thus good development potential for innovations in the future. Another group of relatively backward countries include Latvia, Italy, Spain and Norway,

[11] Here it should be noticed that in case of Turkey, most of the innovation data (except for patenting activity and high-tech export) were missing.

which are in the worst cluster by utilising innovations and have only a bit better position (cluster 3 in Table 2) by innovation activity. Norway's position in this group is hard to explain with the available data and Spain diverts also from Latvia and Italy with its small positive values of several innovation indicators. Yet, the latter two countries share several similarities among innovation determinants, like negative values of all R&D and human capital indicators and also most social capital indicators (except norms).

Bulgaria, Poland and Slovakia show slightly better performance than above-mentioned countries – although they do not innovate much by themselves, they perform pretty well in utilising innovations through sales of new-to-market products. However, although all three countries have negative factor scores in all R&D and human capital variables, there are differences concerning dimensions of social capital. In Bulgaria and Poland, successful initiation seems to be based on strong norms (in Bulgaria also on informal networks), while in Slovakia these variables have negative values and their possible negative effect is balanced with positive values of formal and civic participation. These findings allow suggest that, as also supposed by theory, different dimensions of social capital can substitute each other in different countries.

An outlier in the analysis of utilisation innovations, Malta, had extremely high level of high-tech exports and it was also good in utilisation of initiated innovations, despite of the large negative factor scores in all types of innovation activity. The factors of innovation do not help to explain this variance: the factor scores of traditional innovation determinants were all negative and only the indicators of civic participation, institutional trust and norms showed relatively high positive values. This suggests that the factors included into the current analysis cannot explain Malta's success in utilising innovations. Instead, this could be caused, for example, by presence of some innovative subsidiaries of multi-national corporations in this relatively small country. Another inexplicable outlier in the previous analysis was Romania with its surprisingly good results in non-technological change and utilisation of imitated innovations, considering its highly negative factor score of all determinants of innovation, except norms.

However, the differences among country pairs or -trios, which were highlighted in section 3, didn't become clearer after looking at the determinants of innovation. For example, comparing Belgium and France, first of them had better results of innovation and also higher values of business R&D, tertiary education, life-long learning and formal and civic participation. Alternatively, although Spain dominated over Portugal with all human capital indicators and with the same social and institutional factors as Belgium over France, it still had worse results in innovation. Some explanation could lay in the fact that in Spain, unlike in Belgium, the values of the most social capital indicators (except trust, norms and governance) were negative – but in Portugal these were even more highly negative. As in case of Spain and Portugal the level of social capital was lower than in case of Belgium and France, it can be presumed that that the effects of social capital elements may differ according to the absolute level of social capital. Determinants of innovation in Baltic countries appeared to be quite similar (most of them largely negative) and cannot thus explain why these countries belong into different innovation clusters.

Summing up this discussion, it could be concluded that generally (at least at cluster level) most dimensions of social capital and institutional quality have a positive effect on innovation. In some cases, formal institutions and different elements of social capital could substitute each other. The same holds for human capital. At the level of individual countries, however, the relations between innovation and influencing factors are not always so clear. Therefore, additional innovation determinants should be included into further analysis in order to derive more complex theoretical framework as a possible basis for an efficient innovation policy.

7. LIMITATIONS AND FUTURE RESEARCH

This study has also some limitations. First, it covers only selected countries at a certain moment, and the set of innovation determinants incorporated into the analysis is definitely not exhaustive.

First of all, further analysis of innovation determinants should include more countries with different development levels, in order to distinguish between the absolute and level effects of some determinants (for example, as it appeared in the current study, the effect of social capital on innovation may depend on the absolute level of social capital in the country).

Further, time series analysis could help to shed more light on the determinants of innovation and possible changes in their relative importance during the time. Also, if broader comparable innovation databases become available, it would be interesting to analyse the effects of innovation determinants by different types of innovations, e.g. product and process innovation separately with the help of a correlation and regression analysis (it was not done here due to small sample available). In addition, it would be interesting to test whether there are also interrelationships between the different factors of innovation.

Institutional determinants of innovation are also widely studied in the context of national innovation systems, as it is reasonable to suggest that innovation activity and its utilisation depend on a given public policy environment (see, for example, Furman et al 2002). Therefore, it is important to complement the results of the current study with an evaluation of how innovation varies with country-level policy differences, which is expected to affect R&D productivity. Alternative policy choices include, first of all, the extent of intellectual property protection and openness to international trade, the share of research performed by academic sector and funded by the private sector (showing the quality of linkages between two), the degree of technological specialisation, etc.

Another interesting alternative is to complement such country-level studies with case studies, as innovation often appears in multinational context – it is concentrated into innovation clusters or industrial districts and demands cooperation of different firms (often from different countries). In such context, social and institutional determinants of innovation became especially important.

8. CONCLUSIONS

This paper analysed the influence of social capital and institutional quality on innovation activity and utilisation of innovations. First, the theoretical background concerning the influence of different dimensions of social capital and institutional quality was introduced. R&D and human capital as traditional factors of innovation that have gained more attention in previous studies were also included. Then, all analysed European countries were divided into clusters in order to explore the similarities and differences in various aspects of innovation. It appeared that the pattern of division of countries into clusters according to innovation activity was clearly different from that according to utilising innovations – if a country has high innovative activity, it does not mean that it is also successful in utilising innovations. The analysis also showed that higher innovation activity goes often hand-in-hand with higher welfare level.

For measuring alternative determinants of innovation, after preliminary explorative factor analysis, latent variables were constructed using confirmatory factor analysis. Then, the mean values of the factors of innovation were calculated for the different clusters concerning both innovation activity and utilisation of innovations. The analysis showed that social capital, especially its structural aspects in the form of formal and informal networks and civic participation, has positive influence on innovation activity and patenting. Among the cognitive aspects of social capital, general and institutional trust follow the same pattern of influence as R&D and human capital. The results suggest that these factors are of special importance for patenting activity, while product and process innovation are less influenced by them. Norms seem to be irrelevant for all types of innovation. Institutional quality, measured by latent variable which was constructed from six indicators of governance, showed the highest variance among clusters of innovation. Good governance associated with higher innovation activity. To summarise, these findings supported our hypothesis that different dimensions of social capital have a different impact on innovation activity, and also that formal institutions and different elements of social capital could substitute each other.

However, the impact of social capital on utilisation of innovations was not so clear. It appeared that Putnam-type networks, civic participation and institutional trust support high-tech exports, while Olson-type networks showed negative influence. With some concession, it could be generalised that utilisation of initiated innovations is positively associated with formal networks and negatively with informal networks and civic participation, while the opposite holds for utilisation of imitated innovations. The effect of norms did not follow any certain pattern. Good governance was related to higher high-tech exports and more successful utilisation of imitated innovations, but seemed not to influence utilisation of initiated innovations.

Concerning traditional factors of innovation it appeared that, expectedly, R&D expenditures had a positive impact on both innovation and utilisation of innovations. The effect was strongest in case of patenting activity and utilisation of initiated innovations, while high-tech exports were less influenced by research financing. The role of human capital in encouraging innovation turned out to be mixed. The indicators of tertiary education and life-long learning showed positive effect on patenting activity, but were irrelevant for other aspects of innovation which, in turn, were most affected by the share of new S&E graduates. Altogether, it seems that different aspects of human capital can substitute each other, but the overall effect of human capital on innovation is positive.

Summing up, it could be concluded that most of the determinants of innovation affect directly innovation activity, but there is no clear pattern of their effects on utilisation of innovations. Also, the analysis of the results on country level enables to suggest that the effect of social capital on innovation depends on the development level of the particular country. Further analysis of the same topic could move in several directions: it can include more broad range of countries and time series, go into details of national innovation systems, or, alternatively, to concentrate in more detail on specific cases on country-level.

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KOKKUVÕTE

Sotsiaalkapital ja institutsionaalne kvaliteet innovatsiooni mõjuritena Euroopas

Käesolev artikkel analüüsib sotsiaalkapitali ja institutsionaalse kvaliteedi seoseid innovatsiooni ja innovatsioonide ärakasutamisega. Esmalt antakse ülevaade teoreetilisest taustast ja senistest uurimustest, mis puudutavad erinevate sotsiaalkapitali dimensioonide ja institutsionaalse kvaliteedi mõju innovatsioonile. Traditsiooniliste mõjuritena on kaasatud ka uurimis- ja arendustegevus ning inimkapital. Varasemad uurimused on – peamiselt andmete puudumise tõttu – kasutanud peamiselt patentimisaktiivsuse andmeid. Käesolev töö täiendab neid uurimusi analüüsides küll väiksemat valimit, kuid hõlmates ka teisi innovatsioone kirjeldavaid näitajaid: lisaks tooteinnovatsioonidele ka protsessiinnovatsioonid ja mitte-tehnoloogilised innovatsioonid, samuti innovatsioonide ärakasutamist kirjeldavad näitajad. Tulenevalt väikesest valimist (29 Euroopa riiki) on alternatiivina tavapärastele meetoditele kasutatud klasteranalüüsi. Esmalt klasterdati riigid nii innovatsiooni kui ka selle ärakasutamise lõikes ning ilmnes, et tekkinud mustrid on erinevad – innovatsioonis edukad riigid ei pruugi olla edukad innovatsioonide ärakasutamises. Ilmnes ka, et kõrgem innovatsiooniaktiivsus on seotud ka kõrgema heaolutasemega.

Et sotsiaalkapitali näol on tegu mitmedimensioonilise nähtusega ja võib eeldada, et erinevad dimensioonid mõjutavad innovatsioone erinevalt, siis konstrueeriti latentsed muutujad kuue sotsiaalkapitali dimensiooni ja institutsionaalse kvaliteedi kirjeldamiseks ning leiti nende latentsete muutujate keskmised väärtused klastriti. Analüüs näitas, et sotsiaalkapital, eriti selle strukturaalsed aspektid – formaalsed ja informaalsed võrgustikud ning kodanikuosalus – mõjutavad positiivselt innovatsioone ja patentimisaktiivsust. Kognitiivsete aspektide hulgas on üldise ja institutsionaalse usalduse mõju sarnane uurimis- ja arendustegevuse ning inimkapitali mõjuga – täheldada võib küll tugevat positiivset mõju patentimisaktiivsusele, kuid ülejäänud innovatsiooni aspekte mõjutavad need tegurid vähem. Normid käesoleva analüüsi tulemuste kohaselt innovatsioone ei mõjuta. Kokkuvõttes leidis kinnitust oletus, et erinevad sotsiaal-

kapitali dimensioonid mõjutavad innovatsioone erinevalt. Samuti näitasid tulemused, et usaldus ja normid ühelt poolt ning inimkapital ja uurimis- ja arendustegevus teiselt poolt võivad olla üksteist täiendavateks innovatsiooni mõjuriteks. Innovatsioonide ärakasutamise osas ei olnud tulemused nii selged. Ilmes Putnami-tüüpi võrgustike, kodanikuosaluse ja institutsionaalse usalduse soodne ja Olsoni-tüüpi võrgustike ebasoodne mõju kõrgtehnoloogilisele ekspordile. Samuti võib välja tuua, et initsieeritud innovatsioonide ärakasutamine on positiivselt seotud formaalsete võrgustike ning negatiivselt seotud informaalsete võrgustike ja kodanikuosalusega, imiteerimise ärakasutamise juures kehtivad vastupidised seosed. Institutsionaalse kvaliteedi osas selgus, et kõrge institutsionaalne kvaliteet on seotud kõrge innovatsiooniaktiivsusega, suurema kõrgtehnoloogilise ekspordiga ning edukama imiteerimisega.

Ootustega kooskõlas oli tulemus, mis kinnitas uurimis- ja arendustegevuse positiivset mõju nii innovatsioonidele kui ka nende ärakasutamisele. Mõju oli eriti tugev patentimisaktiivsusele ja initsieeritud innovatsioonide ärakasutamisele. Inimkapitali osas selgus, et kõrghariduse ja eluaegse õppe suuremal osakaalul on positiivne mõju patentimisaktiivsusele, kuid need ei mõjuta teisi innovatsiooni aspekte, mida mõjutas kõige rohkem hoopis inseneriõppe lõpetanute osakaal. Seega võib järeldada, et ka inimkapitali erinevad aspektid täiendavad üksteist innovatsiooni faktoritena.

Kokkuvõttes võib öelda, et institutsionaalne kvaliteet ja enamus sotsiaalkapitali dimensiooni mõjutavad positiivselt innovatsioone, kuid nende mõju innovatsioonide ärakasutamisele ei ole üheselt välja toodav. Edasises uurimistöös võiks võimaluse avanemise korral hõlmata rohkem vaatlusi ja ka aegridu, keskenduda innovatsioonisüsteemide iseärasustele või alternatiivina kasutada ka juhtumianalüüsi.

Kuna ühtede sotsiaalkapitali dimensioonide positiivset mõju innovatsioonile vähendab teiste dimensioonide negatiivne mõju, võib juhtuda, et kui kasutada vaid üht üldist sotsiaalkapitali kirjeldavat indeksit, siis alahindavad tulemused sotsiaalkapitali tegelikku mõju innovatsioonile. Seepärast tuleks edaspidises uurimistöös kindlasti analüüsida erinevate sotsiaalkapitali dimensioonide mõju eraldi.

Appendix A. Indicators of innovation and its utilisation

Indicator	The exact name of indicator according to the source	Source	Year(s)
USPTO patents per million population	Number of patents applied for at the European Patent Office (EPO) by year of filing per million population	EIS	Average of 2002, 2003 (Bulgaria 2002)
EPO patents per million population	Number of patents granted by the US Patent and Trademark Office (USPTO) by year of grant per million population	EIS	Average of 2002, 2003 (Turkey 2003)
Innovative enterprises (% of enterprises)	Enterprises with innovation activities (% of total enterprises)	Eurostat (CIS)	2004
Product innovation (% of enterprises)	Enterprises with product innovation (% of total enterprises)	Eurostat (CIS)	2004
Process innovation (% of enterprises)	Enterprises with process innovation (% of total enterprises)	Eurostat (CIS)	2004
Non-technological change (% of SME-s)	Small and medium-sized enterprises (SME-s) using non-technological change (% of SMEs)	EIS (CIS)	Average of 2000, 2004 (Finland, Latvia, Sweden, Slovenia, Switzerland, Iceland 2000; Ireland, Poland 2004)
Exports of high technology products (% of total exports)	Exports of high technology products (% of total exports)	EIS	Average of 2002–2004
Sales of new-to-market products (% of turnover)	Sales of new-to-market products for all enterprises (% of turnover for all enterprises)	EIS(CIS)	2004
Sales of new-to-firm not new-to-market products (% of turnover)	Sales of new-to-firm not new-to-market products for all enterprises (% of turnover for all enterprises)	EIS (CIS)	2004

Apendix B. Factor scores of patenting activity and standardised values of indicators of innovation and its utilisation

	Patenting activity	Innovative enterprises (% of enterprises)	Product innovation (% of enterprises)	Process innovation (% of enterprises)	Non-technological change (% of SME-s)	Exports of high technology products (% of total exports)	Sales of new-to-market products (% of turnover)	Sales of new-to-firm not new-to-market products (% of turnover)
Austria	0.73	1.13	1.27	1.46	0.92	0.19	–0.42	–0.39
Belgium	0.30	1.04	0.97	1.00	0.25	–0.40	–0.57	0.43
Bulgaria	–0.85	–1.57	–1.18	–1.97	–2.10	–0.85	0.81	–0.77
Czech Republic	–0.78	0.08	0.15	0.34	–0.16	–0.13	0.51	0.32
Denmark	0.85	1.09	0.74	0.65	0.11	0.11	–0.42	–0.27
Estonia	–0.82	0.85	1.18	0.65	0.41	–0.06	–0.72	0.26
Finland	1.56	0.45	0.38	0.09	0.49	0.66	1.26	–0.48
France	0.36	–0.35	–0.66	–0.16	–0.73	0.80	–0.05	–0.33
Germany	1.75	2.07	1.84	1.01	1.33	0.19	0.44	0.96
Greece	–0.81	–0.11	–0.07	0.55	0.65	–0.51	–0.57	–0.15
Hungary	–0.74	–1.22	–1.21	–1.49	–1.09	0.65	–0.80	–1.24
Iceland	0.54	1.09			0.98	–0.92	–0.53	–0.10
Ireland	–0.13	1.10	1.28	1.71	0.68	1.85	–0.27	–0.65
Italy	–0.18	–0.07	–0.77	0.26	0.05	–0.40	–0.01	–0.33
Latvia	–0.83	–1.47			–0.30	–0.86	–1.06	–1.51
Lithuania	–0.82	–0.65	–0.88	–0.69	–0.89	–0.83	–0.72	–0.42
Luxembourg	0.67	1.11	1.34	0.98	1.83	1.19	0.03	0.70
Malta	–0.79	–1.23	–0.97	–1.62	–1.18	3.60	2.72	0.58
Netherlands	1.02	–0.23	–0.13	–0.43	–0.54	0.58	–0.87	–0.71
Norway	0.07	–0.02	–0.03	–0.86	–0.65	–0.73	–1.58	–0.48

	Patenting activity	Innovative enterprises (% of enterprises)	Product innovation (% of enterprises)	Process innovation (% of enterprises)	Non-technological change (% of SME-s)	Exports of high technology products (% of total exports)	Sales of new-to-market products (% of turnover)	Sales of new-to-firm not new-to-market products (% of turnover)
Poland	–0.85	–0.93	–1.12	–0.80	–1.44	–0.84	0.66	–0.39
Portugal	–0.84	0.27	–0.29	0.75	0.41	–0.50	–0.72	–0.33
Romania	–0.87	–1.32	–1.14	–0.98	0.45	–0.74	0.29	0.82
Slovakia	–0.81	–1.07	–1.15	–1.01	–1.96	–0.78	2.42	–0.10
Slovenia	–0.48	–0.77			0.76	–0.63	0.40	0.05
Spain	–0.66	–0.19	–0.73	0.03	–0.22	–0.57	–0.95	0.96
Sweden	1.56	0.94	1.19	0.55	0.29	0.07	0.74	–0.48
Switzerland	2.71				1.61	0.72		4.05
Turkey	–0.86					–0.87		

Appendix C. Welfare indicators and their average values in different clusters of innovation (UNDP, 2006)

Clusters of innovation activity	HDI 2004	GDP per capita 2004 (USD, PPP)
Cluster 1 (average)	0.946	36,005
Austria	0.944	32,276
Denmark	0.943	31,914
Finland	0.947	29,951
Germany	0.932	28,303
Iceland	0.960	33,051
Luxembourg	0.945	69,960
Sweden	0.951	29,541
Switzerland	0.947	33,040
Cluster 2 (average)	0.912	24,287
Belgium	0.945	31,096
Czech Republic	0.885	19,408
Estonia	0.858	14,555
Greece	0.921	22,205
Ireland	0.956	38,827
Portugal	0.904	19,629
Cluster 3 (average)	0.912	24,230
France	0.942	29,300
Italy	0.940	28,180
Latvia	0.845	11,653
Netherlands	0.947	31,789
Norway	0.965	38,454

Clusters of innovation utilisation	HDI 2004	GDP per capita 2004 (USD, PPP)
Cluster 1		
Malta	0.875	18,879
Cluster 2		
Switzerland	0.947	33,040
Cluster 3 (average)	0.932	37,338
France	0.942	29,300
Hungary	0.869	16,814
Ireland	0.956	38,827
Luxembourg	0.945	69,960
Netherlands	0.947	31,789
Cluster 4 (average)	0.885	19,144
Bulgaria	0.816	8,0780
Czech Republic	0.885	19,408
Finland	0.947	29,951
Germany	0.932	28,303
Poland	0.862	12,974
Romania	0.805	8,480
Slovakia	0.856	14,623
Slovenia	0.910	20,939
Sweden	0.951	29,541

Clusters of innovation activity	HDI 2004	GDP per capita 2004 (USD, PPP)
Romania	0.805	8,480
Slovenia	0.910	20,939
Spain	0.938	25,047
Cluster 4 (average)	0.842	13,175
Bulgaria	0.816	8,078
Hungary	0.869	16,814
Lithuania	0.857	13,107
Malta	0.875	18,879
Poland	0.862	12,974
Slovakia	0.856	14,623
Turkey	0.757	7,753

Clusters of innovation utilisation	HDI 2004	GDP per capita 2004 (USD, PPP)
Cluster 5 (average)	0.906	23,763
Austria	0.944	32,276
Belgium	0.945	31,096
Denmark	0.943	31,914
Estonia	0.858	14,555
Greece	0.921	22,205
Iceland	0.960	33,051
Italy	0.940	28,180
Latvia	0.845	11,653
Lithuania	0.857	13,107
Norway	0.965	38,454
Portugal	0.904	19,629
Spain	0.938	25,047
Turkey	0.757	7,753

Appendix D. Indicators of social capital

Indicator	The exact name of indicator according to the source
Belonging to Putnam-type organisations	Belong to religious or church organisations, education, arts, music or cultural activities, average membership
Belonging to Olson-type organisations	Belong to professional associations, political parties or groups, labour unions, average membership
Unpaid work for Olson-type organisations	Unpaid voluntary work for religious or church organisations, education, arts, music or cultural activities, youth work, political parties or groups, labour unions, average number of organisations mentioned
Unpaid work for Putnam-type organisations	Unpaid voluntary work for professional associations, political parties or groups, labour unions, average number of organisations mentioned
General trust	Most people can be trusted rather than you need to be very careful in dealing with people, people trusted, %
Satisfaction with the democracy	Satisfied with the way democracy is developing in our country, average on scale 1–4
Confidence in the civil service	Confidence in the civil service, average on scale 1–4
Confidence in parliament	Confidence in parliament, average on scale 1–4
Confidence in the police	Confidence in the police, average on scale 1–4
Voting activity	The number of votes (parliamentary elections) divided by the number of names on the voters' register %
Attending lawful demonstrations	Different forms of political action that people can take: attending lawful demonstrations, have done, %
Signing a petition	Different forms of political action that people can take: signing a petition, have done, %

Indicator	The exact name of indicator according to the source
Cheating on taxes, not justified	Cheating on taxes if you have a chance, not justified, average on scale 1–10
Claiming government benefits, not justified	Claiming government benefits to which you are not entitled, not justified, average on scale 1–10
Someone accepting a bribe, not justified	Someone accepting a bribe in the course of their duties, not justified, average on scale 1–10
Spending time with friends	How often spend time with friends, weekly, %
Spending time socially with colleagues	How often spend time socially with colleagues from work or your profession, weekly, %
Friends important in life	Importance of friends in life, average on scale 1–4

Sources: IDEA (voting activity) and WVS (other indicators).

Appendix E. Indicators of R&D and human capital

Indicator	The exact name of indicator according to the source	Year(s)
Business R&D expenditures (% of GDP)	BERD (Business enterprise expenditure on R&D) (% of GDP) per 1000 population aged 20-29	2000 (Greece, Portugal, Sweden, Norway 2001; Austria, Malta 2002)
Public R&D expenditures (% of GDP)	Difference between GERD (Gross domestic expenditure on R&D) and BERD (Business enterprise expenditure on R&D) (% of GDP)	2000 (Greece, Portugal, Sweden, Norway 2001; Austria, Malta 2002)
Population with tertiary education	Population with tertiary education (ISCED 5 and 6) per 100 population aged 25-64	2000
New S&E graduates	Number of S&E (science and engineering) graduates per 1000 population aged 20-29	2000
Participation in life-long learning	Number of persons involved in life-long learning per 100 population aged 25–64	2000 (Slovenia, Bulgaria 2001; Czech Republic, Ireland, Slovakia 2002)

Source: EIS

Appendix F. Results of exploratory factor analysis: rotated component matrix* of social capital indicators and % of total variance explained

Indicators	Factors				
	1	2	3	4	5
Belonging to Putnam-type organisations	0.87				
Belonging to Olson-type organisations	0.84				
Unpaid work for Olson-type organisations	0.76		0.44		
Unpaid work for Putnam-type organisations	0.74		0.51		
General trust	0.73	0.43			
Satisfaction with the democracy		0.76			
Confidence in the civil service		0.74		0.42	
Confidence in parliament		0.73			
Confidence in the police		0.71		0.42	
Voting activity			0.85		
Attending lawful demonstrations			0.79		
Signing a petition	0.55		0.63		
Cheating on taxes, not justified				0.85	
Claiming government benefits, not justified				0.84	
Someone accepting a bribe, not justified				0.48	0.41
Spending time with friends					0.86
Spending time socially with colleagues					0.81
Friends important in life	0.40				0.65
Variance explained (%)	21.80	17.94	14.80	14.11	12.90
Cumulative variance explained (%)	21.80	39.74	54.53	68.65	81.54

*For reasons of simplicity and clarity, the coefficients with absolute values less than 0.4 are suppressed.

Appendix G. Factor scores of dimensions of social capital and governance, and standardised values of general trust

	Formal networks	Putnam-type formal networks	Olson-type formal networks	Informal networks	Civic participation	General trust	Institutio-nal trust	Norms	Gover-nance
Austria	0.30	0.31	0.26	–0.08	0.26	0.12	0.89	0.34	0.79
Belgium	0.37	0.46	0.26	–0.28	1.57	–0.07	–0.25	−	0.16
Bulgaria	–0.70	–0.99	–0.34	0.50	–1.33	–0.30	–1.17	0.61	–1.56
Czech Republic	–0.17	–0.16	–0.16	–0.82	0.58	–0.48	–1.38	0.04	–0.57
Denmark	0.73	0.05	1.38	0.39	0.93	2.08	1.36	1.43	0.95
Estonia	–0.75	–0.55	–0.91	–1.21	–1.33	–0.54	–0.70	−	–0.25
Finland	0.80	0.88	0.63	0.70	–0.39	1.57	0.89	0.20	1.28
France	–0.83	–0.67	–0.93	0.19	1.09	–0.58	–0.02	−	0.14
Germany	–0.71	–0.43	–0.95	–0.26	0.61	0.18	0.43	0.22	0.72
Greece	0.92	0.69	1.11	1.13	1.23	–0.49	–1.55	−	–0.33
Hungary	–0.67	–0.57	–0.73	–1.23	–1.74	–0.60	–0.42	−	–0.30
Iceland	1.65	1.18	1.96	0.36	0.45	0.56	1.67	0.90	1.12
Ireland	–0.02	0.20	–0.25	1.52	0.09	0.20	1.07	0.57	0.88
Italy	–0.08	–0.04	–0.10	0.07	1.03	0.05	–0.20	0.49	–0.33
Latvia	–0.74	–0.75	–0.66	–1.52	–0.39	–0.88	–0.69	0.18	–1.02
Lithuania	–1.00	–0.89	–1.04	–1.63	–1.16	–0.42	–1.79	−	–0.92
Luxembourg	0.19	0.42	–0.07	0.34	0.84	–0.36	1.46	−	1.13
Malta	0.04	0.17	–0.07	–1.26	0.55	–0.67	0.86	1.82	–0.44
Netherlands	1.47	2.18	0.59	0.96	0.70	1.68	0.72	0.39	1.22
Norway					0.74	2.01		0.59	0.69
Poland	–0.84	–0.95	–0.66	–1.20	–1.61	–0.78	–0.33	0.24	–0.57
Portugal	–1.15	–0.93	–1.30	0.71	–1.04	–1.31	0.80	0.10	0.26

	Formal networks	Putnam-type formal networks	Olson-type formal networks	Informal networks	Civic participation	General trust	Institutio-nal trust	Norms	Gover-nance
Romania	–0.55	–0.97	–0.05	–1.08	–1.16	–1.30	–1.51	0.22	–2.05
Slovakia	0.75	0.57	0.91	–0.68	0.32	–0.97	–0.68	−	–0.98
Slovenia	–0.10	–0.18	–0.01	0.31	–0.79	–0.61	–0.74	−	–0.35
Spain	–0.86	–0.71	–0.95	0.79	–0.26	0.26	0.42	0.09	0.42
Sweden	3.10	3.02	2.94	1.18	1.66	2.07	0.85	0.04	0.99
Switzerland					–0.63	0.55		0.17	1.25
Turkey	–1.15	–1.33	–0.86	2.07	–0.81	–0.97	0.00	2.15	–2.33

Appendix H. Factor scores of R&D and human capital and standardised values of initial indicators

	R&D	Business R&D expenditures (% of GDP)	Public R&D expenditures (% of GDP)	Human capital	Population with tertiary education	New S&E graduates	Participation in life-long learning
Austria	0.68	0.64	0.60	–0.52	–0.62	–0.27	–0.09
Belgium	0.42	0.72	0.06	0.42	0.86	0.25	–0.28
Bulgaria	–0.83	–0.99	–0.52	–0.65	–0.16	–0.39	–0.94
Czech Republic	–0.23	–0.21	–0.21	–0.94	–0.92	–0.62	–0.39
Denmark	0.87	0.75	0.84	1.20	0.75	0.67	1.44
Estonia	–0.66	–0.96	–0.25	0.26	1.07	–0.31	–0.38
Finland	1.94	1.87	1.69	1.89	1.45	1.56	1.29
France	0.86	0.54	1.03	0.76	0.23	2.31	–0.77
Germany	0.93	1.03	0.68	0.02	0.49	–0.06	–0.47
Greece	–0.72	–0.87	–0.44	–0.61	–0.29	–0.10	–0.98
Hungary	–0.58	–0.70	–0.37	–1.00	–0.62	–0.83	–0.73
Iceland	1.83	0.82	2.54	0.89	0.47	–0.02	1.77
Ireland	–0.54	–0.12	–0.87	1.20	–0.12	3.27	–0.18
Italy	–0.27	–0.47	–0.02	–1.05	–1.13	–0.58	–0.44
Latvia	–1.08	–0.91	–1.06	–0.25	–0.16	–0.23	–0.11
Lithuania	–0.71	–0.97	–0.33	1.49	2.60	1.04	–0.77
Luxembourg	–0.42	0.84	–1.61	–0.89	–0.13	–1.39	–0.52
Malta	–1.28	–1.04	–1.30	–1.56	–1.61	–1.06	–0.56
Netherlands	0.66	0.25	0.95	0.31	0.50	–0.56	0.80
Norway	0.24	0.07	0.37	0.85	1.38	–0.12	0.52
Poland	–0.72	–0.83	–0.48	–0.90	–0.93	–0.39	–0.52
Portugal	–0.36	–0.80	0.14	–1.15	–1.22	–0.46	–0.69
Romania	–1.36	–0.81	–1.69	–1.39	–1.17	–0.83	–1.00
Slovakia	–1.01	–0.60	–1.26	–0.88	–1.05	–0.67	–0.01

	R&D	Business R&D expenditures (% of GDP)	Public R&D expenditures (% of GDP)	Human capital	Population with tertiary education	New S&E graduates	Participation in life-long learning
Slovenia	0.12	–0.12	0.33	–0.29	–0.42	0.08	–0.18
Spain	–0.55	–0.52	–0.48	0.08	0.35	0.29	–0.50
Sweden	2.52	3.00	1.61	1.45	1.16	0.65	1.54
Switzerland	0.94	1.24	0.49	1.24	0.52	–0.52	3.14
Turkey	–0.72	–0.87	–0.44		–1.28	–0.69	