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PATTERNS OF TECHNOLOGICAL INNOVATION:
THE SOCIO-CULTURAL DETERMINANTS OF INNOVATIVE OUTPUTS

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ABSTRACT:
The epistemological positions of this paper are twofold – on the one hand, the heterogeneity assumption: diversity in the production of technological innovation according to the predominant religious culture of countries; on the other, the hypothesis that higher religious fractionalization can generate positive effects on innovative outputs. The purpose of this paper is to analyze and prove these stances through an empiricist-positivist research method. The findings show that countries with a predominance of the Protestant, Jewish and Eastern religions have technological performance higher than countries with other predominant religious cultures. In addition, the statistical evidence, in general, supports *de facto* the hypothesis that higher religious fractionalization, *ceteris paribus*, generates positive effects on innovative outputs, in particular among the richer and more democratic countries, which are mainly located in the European and North-American geo-economic areas.

KEY WORDS: Religion; Innovation; Fractionalization; Democratization; Civilization.

JEL CODES: A10; O10; O30; P50; Z12.

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1. Introduction

The debate on the determinants of economic growth has been ongoing since the first relevant contributions presented by Adam Smith in 1776 and John Rae in 1838 (Coccia, 2005, pp. 124-128). Economists, sociologists and scholars of the social sciences have long been interested in analyzing the main causes of economic growth, focusing on labor and population (cf. Barro and Sala-i-Martin, 2004, Chp. 9), institutions (Glaeser *et al*., 2004; Acemouglu *et al.,* 2008), democratization (Personn and Tabellini, 2006), and other socio-economic factors. As economic growth is a multicausal process, current economic literature has also been analyzing the role of culture (Guiso *et al.,* 2006, pp. 23 ff), economic governance (cf. Dixit, 2009, pp. 5 ff) and religion[1].

Barro and McCleary (2003) argue that:

> successful explanations of economic performance must go beyond narrow measures of economic variables to encompass political and social forces (p. 760).

In fact, Linstone (1999, p. 69, *passim*) analyzes the current global scenarios through a "multiple perspective approach" that includes technical, organizational, personal and religious dimensions[2]. Guiso *et al.* (2006) show that the cultural hypothesis is more and more important in order to investigate several economic issues. Other scholars, such as Akerlof and Kranton (2000), study the interaction between identity ("a person's sense of self", pp. 715 ff) and economic outcomes[3]: "the choice, or lack thereof, of different identities affects an individual's economic behavior" (Akerlof and Kranton 2000, p. 748). Greif (1994) examines the importance of cultural factors in determining successful institutions and the historical importance of distinct cultures in economic development

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1 Iannaccone (1998); Barro and McCleary (2003, pp. 760 ff); McCleary and Barro (2006, pp. 49 ff; 2006a); Guiso *et al.* (2003, pp. 225 ff); McCleary (2008).

2 Cf. also Linstone (2003, pp. 283-284 and p. 295); Linstone (2007, pp. 231-232); Linstone (2010, pp. 696-698).

3 See also Akerlof and Kranton (2010).

(pp. 912 ff). A vital determinant of economic growth is technological innovation[4], which is a complex process affected by several socio-economic variables. As a matter of fact, when investigating the social and institutional determinants of technological innovation, Coccia (2010), states that: " 'democracy richness' generates a higher rate of technological innovation with fruitful effects for the wellbeing and wealth of nations (pp. 248 and 257) [and] . . . . democratization generates greater production of technology, *i.e.* technical and economic change" (p. 260). As democratization is a process generated by the civilization and history of people[5], in order to investigate, from a different perspective, the underlying cultural forces driving the patterns of technological innovation, this paper considers the role of the predominant religious cultures in various countries.

Although several works have provided many valuable insights into the theory of technological innovation, there are issues that have not yet been accurately explored by economists of technical change – such as, whether and how the production of technological innovation across countries differs on the basis of the predominant religious culture of their population.

The aim of this paper is to provide an in-depth investigation of the cultural determinants of technological innovation, focusing on the analysis of the relationship between innovative outputs and predominant religious culture across countries. In particular, the purpose of this article is twofold. On the one hand, it aims at verifying the heterogeneity assumption, i.e. diversity in the production of technological innovation according to the

[4] For an accurate analysis of this main variable of economic growth, see Aghion and Howitt (1998, Chps. 2 and 10).

[5] Archibugi (2004, p. 439) states: "Democracy is to be conceptualized as a process rather than as a set of norms and procedures". This concept of democratization is analyzed by Archibugi (2004) through the: "Seven assumptions for cosmopolitan democracy" (pp. 439 ff). In addition, cf. also Mokyr (2002, Chp. 2) for an interesting discussion about the critical role of good institutions in driving technological revolutions.

predominant religious culture of countries. On the other hand, it proves the hypothesis that higher religious fractionalization can generate, *ceteris paribus*, benefits on innovative outputs. These epistemological positions are demonstrated by means of an empiricist-positivist research method. This study can shed light on the complex socio-cultural-economic determinants of technological innovation and provide main scientific findings about non-market forces[6] that differentiate the current and future patterns of technological innovation. Before discussing this topic, the next sections describe the theoretical background and the empiricist-positivist research method.

2. Theoretical background for analyzing the interactions between religion and technological innovation

The term religion has an uncertain origin. The Latin etymology of the word may be *relegĕre* (to collect ritual acts)[7], whereas it is *religare* (*i.e.* to tie, to bind) according to the philosopher Augustine (*De civ. Dei, X, 3*). The philosopher Cicero (in *De nat. deor. II, 28*) argues that the meaning of religion is *to choose;* probably the origin of the word is *religere:* to repeat ritual acts. Deneulin and Rakodi (2010) claim that religion is: "an institutionalized belief system that unites a community of believers around social practices, rather than 'spirituality', which concerns the individual, potentially in a socially and historically detached way (p. 3, original emphasis). . . . Benthall . . . adopts a 'fuzzy' concept of religion, arguing that it is not a single category but a social field" (p. 7, original emphasis)[8].

Adam Smith in *The Wealth of Nations* (1776) discusses the interaction between economic forces and religion, and argues: "that market forces constrain churches just as

[6] Cf. Iannaccone (1998, pp. 1465 ff).
[7] Cf. Devoto G., Oli G. C., *Il Dizionario della Lingua Italiana*, Le Monnier.
[8] Several international journals such as *Religion* by Elsevier and *The Journal of Religion* by University of Chicago Press discuss interesting topics concerning religious issues.

they constrain secular firms; and that the benefits of competition, the burden of monopoly, and the hazards of government regulation are as real for religion as for any other sector of the economy" (quoted by Iannaccone, 1998, p. 1478). Max Weber in *The Protestant Ethic and the Spirit of Capitalism,* published in 1905, discusses how the Protestant religious culture affects the economic attitude of people and the entrepreneurship that have supported the capitalistic systems[9]. The current economic literature also considers, among the determinants of economic growth, the role of religion that is a main socio-cultural element of civilization (Barro and McCleary, 2003; 2005; Guiso *et al.*, 2006).

This relationship between religion and economic growth has been mainly analyzed, in the socio-economic sciences, from an empiricist-positivist stance. McCleary and Barro (2006) combine two approaches: *a)* religion (dependent variable) is affected by economic growth and political institutions (explanatory variables); *b)* religion and other ethnic and social characteristics of people (explanatory variables) affect the economic outcome of countries (dependent variable). These scholars find: "growth effects from religious beliefs and participation" (McCleary and Barro, 2006, p. 71). Guiso *et al.* (2003) analyze the interplay between intensity of religious beliefs[10] and economic attitudes (such as toward cooperation, government institutions, women's propensity to work, legal rules, and fairness of the market). They: "find that on average, religious beliefs are . . . conducive to higher per capita income and growth . . . . Christian religions are more positively associated with attitudes conducive to economic growth"

[9] Cf. Barro and McCleary (2003, p. 760) and McCleary and Barro (2006, pp. 49-50); see also Guiso *et al.* (2003, pp. 226 – 231). Several scholars have criticized Weber's stance, such as Iannaccone (1998) who states: "Samuelsonn and Tawney demonstrate that nearly all the capitalist institutions emphasized by Weber *preceded* the protestant Reformation that he viewed as their cause" (p. 1474, original emphasis).

[10] These are measured by percentage of positive answers to some questions such as: " 'how often do you attend religious services these days?' " . . . " 'Do you believe in God' ?" (Guiso *et al.,* 2003, p. 234).

(Guiso *et al.*, 2003, p. 225)[11]. Alesina *et al.* (2003), instead, re-examine the effects of ethnic, linguistic, and religious heterogeneity on the quality of institutions, policies and economic growth (pp. 155-158). In 2007, The University of Southern California organized a conference on patterns of civilization. Some key papers were included in the special issue "The Economic Performance of Civilizations: Roles of Culture, Religion and the Law" of the *Journal of Economic Behavior and Organization* edited by Timur Kuran (volume 71, September-no. 3, 2009, pp. 589-718). Kuran (2009, p. 591) claims that: "The articles point to diverse ways in which religion affected economic performance".

Bettendorf and Dijkgraaf (2010): "find support for the hypothesis that the effect of religion on income is more favourable in high-income countries. While a negative effect of religion on income is found for low-income countries, this effect is positive for high-income countries" (p. 23)[12]. However, these authors also argue that it is important to check the countries included within the sample since this might influence the final results.

Religion and other socio-economic elements shape the culture of societies, which affects the patterns of technological innovation. A critical economic issue is to explore current *heterogeneity* in technological opportunity and innovative outputs according to the predominant religion of countries, since this economic analysis can provide main insights to understand and support future patterns of economic growth. In fact, if the neoclassical assumption of homogeneity is relaxed, it is possible to analyze the current

[11] This study is based on the World Values Surveys by the University of Michigan and includes 80% of the world's population: the 1995-1997 survey covered 54 independent countries.
Cf. also Iannaccone (1998, pp. 1474-1478) on these topics.

[12] Income was measured with a 10 income deciles and the respondents were asked which class their household was in, counting all wages, salaries, pensions and other incomes. Several measures are used to investigate the beliefs and practices of religious individuals, such as church membership and participation. For details, see Bettendorf and Dijkgraaf (2010, pp. 14-16 and pp. 20-22 and appendix A of this article)

spatial morphology of the patterns of technological innovation in different cultural settings. In particular, the opportunities for technical change are not only a function of technologies themselves but also of the underlying cultural, scientific and socio-economic contexts, underpinned in the history and civilization of societies[13]. Therefore, as the patterns of technological innovation are multicausal processes in which the culture of the society plays a relevant role[14], the purpose of the present paper is to empirically analyze the interplay between predominant religious culture[15] and innovative performances, in order to support the following epistemological positions- *a*) the heterogeneity assumption based on diversity in the production of technological innovation according to the predominant religious culture of countries; *b*) the hypothesis that higher religious fractionalization, *ceteris paribus*, has a positive impact on the technological performance of countries (*i.e.* higher number of patents, researchers, R&D Intensity, etc.). This economic analysis may enhance our understanding of diverse spatial and temporal technological innovation patterns in current and future economies.

3. Research strategy

3..1 Data and their sources

A first aspect to consider is the classification of countries per predominant religious culture, which has received attention by several scholars and leading international institutions. Religion and religious observance are complex and contested concepts, so

13 For instance, Steil *et al.* (2002, Chps. 1 and 2) analyze the main economic and historical sources of technological innovation across countries; Instead, Dixit (2009) discusses the main role of economic governance in current economies.

14 In fact, religious culture reflects the historical, cultural, social, political and economic processes of nations over time.

15 The predominant religion is computed by the number of current adherents, based on a combination of census reports and population surveys. Results can vary widely depending on the chosen definitions of religion, on whether historically predominant religious cultures are considered, or those who actively 'practice' a particular religion only, etc.

that the collection of data is a very difficult task and, in general, the results depend on what is measured by the data. For instance, the surveys can assume that the concepts of religion and God are common and interpreted in the same way across countries, they can consider dataset dominated by protestant countries or not, etc. (see Deneulin and Rakodi, 2010, p. 6). The CIA World Factbook[16] (2010) classifies countries per predominant religious cultures, which are: Roman Catholic, Protestant, Orthodox, Jewish, Muslim, Hindu and Eastern (Table 1A in Appendix A shows a list of countries according to their main religious culture). Although this classification has some limits, because there are countries where it is very difficult to find a predominant religion (*e.g.* China, India, etc.), and/or there are sets that include countries with a different socio-cultural context, the results provide a proxy, on a large scale, of the main predominant religion across countries (the analysis is carried out not per country but per religion, under which a set of different countries are listed). This dataset by Norris (2008), including data across countries and over time, is applied in the present research. It contains key data on the social, economic and political characteristics of 191 nations, from 1972 to 2005.

[16] The CIA World Factbook (2010) provides information on the history, people, government, economy, geography, communications, transportation, military, and transnational issues for 266 world entities.

Table 1 – Variables

Variables	Metrics and Description
Predominant religion according to the CIA World Factbook	The CIA collects data on predominant religious cultures across countries, which are classified as: Roman Catholic, Protestant, Orthodox, Jewish, Muslim, Hindu and Eastern. Predominant religion is computed by the number of current adherents based on a combination of census reports and population surveys that consider historically predominant religious cultures, those who actively 'practice' a particular religion, etc.
Religious fractionalization *Year 2000* *This indicator has a stability over the medium term*	Alesina *et al.* (2003, pp. 158ff) compute the fractionalization as one minus Herfindahl index of religious group shares, and find that two randomly selected individuals from a population belong to different groups. The formula is: $\mathrm{FRACT_j} = 1 - \sum_{1=1}^{N} s_{ij}^2$, where *sij* is the share of group *i* (*i*=1…N) in country *j*. It indicates a measure of fragmentation (heterogeneity) based on a broader classification of religious groups. The data are from Encyclopaedia Britannica (2001) and cover 294 different religions in 215 countries and dependencies.
Index of democratization *1990-1996* *This indicator has a stability over the long term*	Measured by means of the Freedom House 7-pt rating - reversed scale 1 least democratic, 7 most democratic "The Freedom House Index of liberal democracy was launched by Raymond Gastil . . . of the University of Washington in Seattle (USA). Gastil developed a methodology, which assigned ratings of political rights and civil liberties for each independent nation. It now includes 192 countries and 18 independent territories. The index of political rights consists of 10 criteria, which are grouped into three parts: electoral process, political pluralism and participation, and government functioning. This index ranges from 1 (best value) to 7 (worst value) and, in many publications, it is shown on a rotated scale. The index monitors the existence of political rights in terms of electoral processes, political pluralism, and the functioning of the government. It has been employed by many scholars such as Diamond . . ., Barro . . . , Inglehart and Welzel . . . Despite its virtues, the index has been subject to criticism on a number of methodological grounds" (Coccia, 2010, p. 252).
Indicator of technological development *1995-2001*	Patents of residents per million people (number of patent applications filed by residents). They are applications filed with a national patent office for exclusive rights to inventions – a product or process that provides a new way of doing something or offers a new technical solution to a problem.
Other metrics of technological development *1995-2001*	Scientific and technical journal articles per 1,000 people Researchers in R&D per million people R&D expenditure as % of GDP
Economic variables *1994-2000*	GDP per capita, current prices, US$ (1995-2001) The Gross Domestic Product (GDP) is a measure of the economic activity. It is defined as the value of all goods and services produced minus the value of any goods or services used in their creation

The research shows *how* some key socio-cultural-economic indicators of countries (e.g. Freedom House-Index of liberal democracy, Category of Gross Domestic Product –

GDP– per capita of countries <2,000$, 2,000 to 5,000$, 5,001 to 10,000$, >10,000$, Religious fractionalization by Alesina *et al.*, 2003) differ based on the countries' predominant religion. The interaction among these variables is also investigated per geo-economic regions (Africa, Asia and Pacific, C&E Europe[17], Middle East, North America, South America, Scandinavia and Western Europe). Table 1 presents the main variables of this research.

Technology is the other vital variable analyzed[18]. The data on technological innovation outputs are from the World Bank's "World Development Indicators" (World Bank, 2009). In particular, innovations are protected by patents, which indicate the current innovation of countries and also commercially promising inventions. Therefore, the most common metrics of innovative output, mainly in advanced countries, is the number of patent applications filed by residents (*cf.* Steil *et al.,* 2002, pp. 3-22)[19]. Patents indicate the current state as well as the potential trends of technological development in a given country. In addition, this research also considers other measures of innovative output in order to increase the robustness of the empirical analysis, which are:

- Research & Development (R&D) Expenditures (as percentage of GDP) are current and capital expenditures on the creative and scientific activity, which increases the stock of knowledge. These R&D expenditures include fundamental, applied research and experimental development work leading to new devices, products, or processes.

[17] C & E Europe is the group of countries in Central and Eastern Europe, a definition which has long been a source of controversy.

[18] Technology is based on inventions and innovations. Invention is a commercially promising product or service, based on new science and/or technology that meets the requirements for a patent application and/or the patent is already granted. On the other hand, innovation, which already has a valid and granted patent, is the successful entry of a new science or technology-based product into a particular market (cf. Coccia, 2010, p. 252).

[19] Patents as sources of innovation can have some limits: for instance, transaction costs and disclosure rules vary among countries. Moreover, patented inventions give no information on innovation and on the process of development of technology, involving the translation of a blueprint into a working device suitable for mass production (Coccia, 2010, pp. 252-253).

- Number of Researchers in R&D are people engaged in professional R&D activities who have received technical training in any branch of knowledge or technology in higher education.
- Number of scientific and technical journal articles include those published in a stable set of about 5,000 of the world's most influential scientific and technical journals, tracked since 1985 by the Institute of Scientific Information's Science Citation Index and Social Science Citation Index.

These dimensions are a good proxy of technical change development in advanced countries according to the "Pythagorean concept of technology" (Sahal, 1981, pp. 22-25).

3..2 Epistemological positions and empiricist-positivist research method

the purpose of this article is twofold. On the one hand, it aims at verifying the heterogeneity assumption, i.e. diversity in the production of technological innovation according to the predominant religious culture of countries. On the other hand, it supports the hypothesis that innovative outputs benefit from a social structure based on higher religious fractionalization. These epistemological positions are proved by empirical evidence, applying the SPSS statistics software (SPSS, 2010). Some variables are normalized by logarithmic transformations in order to apply the correlation and regression analyses. In addition, statistical outputs, based on bar graphs and tables, show the morphology of predominant religions per democratization index, GDP per capita and geo-economic regions.

The connectedness of data is analyzed by some indices. Gini suggests measuring the connectedness by using the indices η and η_1 (Girone and Salvemini, 1988, ch. 15):

$$\eta = \frac{\sum_{i=1}^{s}\sum_{h=1}^{t}\left|Nn_{ih} - n_{i0}n_{0h}\right|}{2\left(N^2 - \sum_{h=1}^{t} n_{0h}^2\right)}$$

Where n_{ih} is the frequency within the table $n \times n$ of x and y, whereas N is the Total of cases.

η is the connectedness index of the consequent statistical variable y from the precedent variable x. This index has a range from 0 if the statistical variables are independent, whereas it is 1 if there is max connection of y from x.

$$\eta_1 = \frac{\sum_{i=1}^{s}\sum_{h=1}^{t}\left|Nn_{ih} - n_{i0}n_{0h}\right|}{2\left(N^2 - \sum_{i=1}^{s} n_{i0}^2\right)}$$

η_1, *vice versa,* is the connectedness index of the consequent statistical variable x from the precedent variable y. *Mutatis mutandis*, the range of index $\eta_1 \in [0, 1]$. The higher/lower magnitudes of these indices indicate the (stronger/weaker) direction of influence between x and y.

If it is not possible to detect a precedent statistical variable, the index of connection α is given by the geometric mean of the indices of connectedness η and η_1:

$$\alpha = \sqrt{\eta \cdot \eta_1}$$

Index α is an appropriate measure of the association between x and y; it ranges in values from 1 (max *bijective* connection between statistical variables) to 0, which indicates independence. This index is calculated between predominant religion (x) and Freedom House index of democratization (y), between x and GDP per capita category, and between x and geo-economic region.[20]

These analyses are also integrated by bivariate and partial correlations in order to support the heterogeneity assumption.

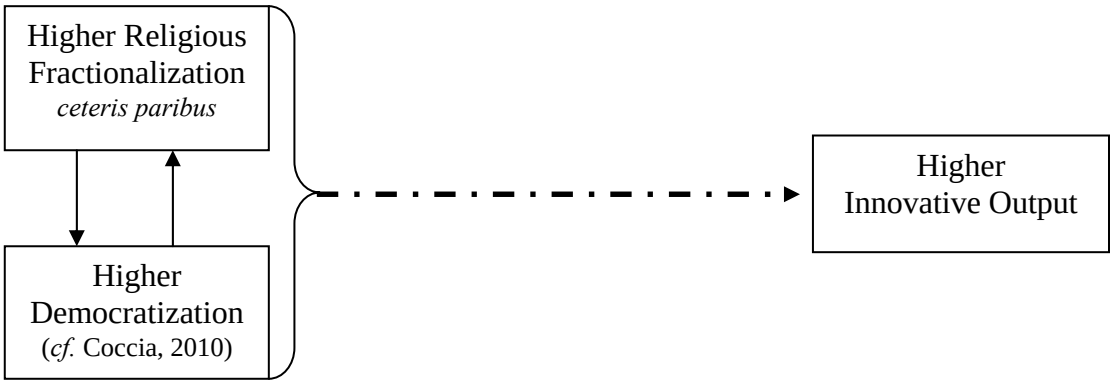
In addition, considering the theoretical background discussed before and the economic

[20] In general, these indices are applied to qualitative data.

analysis by Alesina *et al.* (2003), showing that religious fractionalization has a positive correlation with measures of good governance, the following hypothesis is stated:

- *Hypothesis*: Social structures based on higher religious fractionalization, ceteris paribus, generate fruitful effects on innovative outputs.

The basic hypothesis can be represented by the following chart.



Remark: For instance, Portugal has an average religious fractionalization of 0.14 and average production of patents per million people of about 13 units, whereas, the USA have an average religious fractionalization of 0.82, with about 600 patents per million people (1995-2001).

The purpose of the present study is also to determine whether the statistical evidence, based on correlation and regression analyses, supports this hypothesis (*Hp*), thus providing scientific arguments in favor of it.

Model settings

- Countries with GDP per capita greater than 5,000$, because patents are an indicator of technological development in developed rather than developing countries, where innovation may not be technological and may not be patented.

- Countries with a democratization index greater than 3.5, since they have better institutions (*e.g.* Patent office) in order to support patterns of technological innovation.
- Religious fractionalization indicates a socio-cultural diversity and also has a good correlation with ethnic fractionalization (combined linguistic and racial, see Alesina 2003).

The logic relationship to support the *Hp* is:

Innovative outputs = f (religious fractionalization)

The specification is based on linear models of regression with a leading indicator:

$$\text{Ln patents } y_{i,t} = \lambda_0 + \lambda_1 \text{ religious fractionalization}_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where *i* is the country, *t* is the time. The production of technology ($Ln\, y_{i,t}$) is measured by the number of patents filed by residents per million people, as well as other technological variables described in the research methodology section (*e.g.* R&D investments, Researchers, etc.). It is assumed that the error term is normally and independently distributed (NID) with mean 0 and variance σ^2, *i.e.* $\varepsilon_{i,t} \sim NID(0, \sigma^2)$. This model (1) is also verified by controlling the following variables (*ceteris paribus*): index of democratization and GDP per capita category of countries. The equation (1) is estimated by the Ordinary Least Squares method (OLS), using the SPSS statistics software (2010). *A priori*, we would expect λ_1 to be positive. In addition, this research uses a general model (1) *Loglinear* with two explanatory variables (GDP per capita and religious fractionalization), estimated by Prais-Winsten method, by the autoregression estimate procedure from time series with first-order autocorrelated errors. The purpose of the model to provide critical predictions of patents per million people, and as a

consequence, of future patterns of technological innovation across countries. Moreover, for what concerns the arithmetic mean of religious fractionalization, we consider two groups of countries: higher *vs.* lower religious fractionalization. ANOVA is applied to test, between the two groups of countries, the systemic effect of different socio-economic-cultural backgrounds on the production of patents.

4. Morphology of religions and innovation outputs across countries

The analysis of the distribution of predominant religious cultures across geo-socio-economic contexts provides a background which underpins the interaction between religious fractionalization and patterns of technological innovation. The empirical analysis, based on data from the CIA World Factbook (2010), shows that democratization, measured through the Freedom House index over 1990-1996, is higher in countries with predominant Hindu, Jewish, Protestant and Roman Catholic religion (see Figure 1). As far as the GDP per capita (1994-2000) is concerned, countries with predominant Jewish and Protestant religion display higher values (Figure 2). This result is associate to Figure 1, because the richer countries have institutions that are more democratic. Another main indicator is the religious fractionalization measured by Alesina *et al.* (2003): Higher values are in countries with predominant Hindu, Protestant and Orthodox religion (Figure 3).

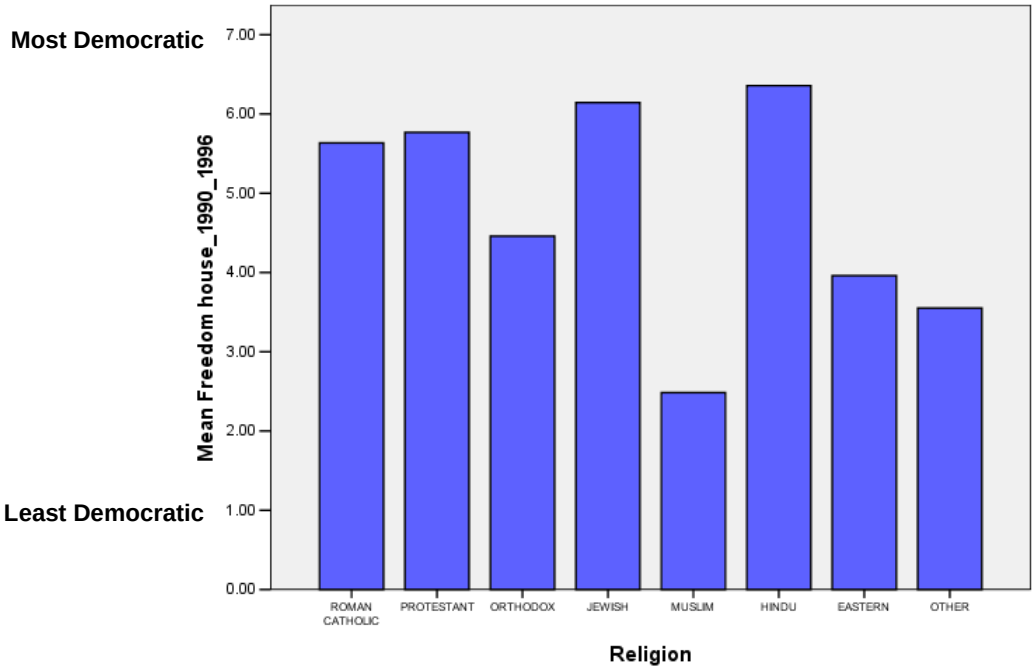


Figure 1: Democratization index (Freedom House) per predominant religion

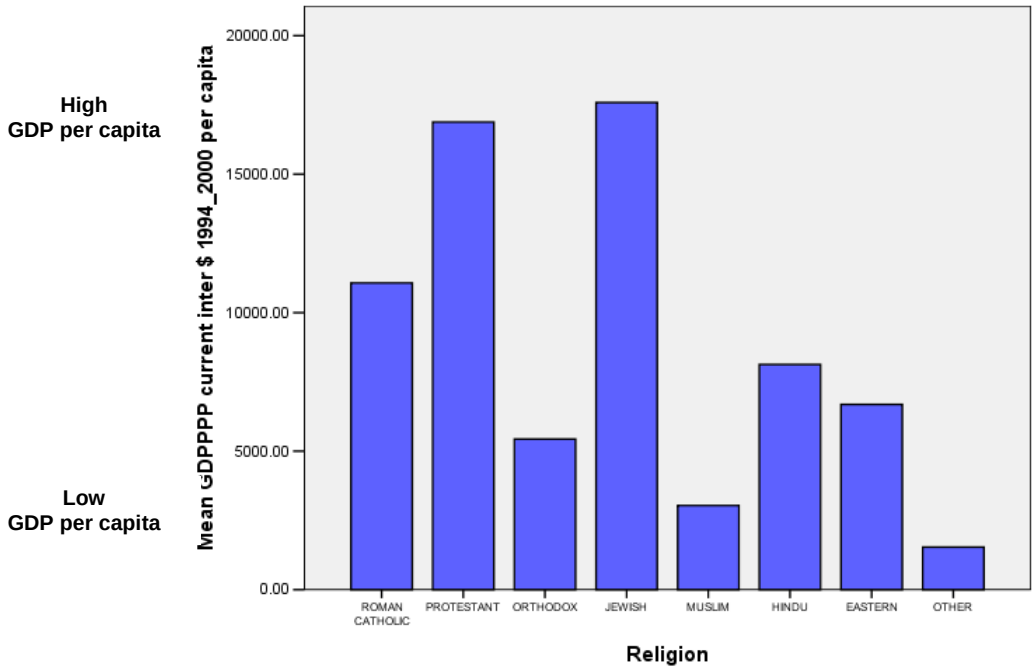


Figure 2: GDP per capita per predominant religion

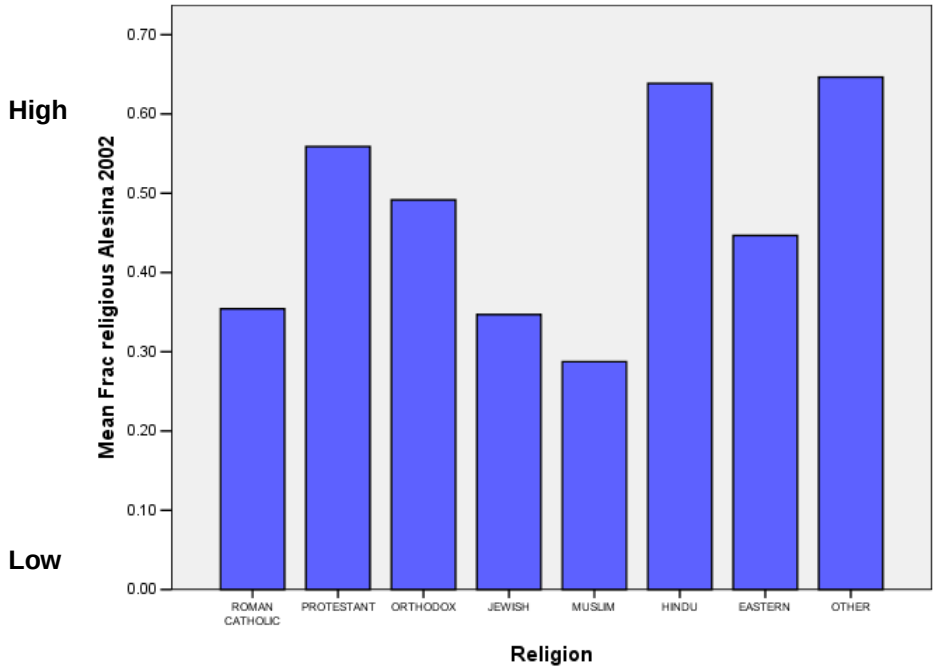


Figure 3: Religious fractionalization by Alesina per predominant religion

Tables 2-4 display the distribution of countries between predominant religion (*x*) and Freedom House index of democratization (*y*), between *x* and GDP per capita category, and between *x* and geo-economic region. In particular, table 2 shows that more than 90 percent of the "most democratic" countries have a predominance of the Roman Catholic and Protestant religion, whereas roughly 70% of "least democratic" countries have a predominance of the Muslim religion (using the Freedom House index and CIA World Factbook data). If the GDP per capita of countries is considered, table 3 shows that about 78% of countries in the 5,001 to 10,000$ and greater than 10,000$ brackets have a predominance of the Protestant and Roman Catholic religion. Instead, Table 4 shows the distribution of countries per predominant religion and main geo-economic region: roughly 69% of countries with predominant Roman Catholic religion are located in South America and Western Europe, 75% of Orthodox countries in C & E Europe, and about 40% of Muslim countries, of course, in the Middle East, because of historical and

cultural contexts.

Table 2: Countries per predominant religion and level of democratization

Democratization: Freedom House	*Roman Catholic*	*Protestant*	*Orthodox*	*Jewish*	*Muslim*	*Hindu*	*Eastern*	*Other*	**Total**
Least Democratic 1	-	-	-	-	7	-	2	1	**10**
2	-	-	-	-	6	-	-	1	**7**
3	1	4	1	-	4	-	-	1	**11**
4	5	1	5	-	4	-	2	1	**18**
5	8	-	3	-	1	-	2	2	**16**
6	5	2	2	1	1	-	2	1	**14**
Most Democratic 7	16	12	1	-	-	1	1	-	**31**
Total countries	**35**	**19**	**12**	**1**	**23**	**1**	**9**	**7**	**107**
%	32.71	17.76	11.21	0.93	21.50	0.93	8.41	6.54	100.00

Table 3: Countries per predominant religion and level of GDP per capita category

GDP per capita category	*Roman Catholic*	*Protestant*	*Orthodox*	*Jewish*	*Muslim*	*Hindu*	*Eastern*	*Other*	**Total**
Less than 2,000$	7	4	9	-	18	-	5	5	**48**
2,000 to 5,000$	12	3	1	-	3	1	1	2	**23**
5,001 to 10,000$	6	-	-	-	2	-	1	-	**9**
> 10,000$	10	12	2	1	-	-	2	-	**27**
Total countries	**35**	**19**	**12**	**1**	**23**	**1**	**9**	**7**	**107**
%	32.71	17.76	11.21	0.93	21.50	0.93	8.41	6.54	100.00

Table 4: Countries per predominant religion and geo-economic location

Region	*Roman Catholic*	*Protestant*	*Orthodox*	*Jewish*	*Muslim*	*Hindu*	*Eastern*	*Other*	**Total**
Africa	1	5	1	-	3	1	-	6	**17**
Asia & Pacific	1	2	-	-	4	-	9	-	**16**
C & E Europe [a)]	7	2	9	-	7	-	-	-	**25**
Middle East	-	-	-	1	9	-	-	-	**10**
North America	2	1	-	-	-	-	-	-	**3**
South America	14	-	-	-	-	-	-	1	**15**
Scandinavia	-	5	-	-	-	-	-	-	**5**
Western Europe	10	4	2	-	-	-	-	-	**16**
Total countries	**35**	**19**	**12**	**1**	**23**	**1**	**9**	**7**	**107**
%	32.71	17.76	11.21	0.93	21.50	0.93	8.41	6.54	100.00

Note: a) Central and Eastern Europe

The magnitude of the indices of connectedness provides key information about the direction of the interaction between predominant religion and index of democratization, or GDP per capita category, or geo-economic region (table 5):

- The geographic area (region) affects the predominant religion of countries, and not *vice versa* because the magnitude of $\eta=0.62>\eta_1=0.58$[21].
- Predominant religion affects the GDP per capita level of countries, and not *vice versa* because the magnitude of $\eta_1=0.44>\eta=0.38$.
- Level of democratization (Freedom House) and predominant religion of countries have almost similar indices: there is not a real determinant (*i.e.* $\eta\sim\eta_1$).

Table 5: Connectedness and connection between predominant religion and democratization index / GDP per capita category / geo-economic region

Predominant religion and -	*Index of connectedness*		*Index of connection*
	η	η_1	α
Geo-economic region	0.62	0.58	0.60
GDP per capita category	0.38	0.44	0.41
Freedom house	0.48	0.46	0.47

The index of connection (table 5, last column) shows a high association between the predominant religion of countries and their position in geo-economic areas ($\alpha=0.60$). Democratization (measured by Freedom House) and GDP per capita category also have a high association with the predominant religion ($\alpha=0.47$ and 0.41, respectively), though the magnitude is lower in comparison with the spatial variable.

4..1 Empirical analysis of the interaction between predominant religion and innovative output across countries

Statistical evidence shows some interesting results about the interaction between driving indicators of the patterns of technological innovation and the predominant religion of countries. In particular, figure 4 shows that the countries with predominant Eastern, Protestant and Jewish religion are the most productive in terms of patents per million

[21] In general, religious traditions are also affected by historical origin and mutual socio-cultural influences of geo-economic areas, for instance Abrahamic religions originate in the Middle East, Indian religions in India, and Far Eastern religions in East Asia.

people over 1995-2001. The determinants of higher innovative performances can be due to higher GDP per capita of these countries. In addition, a richer context also generates higher R&D expenditures (% of GDP), although this is a necessary but not sufficient condition for higher innovative outputs (e.g. cf. predominant Orthodox countries, figure 5)[22]. This result is similar to the level of scientific human resources per predominant religion of countries, measured by researchers per million people; in fact, R&D expenditures of countries are also the main funding resources for investing in scientific human resources (figure 6)[23].

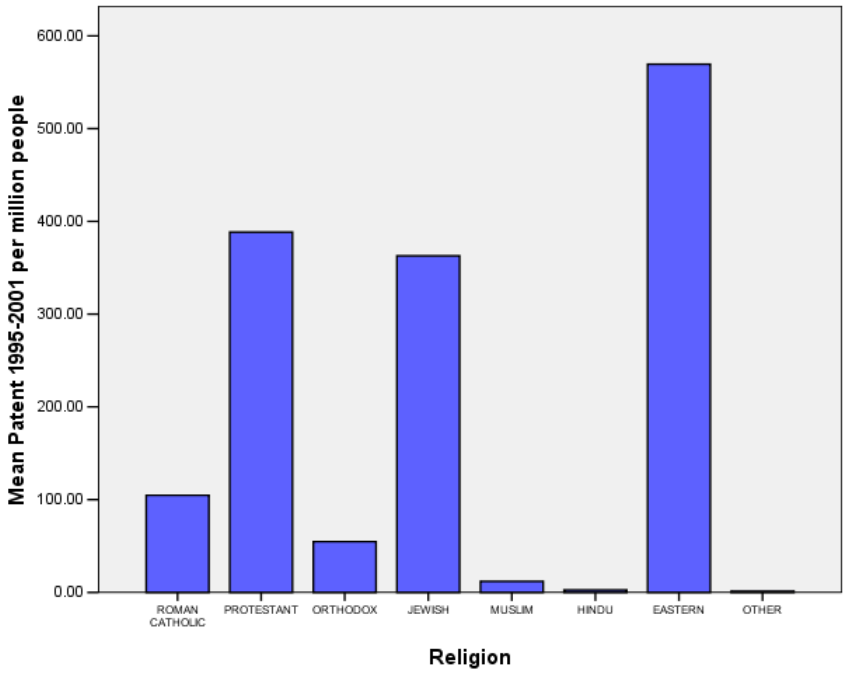


Figure 4: Patents (million people) per predominant religion of countries

[22] Countries with predominant Orthodox religious culture were, in general, untouched by great intellectual currents, such as the Renaissance and the Enlightenment, which have created the socio-economic background that has fertilized and spread the knowledge for industrial revolutions. In fact, lower innovative outputs within the Orthodox countries may be due mainly to the adherents' conservative and state-oriented approach, which may create socio-cultural barriers for economic and creative activities and, as consequence, for patterns of technological innovations (Cf. The Economist, 31 July 2008).

[23] This result is due to the positive association between R&D expenditures and investment in human resources by countries.

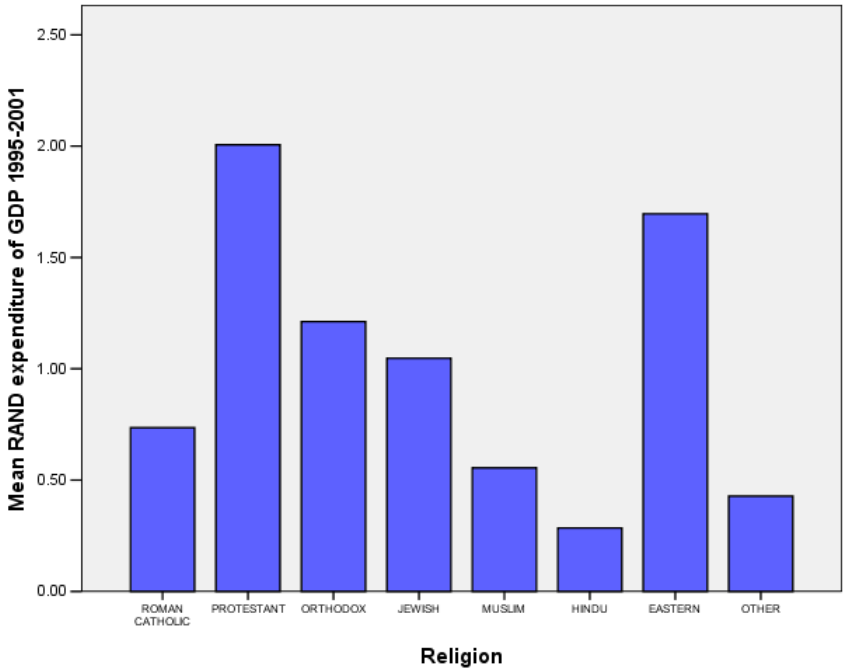


Figure 5: R&D expenditures (% of GDP) per predominant religion of countries

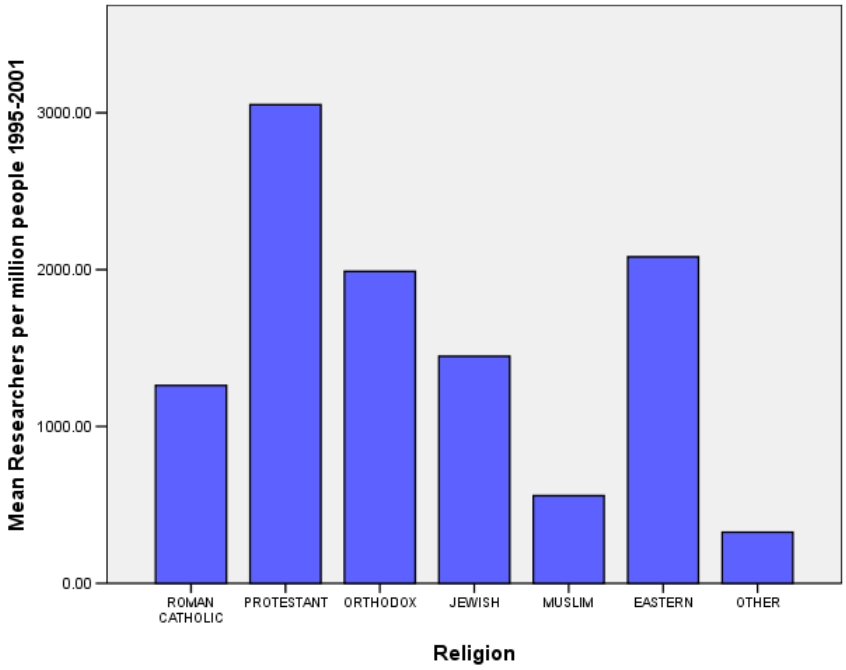


Figure 6: Researchers (million people) per predominant religion of countries

The publications of articles on scientific and technical journals (per million people) over 1995-2001 shows the leadership of countries with predominant Jewish and Protestant religion (figure 7), which are driven by high investments in R&D and the highly qualified scientific human capital of these cultural contexts.

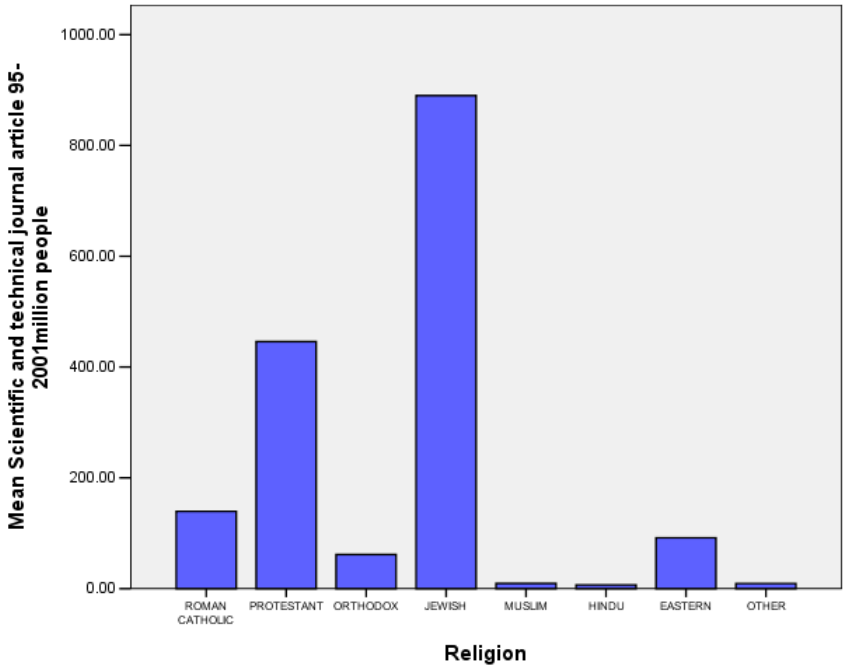


Figure 7: Publications on scientific journals (million people) per predominant religion

The correlation analysis between Religious fractionalization and Patents per million people in richer countries (5,001 to 10,000$ and > 10,000$ per capita) has a positive association equal to $r=+0.49$ and $r=+0.33$ respectively (significant at the 0.01 level). This result is reinforced by the regression analysis (tab. 6), which shows the positive impact of religious fractionalization on the production of patents in countries with GDP category 5,001-10,000$ per capita, whereas there is a lower positive effect in countries with GDP per capita higher than 10,000$.

Table 6: Parametric estimates, OLS results of patents on religious fractionalization per GDP per capita categories > 5,000 $

Category of GDP per capita	Estimated relationship of patents on rel. fractionalization *FR* [A]				R^2Adj	*F*	*Sig.*
5,001 to 10,000$	*LN patent* =	1.91*** *(0.50)*	+	4.05*FR*** *(1.17)*	0.22 *S=1.67*	12.00	0.00 *N=41*
>10,000$	*LN patent* =	4.71*** *(0.21)*	+	2.01*FR*** *(0.44)*	0.11 *S=1.35*	20.90	0.00 *N=170*

[A] *Definitions*: The independent variable is the religious fractionalization *FR*, measured by Alesina across countries. The dependent variable is Patents per million people over 1995-2001 across countries (this variable is transformed in order to have a normal distribution). The standard errors of the constants and regression coefficients are given in parentheses. R^2Adj is the coefficient of determination adjusted, below it there is *S* the standard error of the estimate; to the right, *F* is the ratio of the variance explained by the model to the unexplained variance, and its *Sig.* =significance. *N* is the number of cases.
*** The parameter is significant at 1 percent.

The partial correlation (control variable LN GDP per capita 1994-2000) and regression analyses between Religious fractionalization and Patents per million people in the "most democratic" group also confirm the positive significant interaction:

$r_{patent,Rel.Fract\,|\text{Most Democ}} = 31\%$ (sig. 0.00)

Table 7 shows the estimated relationship.

Table 7: Parametric estimates, OLS results of patents on religious fractionalization in most democratic countries

Democratization level	*Estimated relationship of patents on rel. fractionalization FR* [A]				R^2Adj	*F*	*Sig.*
Most Democratic	*LN patent* =	4.98*** *(0.24)*	+	1.01*FR*** *(0.49)*	0.03 *S=1.39*	4.25	0.04 *N=144*

[A] *Definitions*: The independent variable is the religious fractionalization *FR* measured by Alesina across countries. The dependent variable is Patents per million people over 1995-2001 across countries (this variable is transformed in order to have a normal distribution). The standard errors of the constants and regression coefficients are given in parentheses. R^2Adj is the coefficient of determination adjusted, below it there is *S* the standard error of the estimate; to the right, *F* the ratio of the variance explained by the model to the unexplained variance, and its *Sig.* =significance. *N* is the number of the cases.
*** The parameter is significant at 1 percent; ** The parameter is significant at 5 percent.

Remark:

These results are, in general, confirmed by other indicators of the "Pythagorean concept of technology" but, for the sake of briefness, these empirical results are not reported

because they are roughly similar to those already described. In addition, although the coefficients of the equations are significant, R^2 is not high because residuals of the models include other factors that can affect the production of innovative outputs (such as R&D spending, Researchers, and so on.)

4..2 General model and prediction of future values: diversity as fertilizing socio-economic environments

The econometric model and ANOVA, considering richer and more democratic countries, show the critical impact of religious fractionalization (which is also a proxy of cultural diversity) on production of innovative outputs across countries[24].

Model for richer and more democratic countries

First of all, the coefficient of correlation for the religious fractionalization / patents per million people is r=0.32 (significant at the 0.01 level), whereas the partial correlation with control variable GDP per capita is higher than the previous value ($r_{patent,Rel.Fract\ |GDPPC} = +36\%$, sig. 2-tailed 0.00). The general regression model (1), with two independent variables, is applied to predict the future values for the dependent variable at a given value for the explanatory variables[25]. The multiple regression analysis based on a *Loglinear model*[26] explains the *LN* of patents per million people (1995-2001) from the *LN* of Religious fractionalization and *LN* of GDP per capita (1994-2000). Table 8 indicates a reasonably high R^2 of 0.55 and fairly high *t*-ratios for all coefficients[27].

[24] Some variables are transformed into natural logarithms (LN) in order to have normal distributions.
[25] Verbeek, 2008, pp. 44-45 and pp. 65 ff.
[26] Note that in the Loglinear model the coefficients have the interpretation of elasticities.
[27] The model has some traces of heteroskedasticity.

Table 8: Prais-Winsten estimation results of technological innovation function based on rich countries (>5,000$ per capita and more democratic countries FH>3.5)

Log linear model

Dependent variable: LN (*Patents per million people*) 1995-2001			
Variable	Estimate	Standard Error	*t*-ratio
(Constant)	–26.187***	2.13	–12.31
LN Religious Fractionalization	0.71***	0.22	3.26
LN GDP per capita 1990-2000	3.24***	0.21	15.16
*** Parameter is significant at 0.001	R^2 =0.558	*Adj.* R^2 =0.550	*DW*=2.067

Table 8, *ceteris paribus*, shows an expected patents increase of approximately 0.71% for a religious fractionalization increase of 1% across richer and more democratic countries, where the patents are main indicators of technological development. The R^2 value is so high that confidence in the theoretical model is justified. The exponential of the fitted values predicts the number of patents across countries and over time. The average predicted patents of countries are about 342 per million people, while the average value of actual patents is roughly 412 per million people across countries.

In addition, a European country, such as Italy or France, which has an average religious fractionalization of about 0.36 and an average GDP per capita roughly of 22,559€, has a number of expected *LN* Patents per million people that can be calculated as follows:

$$-26.187 + 0.71\ Ln(0.36) + 3.242\ Ln(22\ 559) = 5.585$$

This corresponds to expected patents per million people of $exp\{5.585\} = 266$[28] (the actual average of patents per million people of these countries is 222 units). Considering the same GDP per capita, if these European countries had the high religious fractionalization of the US, namely about 0.82, they would have a predicted number of patents per million people roughly equal to 478.

[28] This result is based upon the assumption that the error term is normally distributed; in addition, the term that corresponds to one-half of the estimated error variance is not considered.

Now, if we consider the first group of countries with lower religious fractionalization (*i.e. FRACT*<0.42, which is the arithmetic mean of the distribution), which has an average of 125.88 patents per million people, and the second group of higher religious fractionalization (*FRACT*≥0.42), which has an average of 378.34 patents per million people:

$$\mu_{1\ lower\ religious\ fract} = 125.88\ patents\ per\ million\ people$$

$$\mu_{2\ higher\ religious\ fract} = 378.34\ patents\ per\ million\ people$$

Average production of patents per million people clearly increases in countries with higher religious fractionalization, with a constant variation in performance verified by the means plot.

If we assume that the patents per million people are normally distributed, two alternative hypotheses can be considered:

H_0= μ_1 (patents per million people) = μ_2 (patents per million people)

H_1 : μ_1 (patents per million people) ≠ μ_2 (patents per million people)

ANOVA assumes equality of variance across groups and this assumption can be retained for these data (table 9).

Table 9: Test of Homogeneity of Variances based on LN patents 1995-2001

Levene Statistic	df1	df2	Sig.
11.09	1	201	0.001

The results of ANOVA are:

Table 10: ANOVA based on LN patents 1995-2001

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	58.685	1	58.69		
Within Groups	472.131	201	2.35	24.98	0.00
Total	530.815	202			

The significance value of the *F* test in the ANOVA table is 0.00 (table 10). Thus, we must reject the hypothesis that the average production of patents per million people is equal across countries with higher and lower religious fractionalization. In general, the structure of the data shows that countries with more religious fractionalization have a production of patents per million people higher than the first group. Although the variability within groups is 88.94%, the variability between groups assumes a considerably high value equal to 11.06%: this is the effect of the difference in average patents per million people between the two groups.

General remarks on econometric modeling

The econometric models confirm, *ceteris paribus*, the fruitful influence of religious fractionalization (diversity) on patents per million people. In particular, within richer and more democratic countries, there is a *leveraging* effect for the production of innovative outputs. Alesina *et al*. (2003) and Coccia (2010) discuss arguments in support of these vital results. It is important to note that religious fractionalization (which includes cultural, economic and institutional aspects) can be a main proxy of the

determinants of innovative outputs of countries. However, although the coefficients of the equations are significant, some regression lines explain the low variance in the level of patents per million people in terms of the religious fractionalization. Therefore, the residuals of these models have a great amount of variance to be explained. In particular, religious fractionalization is associated with specific cultural settings, so that it is a necessary but not sufficient conditions for higher innovative outputs by countries. For instance, France and Spain have a roughly similar religious fractionalization (≈0.4), but Spain has an average of about 82 patents per million people, whereas France has an average of 333 patents. These two cases confirm that patterns of technological innovation are driven by a complex system of socio-economic forces, represented by an effective national system of innovation governed by University, Industry and Government Linkages (*Triple Helix*). In fact, France has R&D expenditures (% of GDP) of about 2.15%, whereas Spain has lesser than 1%; researchers in R&D per million people are more than 2,600 units in France, while Spain has an average of about 1,900 researchers; Royalty and license fees receipts are about 40 (BoP current US$) in France in 1995-2001 *vs.* roughly 8 in Spain. These elements, in addition to religious fractionalization, also play a critical role in explaining the differences in the production of patents (innovative output) between France and Spain. In addition, patterns of technological innovation depend on the industrial specialization of the countries: countries specialized in finance and/or tourism would not need a high level of patents and/or R&D expenditures in order to ensure economic growth, whereas countries specialized in drugs, chemical engineering, biotechnologies, ICT industries, etc., need a higher level of patents and R&D expenditure to support their industrial dynamics. These main remarks confirm that the innovative output of countries is endogenous, affected by

industrial specialization and by a complex system of socio-economic forces. In other words, the national system of innovation and the structure of the economy support the innovative performance of countries that are fertilized in cultural contexts based on higher ethnic and religious fractionalization (cultural diversity).

5. Discussion

The vital findings of this paper support, through empirical evidence, two main epistemological positions: *first*, the heterogeneity assumption of different innovative outputs according to the predominant religious culture across countries; *second,* the hypothesis of benefits generated by higher religious fractionalization on the innovative outputs of economic systems, *ceteris paribus*.

In particular, the main lessons, underpinned by a empiricist-positivist position, are:

- *The morphology of the predominant religion shows that the geo-political area (region) affects the predominant religion of people, whereas the predominant religion affects the GDP per capita of countries.* These findings are important since some religions are located in specific geo-economic areas that shape the civilization, and as consequence, create a fruitful (or hostile) context to generate higher (or lower) economic and technological performances[29].

- *The present study shows that higher technological performances are a main character of countries with Protestant and Eastern religious cultures*[30]. Protestant

[29] For instance, Guiso *et al.* (2003) shows that: "Christian religions are positively associated with attitudes conducive to economic growth" (p. 225).

[30] Grier shows that: "Protestantism is correlated positively with growth and development" (quoted by Guiso *et al*., 2003, p. 230).

countries have a high positive association (*r=0.54)* for patents per million people/GDP per capita (control variable: democratization index), while the coefficient is *r=0.27* in countries with predominant Roman Catholic religion.

Some vital questions of this paper are:

Why do some religious cultures have higher innovative outputs?

Religion is a fundamental component of societies. Religion, on one hand, sets formal and informal ethical constraints to the human interests; on the other hand, it fosters greater opportunities for economic action by several subjects (consumers, firms, institutions, etc.). "Religion is an important force that shapes people's values, what they consider worthwhile and valuable (p. 4). . . . The economic, political, social, cultural, and scientific spheres cannot function independently of normative considerations, of which religion is an important source" (Deneulin and Rakodi, 2010, p. 5)[31]. John Stuart Mill (1953 [1885], pp. 55ff) discusses the social benefits of religion and argues that the education of any form of ethics is taught as religious education, which has a wide influence on all human actions. Hence, religious doctrines, accepted by the majority of people, have a vast influence on the direction and government of human life, business and all socio-economic activities (despite the fact that non-observant people are also present in a given country). In general, different religious backgrounds generate different ethical constraints and these lead to dissimilar behaviors and economic/technological performance across societies. Ethics is the cultural background of efficient economic systems and it is affected by the predominant religion and culture

[31] Cf. also Habermas (2006); Taylor (2007).

widespread in a particular area and historical period. However, the ethical constraints are not blind to the results of economic and technological activities, so that between ethical and socio-economic actions there are complex feedback effects: the economic sphere has a strong impact on social and ethical rules, and *vice versa*. For instance, the higher technological performance of some religious cultures can be due to their high levels of education[32]. In addition, Protestant countries have been more successful economically because according to: "Blum and Dudley . . . . Protestantism . . . improved the level of mutual trust and cooperation" (quoted by Guiso *et al.,* 2003, p. 230). Moreover, "Protestants and Hindus are the only religious groups that favor incentives. This result is consistent with Weber's view" (Guiso *et al.,* 2003, p. 280). Religion is a subset of the social system of countries, and cultural differences affect the adoption of technological innovations within a society, as described by Herbig and Palumbo (1994, p. 98) for the American and Japanese economies. However, religion and culture, of course, are not the only factors that may influence the innovative performances of countries[33]. Therefore, the patterns of technological innovation are also driven by other *intrinsic* factors, represented by economic governance, dynamics of the population, social and cultural openness, national and regional system of innovation, rule of law, etc.).

Another vital finding of this paper is that the statistical evidence, in general, supports the hypothesis that innovative outputs, measured by patents per million people, receive benefits from higher religious fractionalization, in particular among the "more

[32] Iannaccone (1998, p. 1475) claims that: "American Jews average significantly higher wages … largely attributable to their higher level of education", whereas Guiso *et al.* (2003) argue that: "Catholics in the United States tend to have higher wages . . . . attributed to the quality of their educational system" (p. 231).

[33] Herbig and Palumbo (1994, p. 98) argue: "culture can explain between 33%-65% of the variance [of innovative behaviour]".

democratic" and richer countries, which are mainly located in the geo-economic areas of Western Europe and North America.

Hence, another critical question is:

How does higher religious fractionalization fertilize the cultural background of countries and generate high technological performances?

This research has showed a higher propensity to produce innovative outputs by countries with higher religious fractionalization, springing from ethnic heterogeneity that should foster the cultural interchange that fertilizes the scientific and technological background of societies.

These findings are multicausal and can be explained using the argument by Alesina *et al.* (2003): "religious fractionalization tends to be higher in more tolerant and free societies" (p. 158); Alesina *et al.* (2003) also argue that: "The index of religious fractionalization bears relationship to controlling corruption, preventing bureaucratic delays, tax compliance, transfers, infrastructure quality, . . . lower illiteracy, school attainment, democracy, and political rights. . . . observed religious fragmentation is larger in more tolerant countries" (p. 173 and p. 175). In fact, these elements generate a higher level of democratization, which has, *de facto*, positive effects on economic structures and patterns of technological innovation (*cf.* Coccia, 2010, pp. 260-261). As a matter of fact, democratization is also the background of the economic governance that allows markets, economic activities and transactions to function well. Dixit (2009, p. 5) claims that good governance is important to secure the essential prerequisites of market economies, *i.e.* protection of property rights, enforcement of contracts and collective actions: "Good economic governance thus underpins the whole Smithian process whereby individuals specialize in different tasks and then transact with one another to

achieve the full economic potential of the society" (Dixit, 2009, p. 6).[34]

Therefore, democratization is the vital link between religious fractionalization and innovative outputs, which generates wellbeing for societies and countries. For instance, higher religious fractionalization, such as in the US due to their cultural diversity, has generated a democratic system that is "fuelling America's continuing growth" (Linstone, 2010, p. 697) and also scientific and technological worldwide leadership. Scott Page (2007) describes: "The difference: how the power of diversity creates better groups, firms, schools and societies". However, it is important to note that: "there is a downside to cultural diversity: communication, and hence agreement, may be more difficult to reach . . . . too much diversity may prove as undesirable as too little. Finding a good balance remains the ultimate challenge in dealing with every aspect of multiplicity and one that will always call for thoughtful judgment" (Linstone, 2010, p. 697)[35].

However, Deneulin and Rakodi (2010) criticize the empiricist-positivist research method based on fixed design surveys and streamlined definitions of religion in order to collect and analyze data: "research on religion is. . . not only about collecting 'data' that are subject to verification . . . but also first and foremost about studying the meanings that people give to their social practices and religious adherence and secondly, in line with critical social science, to use this knowledge to empower social actors" (Deneulin and Rakodi, 2010, p. 7, original emphasis). For this reason, an empirical approach should be integrated by hermeneutics, *i.e.* by in-depth interpretations to understand the

[34] It is important to note that if the concept of 'globalizing democracy' is implemented across modern countries in order to regulate mutual international socio-political relationships, this will also lead to major benefits for the origin and diffusion of technological innovations; see Archibugi (2004) and Archibugi *et al.* (2010) for a wide discussion on these topics as well as for a good list of references.

[35] Cf. also Alesina *et al.,* 2003, pp. 157-158, pp. 165-175 and for ethnic conflict see pp. 179-183 of this paper.

social reality[36]:

The present paper has found fruitful socio-cultural interactions between some religious cultures and innovative outputs. It has also showed the leveraging effect of higher religious fractionalization on patents of technological innovation across richer and more democratic countries. Yet, this analysis is, of course, not comprehensive. There is need for further socio-economic research on the cultural determinants of technological innovation, in order to better understand the current complex mechanisms of societies that will support future patterns of economic growth in a more and more global and fast-changing world.

[36] Cf. also Deneulin and Rakodi (2010, p. 9, note 14).

Appendix A - Countries per predominant religion

Table 1A: Classification of countries per predominant religion according to the CIA World Factbook (2010)

Roman Catholic	*Protestant*	*Orthodox*	*Jewish*	*Muslim*	*Hindu*	*Eastern*	*Other*
1. Argentina	1. Australia	1. Armenia	1. Israel	1. Algeria	1. Mauritius	1. China	1. Botswana
2. Austria	2. Denmark	2. Belarus		2. Azerbaijan		2. India	2. Cuba
3. Belgium	3. Estonia	3. Bulgaria		3. Bangladesh		3. Japan	3. Ghana
4. Brazil	4. Finland	4. Cyprus		4. Bosnia and Herzegovina		4. Korea, Rep.	4. Kenya
5. Canada	5. Germany	5. Ethiopia		5. Egypt, Arab Rep.		5. Mongolia	5. Madagascar
6. Chile	6. Iceland	6. Georgia		6. Gambia, The		6. Singapore	6. Malawi
7. Colombia	7. Latvia	7. Greece		7. Indonesia		7. Sri Lanka	7. Zambia
8. Croatia	8. Netherlands	8. Macedonia, FYR		8. Iran, Islamic Rep.		8. Thailand	
9. Czech Republic	9. New Zealand	9. Moldova		9. Iraq		9. Vietnam	
10. Ecuador	10. Norway	10. Romania		10. Kazakhstan			
11. France	11. South Africa	11. Russian Federat.		11. Kyrgyz Republic			
12. Guatemala	12. Swaziland	12. Ukraine		12. Libya			
13. Haiti	13. Sweden			13. Malaysia			
14. Honduras	14. Switzerland			14. Morocco			
15. Hungary	15. Tanzania			15. Pakistan			
16. Ireland	16. Uganda			16. Saudi Arabia			
17. Italy	17. United Kingdom			17. Sudan			
18. Lesotho	18. United States			18. Syrian Arab Rep.			
19. Lithuania	19. Zimbabwe			19. Tajikistan			
20. Luxembourg				20. Tunisia			
21. Malta				21. Turkey			
22. Mexico				22. Turkmenistan			
23. Monaco				23. Uzbekistan			
24. Nicaragua							
25. Panama							
26. Peru							
27. Philippines							
28. Poland							
29. Portugal							
30. Slovak Republic							
31. Slovenia							
32. Spain							
33. Trinidad and Tobago							
34. Uruguay							
35. Venezuela, RB							

Note: Although some countries are listed within a specific category, it is very difficult to find a predominant religion. Examples are China, India, and so on. Orthodox is mainly Greek Orthodox.

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