HOW DOES THE CULTURE BENEFIT TO THE INNOVATION: EVIDENCE FROM THE EUROPEAN COUNTRIES[1]

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Abstract

Culture is deemed as crucial ground for innovation in various respects. The aim of this paper is to explore the relationships between different culture dimensions introduced by Hofstede (2001) and innovation initiation capability measured by the numbers of patent applications using the sample of European countries at the regional level. As a novelty, instead using Hofstede's original index scores the measures of culture dimensions are based on European Social Survey (ESS). We have learned that to be successful in patenting a region should have power distance, uncertainty avoidance, family-related collectivism (as an opposite to friends-related and organisations-related collectivism) and masculinity lower than on average. In addition, abovementioned negative relationships between these culture dimensions and patenting are stronger in case of higher patenting intensity. However, culture solely does not serve as a guarantee for high patenting intensity.

Keywords: innovation, culture, Europe.

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1. INTRODUCTION

Innovation is a crucial process in this globalizing world because the country's economic development depends largely on the continued launching of new products and thus, the knowledge of factors that promote innovation benefits to welfare of many people. Innovation is often hindered by problems that can be successfully solved by tapping into culture concepts. Herein, culture uniforms peoples' behaviour but it may also create barriers between different groups and thus innovation meets the consequences of culture for various reasons nowadays. Peoples' understandings about various phenomena can contribute or block a process of developing and implementing new ideas. We take as our focus the culture and doing so, we argue that **culture**[4] is an appropriate concept to describe how innovation is influenced by various human factors. Culture affects innovation because it shapes the patterns dealing with novelties, taking individual initiatives and collective actions, understandings and behaviours in regard to risk as well as opportunities.

The present paper seeks to examine the relationships between different culture dimensions and innovation initiation capability on the sample of European countries at the national (regional) level. The regional level was chosen for two reasons. First, prior research has shown significant within-country differences in the levels of innovative activities (Dakhli and de Clercq, 2004). Second, for the sake of getting reliable results, a larger sample than the number of European countries is necessary.

Individual creativity as a basis of innovation initiation is not only influenced by organisational factors (i.e. organisational culture) but also highly depends by the surrounding (societal) culture as a whole. Without ruling out the role of organisational determinants, in the current paper we concentrate on societal culture as a factor of innovation initiation. To classify and measure societal culture, we use Hofstede's (2001) dimensions of cultural variation: power distance, uncertainty avoidance, masculinity-femininity, and individualism-collectivism. As a novelty, instead of Hofstede's original index scores, in this study the measures of these dimensions are composed on the basis of European Social Survey (ESS) data with the help of confirmative factor analysis.

This paper is organized as follows. After this introduction, the next section presents the theoretical framework. Section 3 introduces data and measurement and Section 4 the results. The results and limitations are discussed in Section 5 and Section 6 draws conclusions.

2. THEORETICAL FRAMEWORK

2.1. Culture and innovation

Innovation is usually understood as the introduction of something new or significantly improved, like products (goods or services) or processes. Innovation can be viewed as a process with two major phases: innovation initiation and innovation implementation (Glynn, 1996; Nakata and Sivakumar, 1996; Williams and McQuire, 2005). At the initiation phase new and useful ideas are generated, which will be adopted and exploited at the

[4] We admit that the term of culture has various interpretations (see for example Nieborg ja Hermes 2008, McSweeney 2002). There is a room for discussion of relationships between terms of national culture and societal culture in the framework of globalization. Herein we use the term 'culture'.

implementation phase. Aside possible organisational support, initiation largely rests on individual creativity (and once an idea is generated, it needs an organisation to become developed and implemented). In this paper, we focus on initiation phase of innovation measuring it by patenting intensity.

Innovation practises differ from region to region and according to Lasch *et al*. (2007) regional innovation theories focus on three main aspects – innovative milieu, industrial districts, and learning regions. All these issues are related to culture that evolves common and shared experiences and thus coins behaviours of individuals and organisations in various situations. Studies demonstrate that innovation requires specific regional conditions and culture is considered to be an important determinant of innovation (for example, Ulijn and Weggeman 2001, Westwood and Low 2003). The cultural impact derives from the issue as coping with different situations depends on opposed processes – tradition and innovation, at that some cultures have accumulated experience to prefer the former and others the latter. In other words, the openness towards new experiences varies along cultures. In addition, this is not a simple dilemma whereby the other culturally rooted believes (i.e. understanding of role of individuals and organisations) play important role whether fundamentally new idea or object would be introduced when people meet puzzling situations in their lives.

Culture is learned – most intensively in the early years of life – and has a continuing impact on every person's mind during all the life. An understanding of the culture helps us predict behaviour of typical members of the culture in normal situations. Culture could explain some unquantifiable and intangible factors by which all societies are governed, but which are often regarded as "natural" or "normal" and very many definitions exist in order to determine the bounds of this phenomenon. Culture has twofold function – on the one hand, it holds society together and on the other, culture assists an individual in decision making, development and other important spheres. It appears, however, that researchers tend to only agree on two basic issues: (1) that culture affects peoples' mind, and (2) that there are many different aspects of these phenomena.

Culture, of course, is a complicated field of study (see for example, Allaire & Firsirotu 1984; Westwood and Low 2003; James, 2005). Several taxonomies exist in order to capture the variation of mechanisms what form commonly shared but unique combinations of values and behaviour patterns on the societal level. Most definitions of culture used currently in the social sciences are modifications of Taylor's delineation of the concept as 'that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society' (see Buono *et al.*, 1985). Leontiev (2006: 52) exemplifies that "Expressed metaphorically, culture is a type of indicator of the optimal way of acting in the world and of understanding the world, and an indicator of the boundaries that influence the selection of experience in this optimal way.". Optimum implies that culture evolves approved standards as well as deviations from those norms or innovations recognized by individuals and society.

2.2. The impact of culture on innovation initiation

Hofstede (2001) argues that the most important differences between cultures can be captured by finding out the extent to which disparate cultures differ with respect to four dimensions – power distance, uncertainty avoidance, individualism-collectivism, and masculinity-femininity. Next, these dimensions are briefly introduced and their possible influence on

innovation initiation is discussed. The review is intended as illustrative, not exhaustive. Regarding each dimension hypothesis is set up based on theoretical considerations and previous results.

Power distance reveals to what extent power and hierarchical relations are considered essential in the given culture. It discloses the scope to which it is accepted that power in organizations and institutions is unequally allocated, or to what degree hierarchy engenders psychological detachment. Large power distance can be characterized by centralized decision structures and high use of formal rules. In case of small power distance the chain of commands is not always followed.

In case of large power distance, sharing of information can be constrained by hierarchy (van Evergingen and Waarts, 2003). However, innovation significantly depends on the spread of information. In small power distance cultures, the communication across the functional or hierarchical boundaries is more common (Williams and McQuire, 2005; Shane, 1993), making possible to connect different creative ideas and thoughts, which can lead to unusual combinations and even radical breakthroughs. Also, it has been argued that bureaucracy reduces creative activity (Herbig and Dunphy, 1998). Tight control and detailed instructions make employees passive and eliminate creative thinking (Shane, 1992). In case of small power distance there is more trust between different hierarchical levels. When employees believe that it is appropriate to challenge the *status quo*, the creativity is higher. Societies with larger power distance tend to be more fatalistic and hence, have less incentive to innovate (Herbig and Dunphy, 1998). These arguments are supported by several previous studies about the relationship between innovation initiation and power distance. Shane's (1992) analysis showed a negative correlation between the inventions patented and power distance. Later, Shane (1993) provided empirical evidence that power distance has a negative effect on the number of trademarks per capita. Williams and McQuire (2005) found a negative effect of power distance on economic creativity of a country. Hence, our first hypothesis is:

Hypothesis 1: There is a negative relationship between power distance and innovation initiation.

Uncertainty avoidance explains whether tense and vague situations are tolerated or avoided and to what extent. This dimension is related to the acceptance of strenuous and uncomfortable situations and regarded by Hofstede as "what is different, is dangerous". In societies with low uncertainty avoidance, organizational rules can be violated for pragmatic reasons, conflicts are considered as a natural part of life, and ambiguous situations are regarded as natural and interesting. In case of strong uncertainty avoidance, these tendencies are opposite. In working relations the rules play an important role and are carefully followed.

As innovations are associated with some kind of changes and uncertainty, cultures with strong uncertainty avoidance are more resistant to innovations (Shane, 1993; Waarts and van Everdingen, 2005), and thus, less motivated to think creatively. To avoid uncertainty, these cultures adopt rules to minimize ambiguity. Rules and reliance on them, in turn, constrain the possibilities to develop new solutions. Uncertainty-averse attitudes also mean that there is less incentive to come out with a novel idea, which will be possibly rejected. Regarding to previous empirical evidence, Shane (1993) demonstrated that uncertainty avoidance has a negative effect on the number of trademarks per capita. Williams and McQuire (2005)

showed that uncertainty avoidance has a negative effect on economic creativity[5] of a country. Thus, we propose:

Hypothesis 2: There is a negative relationship between uncertainty avoidance and innovation initiation.

Individualism-collectivism dimension shows whether the interests of an individual or a group are more important. According to this dimension, all cultures can be characterized by the strength of social forces, which bring individuals together into social entities. According to Hofstede (2001), individualistic societies are characterized by weak relations between individuals and it is assumed that everyone's responsibility is to take care of himself and his family. On the contrary, in collectivistic societies people are connected to each other through strong and cohesive groups that protect them during their life; it is assumed that people are loyal to these groups. In collectivistic cultures, there is commune-based regulation of a society, and political systems are often unbalanced. People connect their identity with groups more than with other characteristics of personality.

Innovation initiation, differently from innovation implementation, is an act of an individual (Williams and McQuire, 2005). Individualistic cultures value freedom more than collectivistic cultures (Herbig and Dunphy, 1998; Waarts and van Everdingen, 2005). Hence, in individualistic societies employees have more possibilities to try something new. Another important aspect is that in collectivistic societies the contribution of an individual rather belongs to the organisation. In the individualistic societies individuals have more reasons than in collectivistic societies to expect compensation and recognition for inventive and useful ideas (Shane, 1992; Herbig and Dunphy, 1998). Also, there is less emphasis on loyalty to organisation in individualistic societies (Herbig and Dunphy, 1998), which promotes information exchange necessary for innovation. As regards previous results, Shane (1992) found a positive correlation between the inventions patented and individualism. In addition, Shane (1993) showed that individualism has a statistically significant positive effect on the number of trademarks per capita. In the analysis of Williams and McQuire (2005) there appeared to be a positive effect of individualism on economic creativity of a country. This leads to our third hypothesis:

Hypothesis 3: There is a positive relationship between individualism and innovation initiation.

Fourth dimension is **masculinity-femininity**, which shows to what extent culture is dominated by such masculine values as orientation on achievement and competition. Detection of self-assertiveness and other "masculine" values, e.g. independence and career, refers to masculinity, and discretion, modesty, tolerance and solidarity describe feminine behaviour. Masculine societies are dominated by men and "masculine" values – independence and career.

It has been proposed that masculinity has no effect on economic creativity (Williams and McQuire, 2005). This proposition is also confirmed by some empirical evidence. Shane (1993) demonstrated that masculinity has no effect on the number of trademarks per capita. Williams and McQuire (2005) found no significant effect of masculinity on economic creativity of a country. Nevertheless, there are some possible influences that have to be taken into account. In feminine societies the focus is on people and a more supportive climate can

[5] Williams and McQuire (2005) use the term 'economic creativity' for the first phase of innovation between the second phase named 'innovation implementation'.

be found. A warm climate, low conflict, trust and socioemotional support help the employees to cope with the uncertainty related to new ideas (Nakata and Sivakumar, 1996). Therefore, we propose:

Hypothesis 4: There is a negative relationship between masculinity and innovation initiation.

Regarding our hypotheses two points should be stressed. First, all arguments presented as well as hypotheses concern innovation initiation. The influence of the same culture dimensions on innovation implementation can be opposite compared to the effects on innovation initiation, as is pointed out, for example, by Nakata and Sivakumar (1996) or Vedina *et al*. (2007). Second, although the proposed relationships can in principle apply to the whole world, in this study hypotheses are tested for European countries only. We concede that, for example Asian context of innovation differs from Europe. Hence, the conclusions just about Europe will be drawn. Next, the data and measurement used for testing these hypotheses will be introduced.

3. DATA AND MEASUREMENT

The data used in this study were drawn from two databases. The measures of patenting were taken from the Eurostat's Regio database (Eurostat, 2007a). To measure culture dimensions, Hofstede's (2001) indices used so far are not exploited in this study, because they are problematic in various respects, for example, they originate from distant and different periods and are based on different samples. In this study, we base on the Hofstede's concept of culture dimensions, but the indicators describing culture dimensions used in this study came from the database of the European Social Survey (ESS) (Jowell *et al*., 2003; Norwegian…, 2007), that includes among others various questions pertaining to all four culture dimensions. It has to be mentioned that the data in the two databases used differ in their nature: while the ESS data were obtained from a special survey, the data in Eurostat Regio gained from the national statistical offices are of a more general character. However, surveys are the best option available for quantitatively assessing (measuring) the culture dimensions. From ESS, the regional-level indicators are found as means of the individual values. To ensure that the data drawn from the ESS would be representative of the demographic structure of a region, weighted data were chosen.

Data were available for 20 countries[6] at the regional level. Although the author's intention was to include all countries at the NUTS2[7] level (European …, 2007), the ESS data were available only at the NUTS1 level for Belgium, France, Germany and the United Kingdom. These countries had thus to be included in the analysis at this level. To control for possible inadequate representation of these four countries, the analysis of NUTS2(1) level (168 observations) data is complemented by the analysis of data at the NUTS1 level (80 observations). Mainly the first round (2002) of the ESS was used. Three questions (see Appendix A), which were not included in 2002, are taken from the second round (2004). Regarding the point of time of observations, it makes sense to assume that the innovation

[6] The countries included in the analysis are: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, and the United Kingdom. In case of Switzerland, the innovation data were not available; hence Switzerland was not included in the analysis.

[7] The NUTS (Nomenclature of Territorial Units for Statistics) is established by Eurostat. This hierarchical classification subdivides each country into a number of NUTS1 regions, each of which is in turn subdivided into a number of NUTS2 regions and so on (see European ..., 2007 for further information).

process takes time and thus a time lag could be useful between the observations of patent applications and the observations of culture. However, the latest available patenting data at the regional level pertained to 2003. Hence only a one-year time lag is applied in this study. Still, it can be viewed as acceptable, as it can be assumed that culture does not change rapidly and Hofstede's dimensions are quite stable over time (Williams and McQuire, 2005). Next, the indicators and measures included in the analysis will be briefly introduced.

Regarding the measures **national innovativeness in the initiation phase**, the earlier empirical research has used for example per capita number of inventions (Shane, 1992) or per capita number of trademarks granted (Shane, 1993). Williams and McQuire (2005) have included three indicators into their latent variable of creativity: total number of patents granted to residents, total number of scientific and engineering publications and the sum of R&D spending admitting that the latter measures rather the inputs of innovation. In this paper innovation initiation is measured by the number of **patent applications** to the European Patent Office (EPO). Four indicators: the numbers of all patent applications, high-tech, ICT and biotechnology (see Eurostat (2007b) for more detailed information) patent applications were included in the analysis. The exact descriptions of the indicators are presented in Appendix A. The reliability of patenting activity as a measure of innovation initiation can be questioned, as it is far from all-including measure and, for example, some inventions are not patentable or are not patented for strategic reasons (Ahuja, 2000). Yet, this is the only way at the moment to proxy innovation initiation at the regional level in Europe. In case of patenting data there were several outlier values both at the NUTS1 and NUTS2(1) level. To control for possible influences of outliers on the results, both the initial data and data after omitting the outlier values are used. In order to preserve as much valuable information as possible, instead of deleting whole observations, each variable was considered separately and values more than three standard deviations away from the mean of a particular indicator were deleted. The descriptive statistics and correlations of patenting data are presented in Appendices B and C.

As regards the measures of **culture**, all the previous empirical studies about the influence of Hofstede's culture dimensions on innovation initiation (Shane, 1992; Shane, 1993, Williams and McQuire, 2005) as well as on the other aspects of innovation (for example van Everdingen and Waarts, 2003; Waarts and van Everdingen, 2005; Nasierovski and Arcelus, 1999) have used the original indicators from Hofstede (1980, 2001). Although culture does not change rapidly, some changes are still possible since 1967-1973, when the surveys underlying Hofstede's indicators were conducted. Moreover, as these surveys covered only the certain part of societies – employees of IBM Corporation –, it would be interesting to use data describing the same cultural dimensions of the sample representing broader society. As ESS includes a range of questions pertaining the Hofstede's dimensions (except long-term orientation), it offers a possibility to create new (possibly more up-to-date and more general) measures of the four dimensions describing culture. Thus, as a novelty, in this study the latent factors of power distance, uncertainty avoidance, individualism-collectivism, and masculinity-femininity are constructed based on the ESS data. The exact descriptions of the indicators used are presented in Appendix A.

In order to attain less subjective choice of indicators to describe dimensions of culture, a process similar to double classification was carried out. First, indicators possibly measuring culture dimensions were chosen separately by both authors. Next, only those indicators were considered that were selected by both authors. Finally, these remaining indicators were discussed to reach consensus about the best set of indicators for each culture dimension. The indicators used for describing culture dimensions had no outlier values (no values more than three standard deviations away from the mean).

In order to construct latent variables reflecting culture dimensions, confirmative[8] factor analysis was conducted using the principal components method. All the dimensions are described by seven indicators. The choice of indicators is based on the overview given by Hofstede (2001) about the characteristics and differences of dimension extremes: low and high power distance, low and high uncertainty avoidance, individualism and collectivism, masculinity and femininity. For the data analysis here and hereafter SPSS for Windows 15.0 was used. For further analysis, the factor scores of latent variables were saved as variables.

Power distance is described by two indicators showing attitude to politicians, two indicators related to institutional trust, and three indicators describing work-related power distance. All seven indicators loaded into one factor. The indicators, factor loadings and percentages of total variance explained by the factor are presented in Table 1 for both regional levels analysed.

Table 1. Latent factor of power distance: indicators, factor loadings and variance explained

Indicator	NUTS2(1)	NUTS1
Politicians care what people think	-0.90	-0.92
Politicians interested in votes rather than in people's opinions	0.81	0.83
Trust in country's parliament	-0.73	-0.72
Satisfied with the way democracy works in country	-0.57	-0.52
Allowed to influence decisions about work directions	-0.83	-0.82
Allowed to decide how respondent's daily work is organised	-0.81	-0.81
Allowed change your work tasks	-0.74	-0.77
Variance explained (%)	59.96	61.04

Uncertainty avoidance is measured by following indicators. Two indicators reflecting the importance of secure society are complemented with an indicator of importance of secure job. In addition, two indicators reflect the importance of trustworthiness and two indicators describe attitudes to immigrants and dissimilar customs related with them. Again, all seven indicators loaded into one factor. The indicators, factor loadings and percentages of total variance explained by the factor are presented in Table 2.

Table 2. Latent factor of uncertainty avoidance: indicators, factor loadings and variance explained

Indicator	NUTS2(1)	NUTS1
Important: government is strong and ensures safety	0.93	0.93
Important: to live in secure surroundings	0.92	0.93
Important when choosing a job: secure job	0.70	0.75
Most people can be trusted	0.86	0.80
Important: to behave properly	-0.82	-0.79
Better if almost everyone share customs and traditions	0.80	0.78
Immigrants make country a better place to live	-0.64	-0.56
Variance explained (%)	66.67	63.74

[8] While in case of exploratory factor analysis any indicator may be associated with any factor, in case of confirmatory factor analysis the indicators describing a particular latent factor are predetermined on the basis of theoretical considerations (see, for instance, Maruyama, 1998).

In order to measure **individualism** (as an opposite of collectivism) following indicators were included. Two indicators describe importance of being independent and two indicators are related to the satisfaction of individual needs. In addition, three indicators describe collectivism at three levels: organisations, friends and family. Unlike in case of other dimensions, the indicators of individualism-collectivism loaded into two factors. The indicators, rotated (equamax rotation) matrix of factor loadings and percentages of total variance explained by the factor(s) are presented in Table 4. The first factor (F1) captures the individualistic values and can thus be referred to as **overall individualism**. The second factor (F2) demonstrates the contradiction between collectivistic attitudes depending on the target groups. This result is in accordance with Realo *et al.* (1997), who found that collectivism is a hierarchical construct with three levels of relationships: family-related, friends-related and society-related collectivism. Here, the results show that the family-related collectivism has negative relationship with friends-(peers-)related and organisations-(society-)related collectivism. This factor can be named as **family-related collectivism** (as an opposite to friends-related collectivism).

Table 3. Latent factors of individualism-collectivism: indicators, factor loadings and variance explained

Indicator	NUTS2(1)		NUTS1	
	F1	F2	F1	F2
Important to think new ideas and do things in original way	0.85	-0.10	0.81	-0.25
Important to make own decisions and to be free	0.80	-0.05	0.81	0.07
Important to have a good time	0.68	-0.07	0.64	-0.06
Important to seek fun and pleasure	0.69	0.26	0.56	0.03
Family ought to be the main priority in life	-0.12	0.77	-0.17	0.75
Membership of voluntary organisations	0.05	-0.86	0.11	-0.85
Important in life: friends	-0.14	-0.68	-0.15	-0.78
Variance explained (%)	33.29	26.94	30.18	28.03
Cumulative variance explained (%)	33.29	60.23	30.18	58.21

Masculinity (as an opposite of femininity) is first described by three indicators showing different aspects of assertiveness, which are complemented with the importance of work. Masculine values also include the importance of religion. The last two indicators reflect the attitudes to gender inequality and sexual minorities. Again, all seven indicators loaded into one factor. The indicators, factor loadings and percentages of total variance explained by the factor are presented in Table 4.

Table 4. Latent factor of masculinity: indicators, factor loadings and variance explained

Indicator	NUTS2(1)	NUTS1
Important to get respect	0.82	0.79
Important to show abilities and to be admired	0.75	0.72
Important to be successful and recognised for achievements	0.74	0.64
Important in life: work	0.67	0.60
Important in life: religion	0.80	0.78
Men should have more rights when jobs scarce	0.75	0.75
Gays and lesbians should be free to live	-0.73	-0.74
Variance explained (%)	56.81	52.00

As it can be seen from Tables 1-4, the results are quite similar for the NUTS2(1) and NUTS1 level. For further analysis, the factor scores of latent factors were saved as variables. As the factors were constructed with the help of confirmative and not explorative factor analysis, some factors are correlated. Uncertainty avoidance, power distance, masculinity and family-related collectivism are positively correlated with each-other (see Appendix D). The relatively high correlations can be explained by the fact that the European countries analysed can be viewed as a quite homogeneous sample concerning covariance of culture dimensions compared to the sample used by Hofstede (2001) covering countries over the whole world. For example, most European countries have rather small power distance and the larger the power distance, the stronger is the uncertainty avoidance (*ibid*.). In addition, it is possible that the culture dimensions have come closer to each-other. These considerations have been also pointed out by Gooderham and Nordhaug (2002).

Next, the results about the relationships between the culture dimensions measured by latent factors and patenting intensity will be presented.

4. RESULTS

First, correlation analysis[9] of the patenting indicators and factors measuring culture dimensions was conducted. In addition, graphing patenting intensity indicators against the indicators of culture dimensions allowed assuming that patenting intensity grows exponentially with the change of culture (see, for example, hyperbolic graphs in Appendix E). Therefore, the natural logarithms (enabling to evaluate the strength of a hyperbolic relationship) of patenting indicators are complementarily included into the correlation analysis. The correlation coefficients are introduced in Table 5.

As it can be seen from Table 5, power distance, uncertainty avoidance, family-related collectivism and masculinity all have statistically significant negative relationship with all indicators of patenting intensity. The relationship seems to be strongest in case of uncertainty avoidance. Overall individualism appears to have much weaker or no relationship at all with patenting intensity. After omitting outlier values with extremely high levels of patenting intensity, the correlations turned out to be stronger in almost all cases.

Furthermore, in most cases the correlations are even stronger after the logarithmic transformation of patenting data. The only exceptions are biotechnology patent applications at the NUTS2(1) level and partially also at the NUTS1 level, as well as in case of the relationship between uncertainty avoidance and high-tech patent applications. Hence, in case of higher patenting intensity, the differences in the score of the particular culture dimension are associated with larger differences in patenting intensity (except in most cases of biotechnology patent applications).

[9] As the factors describing culture dimensions are correlated, the regression analysis could not be used due to multicollinearity.

Table 5. Correlations between culture dimensions and patenting intensity indicators

			Power distance	Uncertainty avoidance	Overall individualism	Family-related collectivism	Masculinity
NUTS2(1):	With outlier values:	Patent applications	-0.42 **	-0.53 **	0.21 *	-0.46 **	-0.36 **
		High-tech patent applications	-0.35 **	-0.39 **	0.08	-0.32 **	-0.30 **
		ICT patent applications	-0.33 **	-0.37 **	0.08	-0.32 **	-0.28 **
		Biotechnology patent applications	-0.42 **	-0.49 **	0.15	-0.42 **	-0.25 **
	Outlier values omitted:	Patent applications	-0.50 **	-0.59 **	0.24 **	-0.49 **	-0.43 **
		High-tech patent applications	-0.39 **	-0.53 **	0.22 *	-0.41 **	-0.41 **
		ICT patent applications	-0.41 **	-0.55 **	0.19 *	-0.43 **	-0.42 **
		Biotechnology patent applications	-0.43 **	-0.46 **	0.10	-0.41 **	-0.27 **
		ln(Patent applications)	-0.60 **	-0.65 **	0.38 **	-0.67 **	-0.57 **
		ln(High-tech patent applications)	-0.45 **	-0.51 **	0.36 **	-0.53 **	-0.51 **
		ln(ICT patent applications)	-0.49 **	-0.60 **	0.33 **	-0.61 **	-0.50 **
		ln(Biotechnology patent applications)	-0.29 **	-0.29 **	0.16	-0.34 **	-0.27 **
NUTS1:	With outlier values:	Patent applications	-0.38 **	-0.57 **	0.18	-0.45 **	-0.42 **
		High-tech patent applications	-0.43 **	-0.52 **	0.06	-0.38 **	-0.39 **
		ICT patent applications	-0.38 **	-0.47 **	0.06	-0.37 **	-0.35 **
		Biotechnology patent applications	-0.51 **	-0.60 **	0.24 *	-0.48 **	-0.38 **
	Outlier values omitted:	Patent applications	-0.48 **	-0.61 **	0.19	-0.45 **	-0.49 **
		High-tech patent applications	-0.55 **	-0.65 **	0.08	-0.43 **	-0.50 **
		ICT patent applications	-0.53 **	-0.65 **	0.06	-0.46 **	-0.50 **
		Biotechnology patent applications	-0.47 **	-0.56 **	0.23	-0.44 **	-0.36 **
		ln(Patent applications)	-0.60 **	-0.70 **	0.33 **	-0.61 **	-0.67 **
		ln(High-tech patent applications)	-0.61 **	-0.72 **	0.25 *	-0.58 **	-0.69 **
		ln(ICT patent applications)	-0.61 **	-0.72 **	0.25	-0.60 **	-0.65 **
		ln(Biotechnology patent applications)	-0.49 **	-0.54 **	0.35 **	-0.54 **	-0.45 **

** – significant at the 0.01 level, * – significant at the 0.05 level (two-tailed).
ln – natural logarithm

As four out of five culture factors are correlated to each-other (see Appendix D), it is possible to present culture variance in regions analysed on a single figure by putting the mean value of four factors (power distance, uncertainty avoidance, family-related collectivism, masculinity) on one axis and the value of the factor describing overall individualism on the other axis. For the NUTS2(1) level this can be seen on Figure 1 (in case of NUTS1 level, the figure is analogical). To demonstrate the culture differences between the regions with higher and lower patenting intensity, the observations (regions) are distinguished according to the value of the variable describing patent applications. In addition to the regions with patent applications both more and less than the mean value of the sample (without outliers), the outliers are also marked on the Figure 1.

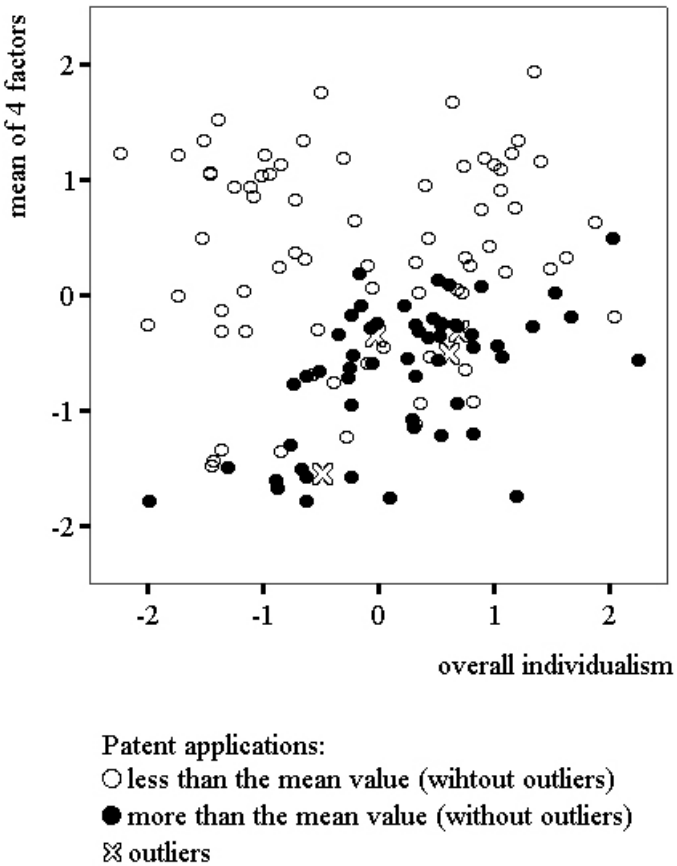

Figure 1. Patenting intensity in the context of mean of 4 factors (power distance, uncertainty avoidance, family-related collectivism, masculinity) and factor describing overall individualism at the NUTS2(1) level.

Figure 1 demonstrates that most of the regions with patenting intensity higher than on average have the mean of four factors (power distance, uncertainty avoidance, family-related collectivism, masculinity) lower than on average; on the contrary, the regions with lower patenting intensity mainly have this mean above average, although there are some regions, where patenting intensity is low despite of low levels of this mean of four culture factors. Regarding overall individualism, it remains rather near the mean level in case of high patenting intensity, whereas in case of low patenting intensity the variance of overall

individualism is higher. Hence, while the differences in patenting intensity can be at least partly explained with the differences in the mean of four factors, the differences in overall individualism do not account for differences in patenting intensity. It can be also seen that the outlier regions (with extremely high patenting intensity) are positioned between the other regions with high patenting intensity and can not be considered as outliers concerning culture dimensions. At last, it can be pointed out that in case of high patenting intensity, the larger is the mean of the four factors, the stronger is also the overall individualism (correlation coefficient 0.54). At the same time, this cannot be seen for regions with low patenting intensity (correlation coefficient 0.09 and not statistically significant).

5. DISCUSSION AND LIMITATIONS

5.1. Discussion of the results

The following discussion can be divided in two parts. First, the results of this study are discussed in the light of four hypotheses and the previous empirical studies. Second, we present the 'by-products' of our study and here we discuss interesting results and implications arising from this study. These results open some issues of the shape and exceptions of the relationship between patenting intensity and culture dimensions as well as the interaction of culture dimensions.

The findings of this study provide significant support for the argument that the innovation initiation capability of a country or region is related to its culture. The results of correlation analysis show that four out of five factors measuring culture dimensions (power distance, uncertainty avoidance, family-related collectivism and masculinity) are moderately negatively related to the number of patent applications. The negative relationships of power distance, uncertainty avoidance and masculinity with patenting intensity confirm our Hypotheses 1, 2 and 4 respectively. In case of power distance and uncertainty avoidance, the results are in accordance with previous results (Shane, 1992, 1993; Williams and McQuire, 2005). However, contrarily, our results show negative relationship of masculinity with patenting intensity, while previous studies have – regardless of some theoretical considerations (Nakata and Sivakumar, 1996) – shown no effect of masculinity on the number of trademarks per capita (Shane, 1993) or on economic creativity of a country (Williams and McQuire, 2005).

Regarding our Hypothesis 3 (concerning individualism-collectivism), the results are more complex. In case of individualism-collectivism, the factor analysis resulted in two different factors allowing assume that at least two aspects of individualism-collectivism have to be distinguished. The first factor can be named overall individualism contains individualistic values. The second factor indicates the existence of different forms of collectivism by contrasting family-related collectivism with both friends-(peers-) related and organisations-(society-) related collectivism. It turned out that overall individualism is weakly positively related or not related to patenting intensity. Hence in this aspect our Hypothesis 3 and the results of previous studies (Shane, 1992, 1993; Williams and McQuire, 2005) are slightly confirmed (the relationships are weak and not statistically significant in all cases). However, it is not clear whether this result means that there are, indeed, no relationship between overall individualism and patenting intensity, or it comes from the fact that Europe is quite homogeneous according to the overall individualism (the standard deviations of indicators describing overall individualism range from 0.22 to 0.46, while standard deviations of indicators describing other factors range from 0.22 to 1.67, the average standard deviations

are 0.32 and 0.62 repectively). At the same time family-related collectivism appeared to be negatively (and friends-related and organisations-related collectivism positively related) to patenting intensity. Thus, collectivism shared with friends and co-members of organisations seems to promote innovation initiation, while loyalty to family seems to hinder innovation initiation. It is possible that cultures highly valuing the family tend to be more conservative and less open to new and creative ideas, while cultures focusing more on the relationships with friends and other persons outside families are more open, and relationships with persons with different background enables to have wider world view as a powerful source of new ideas. This interpretation is also confirmed by the study of Realo *et al.* (1997) showing that the family level collectivism has the highest negative correlation with personality trait Openness.

Regarding the additional results, first, logarithming the patenting indicators indicated that the relationships between the most of patenting indicators (except biotechnology patent applications) and culture dimensions are stronger in the case of higher patenting intensity, as can be seen from the figures in Appendix E as well. Hence, the relationships between culture dimensions and innovation initiation seem to be more complicated than the linear relationships suggested so far in the literature. Regarding of biotechnology patent applications, it can be assumed that the rather linear relationship can be explained by the fact that the levels and range of biotechnology patenting intensity are remarkably lower than in case of patenting intensity on the whole as well as high-tech and ICT patenting intensity (see Appendix B). As only a little section of the non-linear relationship is reflected by the data available and analysed here, it can be easily (however possibly erroneously) approximated to a linear relationship.

Second, mapping the regions according to the culture differences (Figure 1) gave two implications. First, in order to patent more than on average, a region should have power distance, uncertainty avoidance, family-related collectivism and masculinity lower than on average. However, low levels of these culture dimensions cannot be viewed as a guarantee for high patenting intensity. Contrarily, the level of overall individualism seems to have little relevance for patenting intensity. Second, one presumption for high patenting intensity could be the right co-influence of culture dimensions: for high patenting intensity higher power distance, uncertainty avoidance, family-related collectivism and masculinity have to be balanced with higher individualism and vice versa – the factors hindering innovation initiation should be compensated by some factor promoting it. However, this balance itself cannot be always expected to assure success in patenting.

Third, the results also show that in case of some regions with outstanding levels of patenting intensity, there has to be some other factor with strong influence on patenting intensity as the scores of all culture dimensions appeared to be rather at the medium level for these regions. This can be seen from both the figures in Appendix E and Figure 1. This is also confirmed with the result that the correlations between culture dimensions and patenting indicators became stronger after omitting outliers with extremely high levels of patenting intensity. Hence, although the results show that certain characteristics of culture are an important presumption for successful patenting, the outstanding success in patenting rests on some other important factor – culture is important, but the possible influence of cultures is limited and culture alone does not lead to top success in patenting.

5.2. Limitations

Regarding limitations of this study, first, it should be stressed that in this study the hypotheses were tested and conclusions can be drawn for European countries only. Whether the analysed relationships can apply to the whole world, is an object of future studies, when data for larger sample than Europe become available. Second, we have not included into our analysis the later added dimension of long-term orientation because of lack of data. However, as according to the previous results (Hofstede, 2001) it can be assumed that the variance of long-term orientation in Europe is relatively small compared to the whole world, it is possible that when studying European countries, the relationship of long-term orientation and innovations does not appear even if it exists concerning the whole world. Still, if appropriate data will be available, it would be interesting to study the influence of long-term orientation on innovation as well, especially for a larger sample than European countries.

Third, in this paper the numbers of different patent applications were used as indicators of innovation initiation, because at present, only these data were available for the sample analysed. However, it would be interesting to retest the relationships tested in this paper using some other indicators of innovation initiation. Further, it is possible that the relationships found in this study between culture dimensions and patenting intensity, are reflecting not only the impact of culture on innovation initiation, but also the impact of culture on the propensity to protect intellectual property. Fourth, in this study, we focussed on only one major phase of innovation process – innovation initiation, but it can be assumed that the other phase – innovation implementation, which includes for example adoption and diffusion of innovative ideas created at the initiation phase, is related to the culture as well. The relationship between culture and innovation implementation serve as a very interesting subject for future studies. Fifth, for reasons of data unavailability, only a one-year time lag is used in this study. As it is commonly accepted that innovation processes take time, it would be reasonable to test the relationships with longer time lag, if data become available.

6. CONCLUSIONS

The title of our paper poses a question, which has to be answered. We have learned that there is a reliable link between culture dimensions and patenting intensity what we considered as the indicator of initiation phase of innovation. However, although culture undoubtedly plays an important role for patenting intensity, it should be stressed that the relationship is not straightforward and the culture is not a sufficient factor for getting notable outcome in the patenting intensity.

We have found that to be successful in patenting a region should have power distance, uncertainty avoidance, family-related collectivism (as an opposite to friends-related and organisations-related collectivism) and masculinity lower than on average. It turned out that the relationships seem to be more complicated than the linear relationships suggested so far in literature: the relationships are stronger in case of higher patenting intensity where the same differences in culture are associated with larger differences in patenting. For success in patenting relatively higher levels power distance, uncertainty avoidance, family-related collectivism and masculinity have to be balanced with relatively higher individualism and vice versa, but these presumptions do not ensure high patenting intensity. However, although certain characteristics of culture serve as an important presumption for high patenting intensity, culture is not sufficient factor for getting notable outcome in the patenting intensity.

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Appendix A. Indicators measuring innovation initiation and culture dimensions

Concept	Indicator	The exact name of indicator according to the source
Innovation initiation	Patent applications	Patent applications to the EPO by priority year, per million labour force
	High-tech patent applications	High-tech patent applications to the EPO by priority year, per million labour force
	ICT patent applications	ICT patent applications to the EPO by priority year, per million labour force
	Biotechnology patent applications	Biotechnology patent applications to the EPO by priority year, per million labour force
Power distance	Politicians care what people think	Do you think that politicians in general care what people like you think? (Average on scale 1-5)[10]
	Politicians interested in votes rather than in people's opinions	Would you say that politicians are just interested in getting people's votes rather than in people's opinions? (Average on scale 1-5)
	Allowed to decide how respondent's daily work is organised	How much the management at your work allows you ... to decide how your own daily work is organised? (Average on scale 0-10)
	Allowed to influence decisions about work directions	How much the management at your work allows you ... to influence decisions about the general direction of your work? (Average on scale 0-10)
	Allowed change your work tasks	How much the management at your work allows you ... to change your work tasks if you wish to? (Average on scale 0-10)
	Trust in country's parliament	How much you personally trust each of the institutions: country's parliament? (Average on scale 0-10)
	Satisfied with the way democracy works in country	On the whole, how satisfied are you with the way democracy works in your country? (Average on scale 0-10)
Uncertainty avoidance	Important: government is strong and ensures safety	How much each person is or is not like you: It is important to her/him that the government ensures her/his safety against all threats. She/he wants the state to be strong so it can defend its citizens. (Average on scale 1-6)
	Important: to live in secure surroundings	How much each person is or is not like you: It is important to her/him to live in secure surroundings. She/he avoids anything that might endanger her/his safety. (Average on scale 1-6)
	Important when choosing a job: secure job	For you personally, how important do you think each of the following would be if you were choosing a job: A secure job. (Average on scale 1-5*)
	Most people can be trusted	Would you say that most people can be trusted, or that you can't be too careful in dealing with people? (Aaverage on scale 0-10)
	Important: to behave properly	How much each person is or is not like you: It is important to her/him always to behave properly. She/he wants to avoid doing anything people would say is wrong. (Average on scale 0-10)
	Better if almost everyone share customs and traditions	Better for a country if almost everyone share customs and traditions. (Average on scale 1-5)
	Immigrants make country a better place to live	Is country made a worse or a better place to live by people coming to live here from other countries? (Average on scale 0-10, 0-worse, 10-better)

[10] Here and hereafter, if the indicator shows agreement with a statement, the scales are chosen so that larger values reflect more agreement.

Individualism-collectivism	Membership of voluntary organisations	For each of the voluntary organisations[11], please tell me whether any of these things apply to you now or in the last 12 months, and, if so, which: Member. (Average number of memberships per person)
	Family ought to be the main priority in life	A person's family ought to be his or her main priority in life. (Average on scale 1-5*)
	Important in life: friends	How important are friends in your life? (Average on scale 0-10)
	Important to think new ideas and do things in original way	How much each person is or is not like you: Thinking up new ideas and being creative is important to her/him. She/he likes to do things in her/his own original way (Average on scale 0-10)
	Important to have a good time	How much each person is or is not like you: Having a good time is important to her/him. She/he likes to "spoil" herself/himself. (Average on scale 0-10)
	Important to seek fun and pleasure	How much each person is or is not like you: She/he seeks every chance she/he can to have fun. It is important to her/him to do things that give her/him pleasure. (Average on scale 0-10)
	Important to make own decisions and to be free	How much each person is or is not like you: It is important to her/him to make her/his own decisions about what she/he does. She/he likes to be free and not depend on others. (Average on scale 0-10)
Masculinity-femininity	Important to get respect	How much each person is or is not like you: It is important to her/him to get respect from others. She/he wants people to do what she/he says. (Average on scale 0-10)
	Important to be successful and recognised for achievements	How much each person is or is not like you: Being very successful is important to her/him. She/he hopes people will recognise her/his achievements. (Average on scale 0-10)
	Important to show abilities and to be admired	How much each person is or is not like you: It's important to her/him to show her/his abilities. She/he wants people to admire what she/he does. (Average on scale 0-10)
	Important in life: work	How important is work in your life? (Average on scale 0-10)
	Important in life: religion	How important is religion in your life? (Average on scale 0-10)
	Men should have more rights when jobs scarce	Men and women and their place in the family: When jobs are scarce, men should have more right to a job than women. (Average on scale 1-5*)
	Gays and lesbians should be free to live	Gay men and lesbians should be free to live their own life as they wish. (Average on scale 1-5)

* data for year 2004

[11] Trade unions, business/professional/farmers' organisations, political parties, sports/outdoor activity clubs, cultural /hobby activity organisations, religious/church organisations, consumer/automobile organisations, humanitarian organisations etc., environmental/peace/animal organisations, science/education/teacher organisations, social clubs etc., other voluntary organisations.

Appendix B. Descriptive statistics of patenting intensity indicators

		With outliers:					Without outliers:				
		N	Min.	Max.	Mean	Sandard deviation	N	Min.	Max.	Mean	Sandard deviation
NUTS2(1):	Patent applications	158	1.30	720.40	106.67	121.29	153	1.30	338.61	92.68	92.05
	High-tech patent applications	153	0.01	234.07	17.84	32.19	136	0.01	37.19	8.75	9.98
	ICT patent applications	154	0.01	452.18	26.30	49.97	138	0.01	54.79	13.70	15.32
	Biotechnology patent applications	130	0.00	22.70	4.54	5.27	127	0.00	17.36	4.15	4.67
NUTS1:	Patent applications	79	1.93	635.32	129.21	126.67	76	1.93	338.61	112.54	95.26
	High-tech patent applications	79	0.02	168.38	21.27	27.96	74	0.02	54.15	15.55	15.20
	ICT patent applications	79	0.33	320.35	31.66	45.71	74	0.33	76.97	22.36	21.10
	Biotechnology patent applications	79	0.00	21.14	4.89	4.78	77	0.00	15.66	4.49	4.13

Appendix C. Correlations between indicators of patenting intensity*

		Indicator		1.	2.	3.	4.	5.	6.	7.
NUTS2(1):	1.	Patent applications								
	2.	High-tech patent applications		0.79						
	3.	ICT patent applications		0.80	0.97					
	4.	Biotechnology patent applications		0.49	0.47	0.38				
	5.	Patent applications,	outlier values omitted	1.00	0.74	0.78	0.55			
	6.	High-tech patent applications,	outlier values omitted	0.76	1.00	0.93	0.60	0.79		
	7.	ICT patent applications,	outlier values omitted	0.79	0.93	1.00	0.48	0.83	0.93	
	8.	Biotechnology patent applications,	outlier values omitted	0.50	0.45	0.38	1.00	0.54	0.57	0.45
NUTS1:	1.	Patent applications								
	2.	High-tech patent applications		0.82						
	3.	ICT patent applications		0.84	0.97					
	4.	Biotechnology patent applications		0.60	0.52	0.43				
	5.	Patent applications,	outlier values omitted	1.00	0.76	0.82	0.65			
	6.	High-tech patent applications,	outlier values omitted	0.78	1.00	0.98	0.74	0.78		
	7.	ICT patent applications,	outlier values omitted	0.83	0.98	1.00	0.68	0.83	0.98	
	8.	Biotechnology patent applications,	outlier values omitted	0.64	0.54	0.45	1.00	0.68	0.73	0.67

* all coefficients were significant at the 0.01 level (two-tailed).

Appendix D. Correlations between latent factors describing culture dimensions

			1.	2.	3.	4.
NUTS2(1):	1.	Power distance				
	2.	Uncertainty avoidance	0.78 **			
	3.	Overall individualism	0.06	0.19 *		
	4.	Family-related collectivism	0.76 **	0.82 **	0.01	
	5.	Masculinity	0.63 **	0.78 **	0.16	0.72 **
NUTS1:	1.	Power distance				
	2.	Uncertainty avoidance	0.82 **			
	3.	Overall individualism	0.00 **	0.12		
	4.	Family-related collectivism	0.69 **	0.73 **	-0.01	
	5.	Masculinity	0.59 **	0.77 **	0.04	0.62 **

** significant at the 0.01 level, * significant at the 0.05 level (two-tailed).

Appendix E. Observations of clouds between patent applications and latent factors describing culture dimensions at the NUTS2(1) level