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HOW DOES CULTURE CONTRIBUTE TO INNOVATION? EVIDENCE FROM EUROPEAN COUNTRIES

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How does culture contribute to innovation? Evidence from European countries[1]

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Abstract

Culture is deemed to be a crucial basis for innovation in various respects. The aim of this paper is to explore the relationships between different cultural dimensions introduced by Hofstede (2001) and the capability of initiating innovation measured by the number of patent applications using the sample of European countries at the regional level. As a novel approach, instead of using Hofstede's original index scores, the measures for the cultural dimensions are based on the 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 opposed to friend-related and organisation-related collectivism) and lower than average masculinity. In addition, the negative relationships between these cultural dimensions and patenting are stronger when there is a higher patenting intensity. However, culture alone does not serve as a guarantee for a high level of patenting intensity.

Keywords: innovation, culture, Europe

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1. INTRODUCTION

It has long been recognised that innovation is a major force in economic development (see, for example Fagerberg, 1987; Freeman and Soete, 1997; Gregersen and Johnson, 1997; Verspagen, 2006) and thus, the knowledge of factors that promote or constrain innovation benefits the welfare of many people. Innovation is often hindered by problems that can be explained by tapping into concepts of culture. Culture is even mentioned as the first issue when the "Big 10" Innovation Killers are presented (Wycoff, 2003). Culture unifies people's behaviour, but it may also create barriers between people, thus nowadays, innovation faces the consequences of culture for various reasons. People's beliefs and behaviour can contribute or block the process of developing and implementing new ideas. We take culture as our focus, and in 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 novelty, individual initiatives and collective actions, and understandings and behaviours in regard to risks as well as opportunities.

The present paper seeks to examine the relationships between different cultural dimensions and the ability to initiate innovation measured by patenting intensity using 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, particularly in larger countries (Dakhli and de Clercq, 2004). Second, for the sake of obtaining reliable results, a larger sample than the number of European countries is necessary.

Individual creativity as a basis for initiating innovation is not only influenced by organisational factors (i.e. organisational culture), but also greatly depends on the surrounding (societal) culture as a

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

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 novel approach, instead of Hofstede's original index scores, in this study the measures of these dimensions are composed on the basis of the 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 implementation phase. Aside from possible organisational support, initiation largely rests on individual creativity (and once an idea is generated, it needs an organisation for it to become developed and implemented). In this paper, we focus on the initiation phase of innovation by measuring it via patenting intensity.

Previous studies have demonstrated that innovation requires specific conditions (innovative milieu), and culture is considered to be an important determinant of innovation (for example, Ulijn and Weggeman 2001, Westwood and Low 2003). The cultural impact

stems from the fact that coping with different situations is associated with two opposing processes – tradition and innovation – and that some cultures have an accumulated experience that prefers the former and others the latter. In other words, the openness towards new experiences varies in different cultures. In addition, this is not a simple dilemma whereby the other culturally rooted beliefs (i.e. understanding of role of individuals and organisations) play an important role in determining whether a fundamentally new idea or object could 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 throughout life. An understanding of our culture helps us predict the 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 a 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 people's mind, and (2) that there are many different aspects of this phenomenon. As Aycan (2000: 11) has put it: the real issue is not whether but to what extent and in what ways culture influences individual and group phenomena in organizations.

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, a 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. A large power distance can be characterized by centralized decision structures and extensive use of formal rules. In the case of small power distance the chain of commands is not always followed.

In the case of large power distance, the sharing of information can be constrained by the hierarchy (van Evergingen and Waarts, 2003). However, innovation significantly depends on the spread of information. In cultures that exhibit less power distance, communication across functional or hierarchical boundaries is more common (Williams and McQuire, 2005; Shane, 1993), making it possible to connect different creative ideas and thoughts, which can then 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 the 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*, 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 that power distance had a negative effect on economic creativity in 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 the case of strong uncertainty avoidance, the opposite tends to prevail. In working relations rules play an important role and are carefully followed.

On the one hand, as innovations are associated with some kind of change 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 opportunities 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. On the other hand, it can also be supposed that in cultures with stronger uncertainty avoidance,

there is a stronger tendency to protect intellectual property with patenting. However, creating and patenting innovations are sequential phenomena: if there are no innovations there is nothing to patent as well. Regarding the 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 the economic creativity[5] of a country. Thus, we propose:

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

The 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 to form 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 a commune-based regulation of society, and political systems are often unbalanced. People connect their identity with groups more than with other characteristics of personality.

Innovation initiation, as opposed to the innovation implementation, is often seen as the act of an individual (Williams and McQuire, 2005): the initial ideas emerge in the head of an individual and the group can only be supportive or not. Individualistic cultures value freedom more than collectivistic cultures (Herbig and Dunphy, 1998; Waarts and van Everdingen, 2005). Hence, in individualistic societies employees have more opportunities to try something new. Another important aspect is that in collectivistic societies, the contribution of an individual rather belongs to the organisation. In

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

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 the organisation in individualistic societies (Herbig and Dunphy, 1998), which promotes the information exchange necessary for innovation. Looking at 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 by Williams and McQuire (2005), there appeared to be a positive effect of individualism on the economic creativity in a country. This leads to our third hypothesis:

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

The fourth dimension is **masculinity-femininity**, which shows to what extent a culture is dominated by such masculine values as orientation towards achievement and competition. The detection of self-assertiveness and other "masculine" values, such as independence and career, refers to masculinity, and discretion, modesty, tolerance and solidarity describe feminine behaviour. Masculine societies are dominated by men and the "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 of the 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 the 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 be found. A warm climate, low conflict, trust and socio-emotional support help 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 in this paper as well as hypotheses concern innovation initiation. The same cultural dimensions can have the opposite influence on innovation implementationcompared 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 the hypotheses are tested for European countries only. We concede that, for example, the Asian innovation context differs from Europe. Hence, conclusions will only be drawn about Europe. In the next section, the data and measures used for testing the hypotheses will be introduced.

3. DATA AND MEASUREMENT

The data used in this study were drawn from two databases. The measures of patenting intensity were taken from Eurostat's Regio database (Eurostat, 2007a). To measure cultural 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 use Hofstede's concept of cultural dimensions, as the basis, but the indicators describing cultural dimensions used in this study came from the database of the European Social Survey (ESS) (Jowell *et al*., 2003; Norwegian…, 2007), which includes among others, various questions pertaining to all four cultural 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 cultural dimensions. From the ESS, regional-level indicators are found as a 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 only available at the NUTS1 level for Belgium, France, Germany and the United Kingdom. These countries thus had 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 choice of observation years, it makes sense to assume that the innovation 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, this can be viewed as being 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). Now, the indicators and measures included in the analysis will be briefly introduced.

Regarding the measures of **national innovativeness in the initiation phase**, the earlier empirical research has used, for example, per capita numbers of inventions (Shane, 1992) or per capita numbers of trademarks granted (Shane, 1993). Williams and

[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 the case of Switzerland, 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).

McQuire (2005) have included three indicators in their latent variable of creativity: the total number of patents granted to residents, the total number of scientific and engineering publications and the sum of R&D spending admitting that the latter measures rather the inputs than the outputs of innovation. In this paper, innovation initiation is measured using the number of **patent applications** to the European Patent Office (EPO). Four indicators: the numbers of all patent applications, high-tech patent applications, ICT patent applications and biotechnology patent applications (see Eurostat (2007b) for more detailed information) 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 an all-inclusive 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 the case of patenting data, there were several outlier values both at the NUTS1 and NUTS2(1) level. To control for the 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 cultural 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 portion of societies – the employees of the IBM Corporation – it would be interesting to use data describing the same cultural dimensions of the sample representing broader society. In

addition, as the units of the IBM Corporation were located unevenly, a regional bias is also possible in the case of Hofstede's original indicators. As the ESS includes a range of questions pertaining the Hofstede's dimensions (except long-term orientation), it offers an opportunity 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. As the data are given at the regional level in ESS, this approach also enables a regional-level analysis, while Hofstede's indicators are given at the country level. The exact descriptions of the indicators used are presented in Appendix A.

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

In order to construct latent variables reflecting cultural dimensions, a confirmative[8] factor analysis was conducted using the principal components method. All the dimensions are described using 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.

[8] While in the case of exploratory factor analysis any indicator may be associated with any factor, in the 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).

Power distance is described using two indicators showing the 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 using the following indicators. Two indicators reflecting the importance of a secure society are complemented with an indicator of the importance of a secure job. In addition, two indicators reflect the importance of trustworthiness and two indicators describe attitudes to immigrants and the dissimilar customs related to them. Again, all seven indicators loaded into one factor. The results 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

In order to measure **individualism** (as an opposite of collectivism), the following indicators were included. Two indicators describe the 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 with the other dimensions, the indicators of individualism-collectivism loaded into two factors. The indicators, the rotated (equamax rotation) matrix of factor loadings and the percentages of total variance explained by the factor(s) are presented in Table 3. The first factor (F1) captures 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 family-related collectivism has a negative relationship with friends-(peers-)related and organisations-(society-)related collectivism. This factor can be called **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 using 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 attitudes to gender inequality and sexual minorities. Again, all seven indicators loaded into one factor. The results are presented in Table 4.

Table 4. Latent factors 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 can be seen from Tables 1–4, the results are quite similar for the NUTS2(1) and NUTS1 levels. For further analysis, the factor scores for latent factors were saved as variables. As the factors were constructed with the help of a 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 cultural 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 the uncertainty avoidance (*ibid.*). In addition, it is possible that the cultural dimensions have come closer to each other. These considerations have also been pointed out by Gooderham and Nordhaug (2002).

Considering that there were correlations between four factors out of five, a second order factor analysis was also conducted using the principal components method. The results are shown in Table 5.

Table 5. Second order factors of cultural dimensions: indicators, factor loadings and variance explained

Indicator	NUTS2(1)		NUTS1	
	F1	F2	F1	F2
Uncertainty avoidance	0.95	0.04	0.95	0.07
Family-related collectivism	0.91	–0.19	0.89	–0.14
Masculinity	0.90	0.07	0.88	0.06
Power distance	0.88	–0.13	0.87	–0.09
Overall individualism	0.18	0.98	0.08	0.99
Variance explained (%)	66.80	20.30	64.35	20.41
Cumulative variance explained (%)	66.80	87.10	64.35	84.76

As expected, the four correlated factors loaded into one factor and overall individualism into the second factor. Hence, in European countries it seems to be possible to reduce the cultural dimensions analysed in this article to two main dimensions. One captures uncertainty avoidance, masculinity, power distance and family-

related collectivism; the other seems to include only overall individualism at the moment. However, it is possible that some other cultural dimensions exist that correlate with overall individualism, but are not involved in the Hofstede's framework used here.

In the next section, the results of the relationships between the cultural dimensions measured using the latent factors and patenting intensity will be presented.

4. RESULTS

First, a correlation analysis[9] of the patenting indicators and factors measuring cultural dimensions was conducted. In addition, graphing patenting intensity indicators against the indicators of cultural dimensions allowed us to assume that patenting intensity grows exponentially with the change of culture (see, for example, hyperbolic graphs in Appendix E). Therefore, the natural logarithms (enabling us to evaluate the strength of a hyperbolic relationship) of patenting indicators are complementarily included in the correlation analysis. The correlation coefficients are introduced in Table 6.

As can be seen from Table 6, power distance, uncertainty avoidance, family-related collectivism and masculinity all have a statistically significant negative relationship with all the indicators of patenting intensity. The relationship seems to be strongest in the case of uncertainty avoidance. Overall individualism appears to have a much weaker or non-existent relationship 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.

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

Table 6. Correlations between cultural 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

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

As it is possible to reduce the cultural dimensions analysed in this article to two main dimensions (as seen before), it is possible to present cultural variance in the regions analysed on a single figure by putting the second order factor of four factors (power distance, uncertainty avoidance, family-related collectivism, masculinity) on one axis and the second order factor describing overall individualism on the other axis. For the NUTS2(1) level this can be seen in Figure 1 (for NUTS1, the figure is analogical). To demonstrate the culture differences between 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[10] are also marked on Figure 1.

Figure 1 demonstrates that in most regions with high patenting intensity (the number of patent applications in the highest third) the composite factor (power distance, uncertainty avoidance, family-related collectivism, masculinity) is lower than average and the same almost holds for regions with medium patenting intensity. On the contrary, this factor is mainly above average in regions with low patenting intensity. Regarding overall individualism, it remains rather near the mean level in the case of high patenting intensity, whereas in the case of low patenting intensity the variance of overall individualism is higher. Hence, while the differences in patenting

[10] The following regions turned out to be outliers considering the number of patent applications at the NUTS2(1) level: Sydswerige (Sweden), Noord-Brabant (Netherlands), Baden-Württemberg and Bayern (both Germany), and Vorarlberg (Austria).

intensity can be at least partly explained by the differences in the composite factor, 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 or medium patenting intensity and cannot be considered as outliers in terms of the cultural dimensions. Finally, it can be pointed out that in the case of high or medium patenting intensity, the larger the value of the composite factor, the stronger the overall individualism (correlation coefficients 0.36 and 0.59 respectively). At the same time, this cannot be seen for regions with low patenting intensity (correlation coefficient 0.13 and not statistically significant).

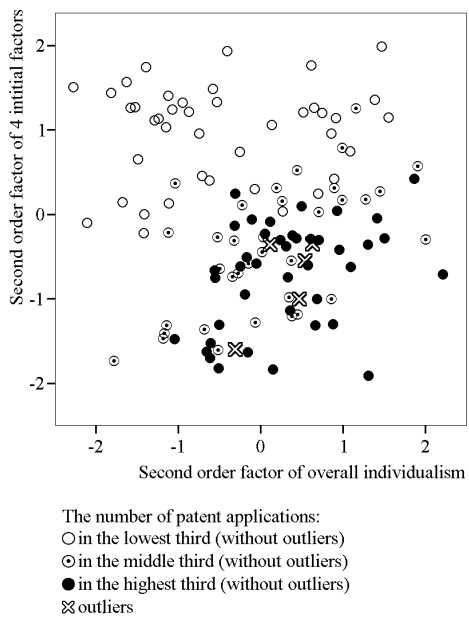

Figure 1. Patenting intensity in the context of second order factor of 4 factors (power distance, uncertainty avoidance, family-related collectivism, masculinity) and second order factor describing overall individualism at the NUTS2(1) level.

5. DISCUSSION AND LIMITATIONS

5.1. Discussion of the results

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

The findings of this study provide significant support for the argument that the capability of a country or region to initiate innovation is related to its culture. The results of correlation analysis show that four out of five factors measuring cultural 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 the case of power distance and uncertainty avoidance, the results are in accordance with previous results (Shane, 1992, 1993; Williams and McQuire, 2005). However, on the contrary, our results show a negative relationship between masculinity and 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 the economic creativity of a country (Williams and McQuire, 2005).

Regarding our Hypothesis 3 (concerning individualism-collectivism), the results are more complex. In the case of individualism-collectivism, the factor analysis resulted in two different factors allowing us to assume that at least two aspects of individualism-collectivism have to be distinguished. The first factor containing individualistic values can be identified as overall individualism. 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 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 relationships between overall individualism and patenting intensity, or that this comes from the fact that Europe is quite homogeneous according to 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 respectively). 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 that value the family highly tend to be more conservative and less open to new and creative ideas, while cultures focusing more on relationships with friends and other persons outside families are more open, and relationships with persons with different backgrounds enables a broader world view as a powerful source of new ideas. This interpretation is also confirmed by the study by Realo *et al.* (1997) showing that family level collectivism has the highest negative correlation with the personality trait Openness.

Regarding the additional results, first, logarithming the patenting indicators indicated that the relationships between most of the patenting indicators (except biotechnology patent applications) and cultural 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 cultural dimensions and innovation initiation seem to be more complicated than the linear relationships suggested so far in the literature. Regarding 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 for

patenting intensity as a whole as well as high-tech and ICT patenting intensity (see Appendix B). As only a small section of the non-linear relationship is reflected in the data available and analysed here, it can be easily (however, possibly erroneously) approximated as a linear relationship.

Second, mapping regions according to cultural differences (Figure 1) provided two implications. First, in order to patent more than average, a region should have lower than average power distance, uncertainty avoidance, family-related collectivism and masculinity. On the contrary, 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 cultural dimensions: for higher 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 for by some factor promoting it. However, this balance itself cannot always be expected to assure success in patenting.

Third, the results also show that in the case of some regions with outstanding levels of patenting intensity, there has to be some other factor with a strong influence on patenting intensity as the scores for all cultural dimensions appeared to be at the medium level for these regions. This can be seen from the figures in Appendix E and Figure 1. This is also confirmed by the result that the correlations between cultural 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, outstanding success in patenting rests on some other important factor – culture is important, but the possible influence of culture is limited and culture alone does not lead to top success in patenting. Hence, including other factors, like, for example, historical background or the quantity and quality of universities in a particular region, is a possibility for future studies, although measuring these factors is a complicated task.

5.2. Limitations

Regarding the 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 a topic for future studies, when data for a sample larger than Europe become available. Second, we have not included the later added dimension of long-term orientation in our analysis because of the lack of data. However, as according to 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 innovation does not appear even if it exists concerning the whole world. Still, if appropriate data become 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 cultural dimensions and patenting intensity, reflect 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 focused on only one major phase of the 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 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 cultural dimensions and patenting intensity, which we considered as an indicator of the initiation phase of innovation. However, although culture undoubtedly plays an important role in patenting intensity, it should be stressed that the relationship is not straightforward and culture is not a sufficient factor for getting a notable outcome in patenting intensity, indicating the need for further analysis of, for example, historical background or the quantity and quality of universities.

We have found that to be successful in patenting, a region should have lower than average power distance, uncertainty avoidance, family-related collectivism (as an opposite to friends-related and organisations-related collectivism) and masculinity. It turned out that the relationships seem to be more complicated than the linear relationships suggested so far in the literature: the relationships are stronger in the case of higher patenting intensity where the same differences in culture are associated with larger differences in patenting. Hence, the character of this relationship should be re-examined in future studies. For success in patenting relatively higher levels of power distance, uncertainty avoidance, family-related collectivism and masculinity have to be balanced with relatively higher individualism and vice versa, but these pre-sumptions do not ensure high patenting intensity.

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KOKKUVÕTE

Kuidas kultuur soodustab innovatsiooni: Euroopa riikide kogemus

Käesoleva artikli eesmärk oli uurida erinevate kultuuridimensioonide ja innovatsioonide initsieerimise seoseid kasutades selleks Euroopa riigi(regiooni)tasandi andmeid. Kultuuri klassifitseerimisel ja mõõtmisel on kasutatud Hofstede (2001) kontseptsiooni, mis toob välja järgmised kultuuri dimensioonid: võimukaugus, ebakindluse vältimine, maskuliinsus-feminiinsus ja individualism-kollektivism. Hofstede algupäraste indeksite asemel koostati kultuuridimensioonide näitajad andmebaasi European Social Survey andmeid kasutades kinnitava faktoranalüüsi abil. Innovatsioonide initsieerimise mõõtmiseks kasutatakse patenteerimisintensiivsuse näitajaid.

Analüüsi tulemused näitasid, et kultuur on patenteerimisintensiivsusega seotud, ja toetasid seega ka teoreetilisi oletusi ja varasemaid tulemusi. Kinnitust leidis, et edukaks patenteerimiseks peab regioonis olema keskmisest väiksem võimukaugus, ebakindluse vältimine, maskuliinsus ja perekonnaga seotud kollektivism (vastandina sõprade ja organisatsioonidega seotud kollektivismile). Patenteerimise seos üldise individualismiga oli nõrk. Lisaks selgus, et patenteerimise seosed kultuuridimensioonidega ei ole lineaarsed: kõrgema patenteerimisintensiivsuse korral seostub sama suur muutus kultuuris suurem muutusega patenteerimisintensiivsuses. Edukaks patenteerimiseks peab suurem võimukaugus, ebakindluse vältimine, maskuliinsus ja perekonnaga seotud kollektivism olema tasakaalustatud suhteliselt kõrgema üldise individualismiga ja vastupidi, kuid see ei ole piisav tingimus. Samuti ilmnes, et kuigi kultuur on oluline edu eeldus, ei piisa sellest tipptasemel patenteerimisintevsiivsuse tagamiseks.

Appendix A. Indicators measuring innovation initiation and cultural dimensions

Concept	Indicator	The exact name of the 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)[11]
	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)

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

Concept	Indicator	The exact name of the indicator according to the source
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? (Average 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)

Concept	Indicator	The exact name of the indicator according to the source
Individualism-collectivism	Membership of voluntary organisations	For each of the voluntary organisations[12], 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)

[12] 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.

Concept	Indicator	The exact name of the indicator according to the source
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

Appendix B. Descriptive statistics of patenting intensity indicators

		With outliers:					Without outliers:				
		N	Min.	Max.	Mean	Standard deviation	N	Min.	Max.	Mean	Standard 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 cultural 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. Observation clouds between patent applications and latent factors describing cultural dimensions at the NUTS2(1) level