EDUCATION-HEALTH GRADIENT IN DIFFERENT CULTURAL ENVIRONMENTS

by

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Abstract

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In this paper we studied education-health gradient in different cultural environments based on World Bank for the period 1980-2007 years. In the first chapter we provide introductory information. The second chapter describes the mechanism of interaction between health, education and cultural environment. In the third chapter we develop a theoretical basis for empirical analysis. The fourth chapter is presenting the methodology of empirical analysis. In the sixth chapter we report on results and in the seventh we present our conclusions on the results and prospects of future study.

For six out of fourteen cultural indicators, which had statistically significant interaction with education, we found complementary relationship with education. Respectively eight indicators appeared to be substitutes to education in health model. The greatest effect of education on health was estimated for the following cultural environments: Muslim countries, countries with the status of the former French colonies and countries with high levels of cultural diversity. The above-mentioned culture environments are recommended for detailed consideration by officials of international organizations and charity funds, as promising areas for health policy implementation through improving of educational level.

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AKNOWLEDGEMENTS

I would like to thank my family.

GLOSSARY

Informational Set is the aggregate of ideas and knowledge, which can be used for the improvement of general individual welfare (IS). IS depends on the technological progress (TP) in the country.

Health Benefiting Informational Set is the aggregate of ideas and knowledge, which can be used for the improvement of individual health (HIS).

Cultural Informational Set is the aggregate of ideas and knowledge, which can be used for the improvement of general individual welfare and received by means of accumulation of cultural capital (CIS).

Educational Informational Set is the aggregate of ideas and knowledge, which can be used for the improvement of general individual welfare and received by means of formal education (EIS).

Cluster of Informational Set is the homogeneous and productive in terms of welfare unit of informational set (CL).

Chapter 1

INTRODUCTION

Nowadays global health exhibits great division, which is expressed in drastic difference of life expectancy between developed and developing countries. For example, people in Japan and Switzerland live almost twice as long as in most African countries (World Bank, 2010). Therefore, research into the differences, which allow people to live so much longer, is of extreme interest.

Research into health inequality has resulted in the formation of a consensus of the main elements of a health model. Education, income and occupational status together with health programs are recognized by most researchers as the main influential factors of health (Feinstein, 1993). Other factors, which are widely recognized, are as follows: geographical location and climate (Curtis & Jones, Is there a place for geography in the analysis of health inequality?, 1998) and policy regime (Page, Morrell, & Taylor, 2002). Sociological studies have added cultural environment to these factors (Landrine & Klonoff, 1992). All factors are important for health production and deserve separate attention and separate research. In this paper we will concentrate on interrelation of education and cultural environment.

Education has been proven to be one of the most influential factors (Feinstein, 1993). Therefore, investment in education can be considered as an instrument for health improvement. However, the level of educational productivity for health improvement often varies among countries. It can differ in several dimensions. For example, the law of diminishing marginal return leads to the conclusion that education should be more productive in countries with lower level of education than in developing countries, as education is one of the major factors influencing productivity and economic development in general. But level of education in the country may not be the unique identifier of diversity in

marginal product of education between countries. The cultural environment can play a vital role in defining the productivity of education. The reasoning of such a statement is that culture creates a specific informational environment, which includes, among other things, information which is beneficial for individual health. Examples of such information can be Islamic hygiene rules or Chinese traditional medicine. Such types of knowledge ensure a certain level of individual health. If a person of a specific culture goes to school she will receive some information, which is beneficial to health. If this information is newly digested, then an individual will receive entire utility from this knowledge. However, if a person received this information from some cultural source (e.g. parental training) before studying in school marginal product of education will diminish significantly. Therefore, in different cultural environments schooling can reveal different levels of productivity.

For formalizing the central idea of this research, it is necessary to define cultural capital as some measurable concept reflecting cultural environment. Cultural capital will be defined as the accumulated information, which is available and understandable to a person if no formal education is available. This type of concept is difficult to measure. However, it can be approximated qualitatively by the introduction into the model of a dummy variable (or category) for religious or cultural groups of agents (ethnic, linguistic, etc.) and quantitatively by the introduction of different types of disruptions, for example, wars, disasters, revolutions.

As cultural capital has been defined, the main hypothesis can be introduced. The main hypothesis of the research is as follows: the marginal product of education is negatively related to the level of cultural capital. If we assume that both education and cultural environment can cause the same health behavior, then it possible to show that these two inputs will operate as substitutes in the process of health production.

If hypothesis will be proven by the data analysis, it would mean that health programs, which include measures for increasing of the educational level, in

some cultural areas would be less effective than in others. Therefore, this research can provide additional information for policymakers, which can improve effectiveness of resource allocation.

In this research macroeconomic data will be used. Therefore, the phenomenon of interrelationship between cultural environment and educational impact on the health gradient will be studied at the country level. The WDI indicators will be used for the construction of the core dataset; this source includes most necessary variables (World Bank, 2010).

The current paper is aimed at testing the strength of possible impact of the cultural environment on the education-health gradient. Large funds are spent by international organizations and private charity funds on educational development programs in countries with problematic health indicators. However, efficiency of their usage can be misevaluated ex-ante, because such evaluation is mostly based on the experience of other countries. Such an approach can mislead policymakers as different cultural environments can cause different results of the program.

If international organization or charity fund would like to support developing country in terms of financial and consulting assistance of educational development program, it can have a list of possible candidates for intervention. Therefore, for maximization of return on invested funds, evaluation of possible impacts of the program should be done for each candidate. In one country we can have a very old culture with developed traditional medicine while in another country, culture, which is distorted by wars and a predominantly tribal type of values construction and primitive health knowledge. However, both states can have same education, income and mortality level. Marginal health product of additional knowledge will be much higher in second country; and ceteris paribus policy introduction will be much more effective (both on monetary and health terms).Therefore, we can see that taking in account of cultural environment for evaluation of educational-health gradient gives precision in estimation of project returns and, therefore, ensures improvement in resource allocation.

In Chapter 1 we will present a review of the literature related to the current thesis paper. In Chapter 2 the mechanism of interaction between education and cultural capital accumulation in the health model will be described. A theoretical framework will be built in Chapter 3. We will describe data sources in Chapter 4. In Chapter 5 the econometric model will be built and empirical results will be reported. We will report our conclusions in Chapter 6.

Chapter 2

LITERATURE REVIEW

Health inequality has been a phenomenon of great interest to humanity for at least three hundred years. In 1662, the British scientist John Graunt used London Mortality Bills for researching the differences in mortality rates between the city of London and its outskirts. He showed that people in London lived shorter lives due to poor environmental and unsatisfactory hygienic conditions (Whitehead, 1997).

However, the first studies of health inequalities, which used complex computational techniques or advanced theoretical concepts, appeared in the second half of the 20th century. One of the first concepts in the sphere of health inequality developed was the absolute income hypothesis, according to which, health depends on income level of the country and its annual growth (Adelman, 1963)). In addition, the author introduced education into the estimation equation for health level. She found that education had a significant effect on health. However, separate analysis of the education-health gradient was not implemented.

The introduction of the relative income measure into the health model became the next logical development of the theory (Rodgers, 1979). The diminishing marginal return of income in health production on the macroeconomic level was noticed by Preston in 1975. This fact became the major argument for the implementation of the policy of material support to poor countries. The 'generosity' of richer countries was expected to increase the level of health all over the world. In addition, he investigated the parallel shifts of curves, which reflected the relationship between health and income per capita. The author

concluded that the crucial parallel shift of the curve from 1930 to 1960 was due to successful programs of medical care in the colonies. (Preston, 1975).

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Development of the health capital concept became one of the fundamental findings in the study of health inequality (Grossman, 1972). Health was described as a stock, which is endowed at birth and changes due to depreciation (aging) and investments (medical expenses, education etc.). One of the major roles in the production function of health the author attributed to education, as a factor, which defines productivity of inputs (medical care, own time).The time preferences theory appeared to be an alternative hypothesis to the health capital concept. It explained inequality in health by differences in the valuation of present and future consumption. People, who value future health consumption more highly, will invest in their health. In addition, the author introduced an instrumental variable approach as a tool of overcoming of the endogeneity issue in the health model, which is caused by the omission of unobservable variable(Fuchs V. R., 1982; Fuchs V. , 1972). The papers of Grossman (1972) and Fuchs (1972, 1982) provoked further empirical studies, which emphasis on evaluation of different factors (Feinstein, 1993).

In the same period first the empirical studies based on Fuchs (1972) and Grossman (1972) appeared. Another explanation of endogeneity was noticed in the health estimation equation. It was described that poor health can cause both lower income and less education (Silver, 1972). Logue and Jarjoura (1990) explicitly divided the population into classes (by income), and showed that the lower-middle-income class is characterized by almost double the heart mortality rate when compared to the higher-middle-income class (Logue & Jarjoura, 1990).

An alternative view on the social classes was developed in the United Kingdom after the publishing of The Black Report (Report on Health inequality by Labor Government of UK). In this report a working group headed by Douglas Black implemented an analysis of the averages of health indicators for different social

classes in Britain. The innovation, which they introduced, lies in the division of the population by social classes using occupational status of individuals instead of their income and/or education. The authors found significant health differences in English and Welsh societies, which had grown over time. While The Black Report had many statistical drawbacks, other studies which endeavored to overcome them, found similar results (Feinstein, 1993)

The new wave of investigation of the education-health gradient began from Angrist and Krueger (1991), who first introduced the compulsory education laws as instruments for education into the analysis of health inequality. The findings of studies of this type were controversial. The effect of education on health inequality was found to be significant in many studies based on US data, however, studies which used data from European countries mostly found the opposite results (Jürges, 2011). There were many other attempts to find a valid instrument for education. The proximity of a mother's living location to college as instrument for infant mortality(Currie & Moretti, 2003) or the discontinuous increase in demand for education, which occurred due to the Vietnam War draft lottery, as an instrument for education (MacInnis, 2006) are two good examples of such attempts. Auld and Sidhu (2005) introduced into the analysis the heterogeneous agent model and found that while most of the correlation between schooling and health is due to unobserved heterogeneity, educational level is important for the health of poorly educated population. Studies of this type allowed resolving endogeneity bias (at least for US data) and proved education to health direction of causality.

Three major factors influencing health were defined by World Bank (1993) in its seminal report *Investing in health*: level of income, health expenditures and health programs. However, named factors appeared to be important they did not explain variation in health entirely. One of major elements, which were omitted from discussion, was cultural environment (Eckersley R. , 2001).

The effect of geographical location on health inequality was widely studied using the data both at the regional level in England and international data. It was

concluded that the impact of geographical position is not crucial for health differences; though in most cases it is significant (Curtis & Sarah, 2004; Curtis & Jones, 1998) Moreover, the importance of gender and ethnic differences for health inequality was investigated based on English data. It was shown that within the country, only gender diversity is significant after controlling for socio-economic differences, while ethnicity becomes statistically insignificant (Cooper, 2002). However, in sociological literature the idea that ethnical and cultural differences are important factors for health inequality dominates (Landrine & Klonoff, 1992). Abel (2008) introduced into the problem of health inequality the concept of culture capital which Bourdieu (1992) broadly defines as people's symbolic and informational resources for action. The author defends the position of cultural diversity as an extremely important factor in defining health differences (Abel, 2008; Bourdieu & Wacquant, 1992).

Another dimension of social life, which has been proven to be important in terms of health differences, is the political regime. It was shown that the policy regime in the Australian state of New South Wales had a drastic influence on frequency of suicides. The conservative regime was associated with a higher suicide risk. It should be noted that the authors accounted for differences in income and climate conditions (Page, Morrell, & Taylor, 2002).

Additional evidence of strong interrelation between health and culture can be found in literature on health communication. Group of studies found that communities representing different cultures are characterized by significantly different informational flows among individuals. Specific approach for health communication with different cultural group is estimated to be much more efficient than culturally unadjusted communication. Moreover, information provided through sources, which are popular among different cultural groups in US appeared to be systematically different (Kreuter & McClure, 2004).

Wide range of epidemiological studies approves close relation between culture and health level. Acculturation appeared to have various impacts on individual health. These effects are different in magnitude; however, they are statistically

significant in most studies (Salant & Lauderdale, 2009). Another study showed that chronically ill African-Americans use different treatments in response to their cultural affiliation (Becker & Gates, 2004). The group of epidemiologic studies showed significant impact of western cultural principals (individualism and materialism) on health behavior. Main concern lies in sphere of trade-off between individual moral rules and life goals dictated by society (Eckersley R. , 2006).

Wang (2010) has implemented research into time preference in different countries. The author studied 45 countries using individual data. He found, that most variation of time preferences across countries can be explained by macroeconomic factors and cultural diversity. Cultural diversity was introduced into the analysis using dummy variables for different cultural groups (Wang, 2010). Therefore, endogeneity in the health model, which is caused by the influence of time preferences (Fuchs, Time Preference and Health: An Exploratory Study, 1982) can be resolved by introduction of differences in cultural environment into the macroeconomic health model.

In conclusion, it can be noted that most authors of economic literature, who investigated health inequality, used income, education and occupational status as the main explanatory variables. However, sociology literature argues for the distinguishable effect of cultural environment on health inequality. Several studies enriched the general trend and paid attention to such factors as geographical location, climate and policy regime. In addition, a variety of econometric techniques were used; the main goal of their use is the omitting of endogeneity in the model caused either by omitted variable bias or simultaneity of health and influential factors. In this paper the sociological and anthropological conclusions about the importance of cultural capital for health will be introduced in a highly developed theoretical economic and econometric model of health production. The contribution of this study lies in the investigation of the impact of cultural environment on the education-health gradient. The null hypothesis is that education and cultural capital are substitutes in the health model (especially for low education environments), therefore,

public educational policy should be adjusted in specific ways for different cultural environments.

Chapter 3

THE MECHANISM OF EDUCATION-HEALTH GRADIENT FORMATION IN DIFFERENT CULTURAL ENVIROMENTS

In the following chapter we will describe the general mechanism of health production. We start from the fundamental factors influencing health: access to information and its cognition (education and cultural channels), economic situation in the country, parental background, global environment and others. While our main interest lies in the description of each informational factor, we will first describe the general mechanism of health production.

Global Environment

Global environment is the impact of the achievements of the rest of the world on individuals in their home country. There are two major aspects: global technology and cultural globalization. Global technology influences health care. For example, the use of gamma rays in the healing cancer will allow for the treating of people all over the world. Cultural globalization means the absorption of western type cultural capital. This type of cultural capital may be received from different sources, for example, movies, newspapers, TV-shows, web-sites, clothing fashion and others. For a better understanding the influence of this factor we can look at some particulars in more details. The western movie is a commodity consumed in great quantities all over the world. Each movie contains not only the story itself but in many cases a wide set of information on the people's behavior. Moreover, western movies play a role of in the patterning local film companies, as many US and European films are considered to be an etalon for the rest of the world. For example, smoking in movies significantly influences the smoking behavior of teenagers and adolescents (Sargent, 2005; Charlesworth & Glantz, 2005). In addition, movie watching influences dating behavior (Rivadeneyra & Lebo, 2008)) and many other spheres. Cho and Choi

(2011) showed that the frequency of images with tanned bodies in movies is associated with pro-tanning behavior. Wei et al (2010) showed that watching TV increases the probability of being subjected to the rape myth for Chinese adolescents. We can also look at the influence of the internet, as showed by Wei et al (2010).Internet usage increases the probability of having premarital intimate relationships even if users do not visit intimate web-sites. If users do visit internet web-sites of an intimate character, their propensity for changes in intimate relationships behavior increases drastically.

Economic Position

The economic position of the country indirectly influences all spheres of individual life; however, in our scheme we depicted only the most direct channels. The wealth of the country directly influences health through the level of education and health care system. However, other channels of influence (e.g. impact of general happiness) will be taken into account by direct inclusion of per capita income in the econometric model.

Parental Background

Parental background includes all of the information accumulated by previous generations and the social norms formed historically. Parental background influences formation of social groups and social self-identification of the person. An individual will choose her position in the society according to thenorms, frames of good and evil, and other information which is inherited from their parents. The specific social environment and identification in their case will define behavioral patterns, which will in turn influence health.

Physical Environment

These factors are known and expected but are not fully under people's control due to additional time or financial costs. Geographical factors, the ecological situation and the individual's environment, which depend on the social group of the individual, rarely can be changed. All these factors directly influence health.

Exogenous Factors

To this group we can add all factors, which are unexpected and lie fully outside of the individual's control. Disasters, wars, economic crises, and unexpected political interventions are generally out of one's control but all definitely influence a person's health.

Genetics

Genetics is a factor which defines health by nature. The genetic structure of defensive reactions to organisms of different levels of aggression from the outside world is the most powerful aspect of genetic influence. By this means, genetics directly influences health. However, there is another means of genetic influence. It can influence the cognitive process, so that the processing of information can be different for people with different genetic codes. In cases where genetic distribution of cognition ability is not uniform among countries, then our estimated can be biased. This problem will be discussed in more detail in the empirical part of the paper.

Now we are ready to describe our focus question, the impact of information on health production. All information an individual receives from either of two sources: education (officially organized process of information gathering) and cultural environment (information gathered as side product of life activities other than education). Education influences individual behavior both directly and through theoretical environment (social self-identification and social group behavior patterns). For example, a person may receive additional knowledge about health benefiting behavior in lesson of biology. In addition, the social environment of the student who received this knowledge will increase the probability that the information will be digested by the individual. Cultural capital can be accumulated through religious beliefs and folk theories. Folk theories are non-scientific constructions of beliefs about a topic formed historically (based on individual experience and the experience of past generations) and/or using sources of information with non-educational goals (e.g. newspapers, internet sites). Individual cultural capital influences individual behavior both directly through health knowledge and through social norms and

social self-identification of the person. Patterns of individual behavior define individual health to a large extent.

Cultural capital, through its components, ensures some level of health which a person can maintain without education. With different religions, different intensities of information flow, different levels of inherited health knowledge from previous generations, a different level of cultural capital is accumulated in the country. For example, it was shown empirically that people from different cultures use dramatically different information processing strategies, which can cause no less different cognition of medical technology through the social institutions. (Chiu, Morris, Hong,, & Menon, 2000). The impact of cultural capital health can be directly seen in the tradition of Islamic prohibition of alcohol drinking and the tradition of ablution, which involves the washing of hands and other parts of the body before prayer (five times a day). Other example of the influence of culture capital on health is the attitude to traditional medicine. For example, in China many traditional medical techniques were developed over several thousands of years, and these techniques are widely used in East Asian countries. However, in Western Europe and the US these techniques are treated as alternative medicine, and consequently the proportion of the use of these medical techniques is different. Therefore, cultural capital can influence health directly.(Barnes, B., & Nahin, 2008).

Therefore, the diversity of cultural capital among countries is formed and the level of health ensured for an average individual without education is also different. If we look both at channels of impact of education and cultural capital on health, we can notice that both these inputs are operating through similar channels (Figure 2.1.). These channels are social environment, social self-identification and direct health knowledge. If cultural capital influences health outcomes by similar means as education, then we can conclude that education and cultural capital are characterized by some level of homogeneity as inputs in health production function. It means that some level of cultural capital can affect health in the same way as some amount of education. In other words information obtained from religion or society can have the same effect on health

as information obtained from formal education. Therefore, information received either from cultural or educational source can give new knowledge or repeat knowledge received from other source. In the first case marginal product of the input will be much higher than in the second. For clarification of last two statements the following example can be provided. If parents trained their children to wash hands every time after coming home, then the marginal product on health of biology lesson on microorganisms and their harmful influence will be much lower. In this example educational equivalent (in impact on health) of cultural capital (parents training) is close to biology lesson of seventh grade, therefore, marginal product of biology lesson on health is close to zero. Therefore, cultural capital plays a role of substitute input to education in health production function. If the above theoretical considerations take place, then education-health gradient is diversified across different levels of cultural capital. This conclusion is crucial for the following development of theoretical and empirical parts of the thesis. It has perspective policy implication in accordance to macroeconomic health programs, as misevaluation of marginal product of input can lead to bias in solution of social planner's optimization problem.

Chapter 4

THEORETICAL FRAMEWORK

2.1. Theoretical mechanism

We will start to build our model from the informational nature of such inputs as formal education and the accumulation of cultural capital. We start by defining the space of all possible information which is useful for daily activity of the person (IS, figure 2). Then we define the parts of this informational set that can be processed either by means of formal education or accumulation of cultural capital. These parts (CIS and EIS, Figure 2) are assumed to be randomly perceived from the general informational set (IS) due to involvement in the processes of formal education and accumulation of cultural capital. Further we define part of the general information set, which includes all information benefitting human health (HIS, Figure 2). Having assumed that these sets are finite, they can be divided into equally productive units of information, clusters (CL) and the amount of clusters in each informational set is known we can construct a probabilistic function of health production in terms of the amount of informational units. In addition, we assume that the productivity of each cluster is constant regardless of their overall quantity and source of reception. This assumption can be treated as unrealistic, because the productivity of one type of information is likely to depend on other types of information digested. However, our logic is that we can group clusters in such a way that their productivity is independent of other clusters. For example, knowledge about HIV and its prophylaxis will influence the effect of information about venereal diseases. We can group these two types of information and form new cluster, which will be independent of knowledge about influenza. We do not consider this assumption as very restrictive as health is a very diverse phenomenon, which consists of many relatively independent elements. If we assume that the beneficial health information set is growing with the same speed as the

information set in general, then we can show that health production depends on the amount of cultural information, the amount of information digested from formal education and the scale of their interaction (derivations provided in Appendix A). Now we can assume that EIS is a non-decreasing function of formal education and CIS is a non-decreasing function of the accumulation of cultural capital (assumption 4). As the interaction by definition is less than or equal to the union of CIS and EIS, then we can conclude that health is a non-decreasing function of formal education and accumulated cultural capital. Interaction is positively related to the level of inputs but negatively related to the size of the general informational set, which can be associated with technological progress. Intuition behind this finding is as follows: technological progress increases the overall amount of information, which can be digested, therefore, decreases the probability of the same information being received from different sources.

Now we can consider the mechanism of interaction between inputs. Interaction happens due to the homogeneity of informational inputs in terms of the impact on health (assumption 6). For example, the aborigine who was taught by his parents that a bad spirit lives in a swamp will not benefit from geological knowledge about the construction of the swamp. From this example we see that though informational flows from formal education and accumulation of cultural capital may actually not interact (may not provide similar information), in terms of health production they will be homogeneous. Therefore, homogeneous in terms of health benefit information received from either formal education or cultural capital as second source will have much lower marginal product. In our model we assumed that information received from "the second source" will have zero marginal return. This type of interaction between the effects of inputs allegorically can be associated with the mismanagement or imperfection of informational flows, which decreases production of health. In our model information is assigned randomly, however in real life formal education can be adjusted for the

cultural environment. For example in biology lessons teachers can stress health topics, which are weakly covered by accumulated cultural capital.

The mechanism of interaction leads to a decrease in the productivity of one input with an increase in usage of another factor. Therefore, we can conclude that cultural capital and formal education are substitutes in health production function in case when both inputs have positive effect on health.

In discussion before this moment we assumed that cultural capital has positive effect on health. Further we use our model to predict relationship between education and health in case if this assumption is violated. First, we assumed that cultural information produces negative effect from the same informational clusters, using which educational information produces positive effect. For simplicity we assumed that inputs have same effect from one unit of information in absolute values. In such situation Assumption 6 six is naturally relaxing as information is not homogeneous (we have two types "good" and "bad": clusters are the same, but they can have different marginal product). In addition, we made an assumption that "bad" information can be perfectly substituted for "good" information but not in opposite direction (Assumption 7). We consider this assumption as natural as ceteris paribus individual benefitting from health improvement. If individual randomly receives information, which can improve her health, but contradicts to information received by cultural source, she will substitute "bad" for "good" information. Using such an extension of the model we made prediction that in case if negative effect of cultural information on health culture and education will be complements (calculations are provided in Appendix A). Intuitive explanation of this prediction is as follows: negative effect of culture on health gives more possibilities of health improvement for formal education, however, formal education does not allow for cultural capital to influence negatively on health, therefore, marginal product of cultural capital

increases (become less negative). In such situation we have complementary relationship.

And the last case, which we studied describes situation, when education cannot substitute "bad" cultural impact. For example, if some cultural information, which negatively influences health, is fundamental religion canon, then education unlikely can substitute effect of such knowledge. In this case we assume that both inputs cannot be substituted by another input (Assumption 8). The sign of interaction depends on timing of input receiving. So that, if we receive information by means of education at first and then use cultural sources, interaction will be same as in previous case with perfect substitution of cultural input by education (it will have positive sign). However, this case is not realistic and most information we receive first from cultural sources and then from education. If we consider extreme case, when all information (from interaction set) at first is received from cultural capital accumulation and then from education, we will find that interaction will have negative sign. This will be the case because cultural capital not only provides negative marginal product, but, in addition, does not allow individual to improve health level by means of education (in frames of interaction between education and culture informational sets). In this case we will receive relationship, when education and cultural capital are substitutes (calculations can be found in Appendix A).

Therefore, we can predict following relationships:

- If education has positive effect, cultural capital has positive effect and interaction has negative effect on health, then inputs are substitutes;
- *Motivation: individual prefers better health, so that uses either education or culture to improve it, however, if information received by one of the sources is equivalent to information received by another source, marginal product of same information received the second time is very close to zero.* .
- If education has positive effect, cultural capital has negative effect and interaction has positive effect on health, then inputs are

compliments, educational information can substitute cultural information, but there is no substitute relationship in opposite direction;

Motivation: individual prefers better health, so that uses education to eliminate negative effect of cultural information, but does not accept cultural information if it contradicts knowledge received by education.

- If education has positive effect, cultural capital has negative effect and interaction has negative effect on health, then inputs are substitutes and there exist barriers for information received by cultural capital to be substituted by information from formal education;

  Motivation: cultural information cannot be substituted by educational information due to psychological or sociological reasons. For example, people drink alcohol knowing that this substance is harmful due to either psychological reasons (e.g. relaxation) or sociological (e.g. tradition of alcohol drinking on holidays).

Introduced assumptions:

1) All informational sets are finite, known and consist of clusters of same size and marginal productivity;

2) An individual digesting information randomly (in frames of educational or cultural informational set). It means that a person using either education or cultural environment as informational source is not able to choose specific information. She cannot ensure information received by different sources to have different effect on health behavior by modifying process of cognition. For example, an individual cannot choose what health benefitting knowledge he will receive in school or at home from parents. This assumption is unlikely to be binding, as rarely people have control on health information receiving by education (especially in primary and secondary school) or from cultural environment.

3) The number of clusters in each informational set is a function of inputs (education and cultural capital, denoted by k); however, products of each

cluster in the health beneficial set is constant (AP=const), therefore, independent of the availability of any other cluster among processed clusters.

4) The number of clusters in each informational set is a non-decreasing function of inputs, which are related to this set and do not depend on level of other input.

5) The health benefiting informational set is growing at the same rate as general informational set.

6) Information received both from education and cultural capital accumulation is homogeneous. It means that if we receive some informational cluster from one of informational sources (either from education and cultural capital) its marginal product will not be changed by its repeated reception from other source.

7) This assumption is used only for case with negative effect of cultural information. Information received my means of education can substitute information received by cultural capital, however, cultural information cannot substitute information received by means of education.

8) This assumption is used only for case with negative effect of cultural information and where substitution of cultural information by means of education is not possible. Cultural information is received before educational information and cannot be substituted by it.

Possible shortcomings of model prediction

We should pay attention to following threats to the robustness of model conclusion. We made two assumptions that can jeopardize our results. Assumption 2 will be violated if individual has possibility to choose what health information to digest and from what source. It can take place if state will introduce education policy, according to which culturally specific health

information will be excluded from education programs, however, some other health knowledge will be added. Then interaction between inputs of health will tend to zero. If assumption 3 will be violated, then different units of information will interact between each other and influence each other's marginal productivity. If their average productivity will diminish because of interaction, then relationships, which we derived, can be even stronger. In opposite case (if interaction between informational units will cause increase in average productivity) relationship will become weaker and can turn to opposite direction.

Possible explanation of assumption 3 violation is that both formal education and cultural capital can positively influence cognition. Such relationship was described by Rosselli et al (2003). In this case information received from each source will increase the maximum capacity of cognition; therefore, marginal product can diminish slower or even grow. Such mechanism can lead to increasing marginal return of inputs. In such a situation empirical investigation can show that our inputs are has relationships, which are opposite to predicted. However, generally it is unlikely that health would experience increasing marginal return on information as health knowledge is very diverse and for healing or preventing of specific disease we often need specific knowledge.

Chapter 5

DATA DESCRIPTION

The main source of data for the research is WDI dataset, which contains most indicators, which are necessary for analysis. (World Bank, 2010).

We use number of World Heritage UNESCO objects in the country as proxy for historical stability of the culture. As UNESCO adds to the list of World Heritage only objects, which are characterized by physical integrity and secured by the state, proximity to such objects can approximate historical integrity of culture (UNESCO, 2012). Data on religion characteristics is got from ARDA National Profiles Dataset (ARDA, 2011). Data is time invariant and, therefore, assumed to be constant over time. It is modified to dummy variables for countries, which have 20% or more representatives of specific religion.

From the EM-DAT dataset of the Center of Research on the Epidemiology of Disasters we drew and the places and quantities of natural catastrophes. The data on armed conflicts we can find in dataset of the Uppsala Conflict Data Program (CRED, 2009; UCDP, 2009).

Political characteristics of the countries were added from the Polity IV database. Three measures are used: political specific (scoring for level of democratization), duration of current political regime and level of political competition (Marshal, Jaggers, & Gurr, 2011).

Data on globalization can be found in the dataset of the KOF globalization index, which provides wide range of indexes characterizing the level of different types of globalization.

Data on religion, ethnic fractionalization, cultural diversity and colonial status is taken from dataset of Fearon (2003). Religion and ethnic fractionalization will capture cultural impact of ethnic and religious rivalry. For example, cultural environment with high level of rivalry inside of society can influence choice of optimal educational level for individual. Data in this sample is time invariant; therefore, it is assumed to be constant over time and studied using of cross-sectional dimension. All values of indexes are normalized to lie between zero and unity.

Variables characterizing health. For expressing health in the model we use life expectancy. This variable is added from the WDI dataset.

Variables characterizing education. Gross secondary school enrollment as a per cent of eligible for studying population is added from the WDI dataset. This variable is chosen because during secondary education the human psyche is most vulnerable to received information, as it coincides in time with the formation of individuality. Therefore, the interaction of education and cultural capital can be revealed in the strongest manner in this period.

Variables characterizing income. Choice of this indicator is straightforward; per capita gross domestic product in constant prices (PPP corrected) is most the precise available income indicator. It is added from the WDI dataset.

Variables characterizing countries' cultural specifications. One variable that covers the historical stability of cultural identification will be proximity to objects from World Heritage List constructed by UNESCO. The second variable characterizing culture is religion dummy, which calculated on the bases of the ARDA dataset, we put unity for all religions, which have twenty or more percent of representatives in a country. In addition to the ARDA dataset the CIA Statistical Factbook was used for constructing dummies of different sections of Christianity. And the third characteristic of cultural capital will be cultural globalization from the KOF globalization index.

Other variables playing role of controls. The main control variable has been already named, it is GDP per capita and culture indicators. Other control variable are as follows: gender, geographic position (distance from equator) (CIA Statistical Factbook, 2011), amount of people died in a war (UCDP, 2009), amount of people deaths caused by natural catastrophes (EM-DAT dataset, 2009), political situation (Policy IV, 2011), environmental factors and demographic characteristics of countries (World Bank, 2010).

The indexes of globalization. Researchers underline such influential factors of globalization on health as follows: institutional, economic and social-cultural (Huynen, 2005).Though we concentrate on socio-cultural aspect, we are able to control for all other channels. Effects of education and culture are expected to be positive, as they represent a set of additional knowledge.

Such indexes as follows are used from the KFO globalization dataset: cultural proximity (number of McDonald's Restaurants per capita, number of Ikea per capita, trade in books percent of GDP), social globalization (telephone traffic, transfers percent of GDP, international tourism, foreign population percent of total population, international letters per capita), informational flow index (internet users per 1000 people, television per 1000 people, trade in newspapers percent of GDP), overall globalization index and political globalization index (embassies in country, membership in international organizations; participation in the U.N. Security Council Missions; international treaties) (Dreher, 2006).

Econometric model:

Basing on theoretical framework developed in chapter three and Grossman production function of health, we can construct econometric model, which will allow us to estimate coefficients of extended health-educational model. We use OLS model, random effect and/or fixed effect regression. We start

from OLS as basic model and then developed it introduction of fixed and random effect regression. Then we implement statistical tests of efficiency of fixed effect regression (F-test) and test for presence of autocorrelation and heteroskedasticity (Wooldridge test and Modified Wald test). In case of availability of heteroskedasticity or/and autocorrelation we use GLS procedure for overcoming of these econometric issues.

Estimated model can be expressed in equation, as follows:

$$H = \beta_1 * Edu + \beta_2 * (Edu)^2 + \beta_3 * Cult * Edu + \beta_4 * (Edu)^2 * Cult + \beta \quad (1)$$

where,

H - health indicator;

Edu - educational indicator (educational attainment and educational attainment allowing for diminishing or increasing marginal return);

Inc - income indicator;

Cult – vector of culture indicators;

Contr – vector of control variables (disasters, wars, gender distribution etc);

Env – vector of environmental indicators;

Inf – information flow index;

Glb- globalization indexes;

Glbcp- cultural proximity globalization indexes.

Our analysis of econometric model will be concentrated on coefficients in front of educational, cultural inputs and their interaction. We will look at signs in front of noted coefficient to notify whether cultural capital and education are substitutes or compliments. Coefficient of in front education is expected to be positive, as many researches showed (Currie & Moretti, 2003),

therefore, if sign in front of estimate of cultural variable will be the same as sign in front of its interaction with educational variable, then we will conclude that this cultural input is compliment to education, if signs will be different, we can conclude that opposite relationship takes place.

In addition, we use mean corrected values of variables for calculation of interaction terms, therefore, we can calculate for how much of input effect interaction is responsible. Formal representation of correction for you can see below (Wooldridge, 2006):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 (X_1 - \overline{X_1})(X_2 - \overline{X_2}) + u \quad (2)$$

Therefore, total effect of factor X1 will be calculated as follows:

$$\lambda_1 = \beta_1 + \beta_3 * \overline{X_2} \quad (3)$$

We can answer major questions stated by the thesis using chosen econometric model: whether inputs are compliments or substitutes and what level of importance caries their interrelation in terms of change in education-health gradient.

In addition, we test our control variables to be influential on coefficients of main interest. We need this procedure as data on some controls are limited and sample can be cut significantly after dropping of observations, where these variables are missing. We run regressions with and without controls for the same sample (where missing values are dropped) and test coefficients of these two regressions to be systematically different. If coefficients are not systematically different we conclude that these variables can be omitted from regression as they do not influence coefficients of our interest. If coefficients appear to be systematically different then we have tradeoff between sample selection problem and omitted variable bias. Then we need study distribution of countries with respect life expectancy, income level and education for two samples and then conclude whether selection bias is large enough. After this

procedure is implemented we make treatment, which model is better and then provide robustness check with sample which we did not used.

As a result, we would be able to make conclusion on cultural specifications, which should be taken in account before introduction of policy directed on development of health through the education.

Chapter 6

EMPIRICAL ANALYSIS

The data analysis is divided on two major parts: summary statistics and regression analysis. In summary statistics the overall numerical characteristics of variables of interest and control variables are studied. In Table 1 the summary statistics of all used in analysis variables is provided. The following characteristics are calculated: average value and standard deviation (for dummy variables frequencies are noted). As we have panel data means and standard deviation are calculated for the first and for the last year. From standard deviation we can see that variation in variables exist, therefore, we can use them for regression analysis. Means inform us average value for each variable; for dummy variables using means we can find proportions of unities in the sample.

On Figure 3 and 4 we can see distribution of religions across different levels of health in first and last year of the used sample (both adjusted and not adjusted for income and education level life expectancy). As can be noted sum of shares for each level does not equal to 1. It happened because religion is identified to be influential in the country if at least 20% of population follows it. Therefore, each country can have more than one religion (vectors of religion dummies are not perfectly orthogonal). Diagonal '10 – 5' divides distribution of health by religion on too halves. The asymmetry of figures across this diagonal shows which religion dominates in more or less healthy countries. On example of Christianity, we can see that, if life expectancy is not adjusted for income and education, distribution of countries with Christianity as religion is a bit skewed to relatively more healthy population (Figure 3a, 4a). If we look at distribution of countries with Christianity across different deciles

of adjusted (for income and education) life expectancy, we will note that countries with more than 20% of Christianity believers either symmetrically distributed between high and low level of health in 1971 or skewed to lower level of health in 2007. From Figures 3 and 4 we can see that life expectancy deviates a lot across different types of religious environment and time dimension.

On Figure 5 and 6 averages of life expectancy across different levels of cultural stability index (number of world heritage objects in the country), real GDP per capita and secondary school enrolment can be found both for 1971 and 2007. As can be seen on Figure 5 patterns of life expectancy change for different levels of education, income and cultural stability index are very similar; they are stable at the beginning (first three deciles) and further they are growing. However, growth is faster across educational and income level than for the level of cultural stability index. On Figure 6 we can note different patterns of life expectancy change for 2007 across all three inputs. Change across education has slow growth up to the fifth decile, then large jump and further slow growth with similar speed. Across different levels of income we have following pattern of life expectancy change: stability for the first three deciles, then large jump and slow growth after it. Life expectancy across cultural stability index changes in the following way: it is constantly growing up to the forth decile then stable up to the eighth decile and growing after it. It should be noted that for all three inputs patterns become similar after fifth decile.

From summary statistics we see that health level differs across various cultural environments. In addition, health changes across cultural stability index levels in the manner, which is similar to changes with respect to different educational levels. Therefore, we can conclude that culture can have effect on interrelation between education and health. In addition, we can note that variables measuring cultural capital have variation across countries (and some

of them across years), same as education and control variables, therefore, we can use regression analysis.

Regression analysis

We started our regression analysis from testing whether control variable influence coefficients of interest. Most of control variables cut our estimation sample by less than 5% of number of observations. For these variables we replaced missing values with zeros and added dummy variables, which have unity in front of missing values. However, two groups of variables cut sample by more than 25%. These two groups are health expenditures and environmental indicators. We tested whether coefficients of regressions both with and without controls for sample with eliminated missing values are systematically different. We used Hausman test, which showed that both groups of controls (which cut sample by more than 25% of observations), do not influence coefficients systematically. Therefore, we do not use environmental indicators and health expenditures in our regression analysis.

In regression analysis we use both GLS model and GLS model with fixed effects. As these estimations allow for receiving of robust estimates in case of heteroskedasticity and autocorrelation; their existence is showed by Wooldridge test of autocorrelation and Wald test of heteroskedasticity. The F-test has shown that fixed effect regression provides more precise estimates than GLS. However, we use model both with and without fixed effects, because for investigation of link between education and culture in health model we need to estimate both coefficients of levels and interactions between studied inputs.

Regression results can be found in Table 2. We provide results of three models OLS as basic model and benchmark for comparison and models, which we will use in analysis GLS model and GLS with fixed effects. In this table you can find coefficients of both controls and variables of interest their standard errors and levels of significance.

As one of the main goals of research is to study nature of interrelationship between education and cultural capital, we should pay attention to coefficients of variables measuring cultural capital and their interaction with education. If we take in account that effect of education[1] on health (as numerous studies has shown, (Cutler & Lleras-Muney, 2006) is positive, for culture to be substitute to education, coefficients of interaction with schooling should have negative sign, if sign is positive then inputs are compliments. For example, if some type of religion influences negatively both health and effect of education, we will observe that inputs are substitutes, as positive shock to either of inputs will cause decrease of marginal product of another input. In Table 3 we can find signs of cultural variables' coefficients and their interaction with educational level. Letters "S" and "C" are signs for substitute and compliment, "n/s" means that relation is not significant and n/p means that relationship was not predicted by the model. If interaction of education and some cultural input has zero coefficient then we can treat this cultural input as perfect substitute (ps) to education, as the same level of health can be achieved by different linear combinations of this inputs.

As can be seen from the Table 3 four out of eighteen relationships are not predicted by the theoretical model. They reflect complementary relationship according to which health production increasing faster if we use both inputs. Buddhism, Catholicism, Islam and cultural diversity are characterized by such relationship with education in health model. Neoreligion and Judaism showed no significant relationship with health. Agnosticism and Hinduism appeared to be perfect substitutes for education; therefore, they have no effect education-health gradient. All other ten out of eighteen relationships can be described by theoretical model. We can note that most of estimated relationships between education and cultural capital (eight out of ten) have no barriers for substitution of cultural information by educational information

[1] In this case we mean effect of education net of the interaction with culture

according to theoretical model. Only proximity to global culture and ethnic religion revealed barriers for substitution of cultural for educational information. For ethnic religion, this rigidity of cultural information can be explained by psychological affection to traditions. For proximity to global culture we have zero direct effect on health but negative effect on education-health gradient. Barriers for substitution of cultural to educational information in this case can be explained by influence of movies, video games, changing of relationships patterns between genders and other features of global culture, which can have no harmful effect on health, but oppose digesting of health information from education. For example, students of secondary school will know about impact and threats of inflectional diseases if they talked about release of new football game on the lesson of biology. Among all cultural inputs, which revealed influence on education-health gradient eight are substitutes and six are complements to education.

Further we study education-health gradient among different countries. We calculated it as partial derivative health by education using GLS fixed effect regression. On Figure 7 we can observe education-health gradient density function. We see that education-health gradient differs a lot in range from -0.3 to 0.1. However, most part of its values is positive, about 20% of values are negative. This finding can be explained by several reasons. First, education as showed group of studies on African countries has positive effect on prevalence of HIV. Such relationship is dictating by changes in female behavior, as more educated women do not marry for longer period and tend to have relationships both with males, who are more and less educated then they are. In addition, methods of contraception, which they use, are mostly pills but not condoms (Gregson, 2001). Another explanation is repressions relatively less educated population. In this case aggregate level of education grows, while aggregate level of mortality also grows, therefore, regression will reveal negative relationship between education and health. Such pressure on

less educated population could take place, for example, in colonial countries and be inherited by post-colonial regimes.

On Figure 8 we can see how education-health gradient is distributed among different religions in 2007. We can note Islamic and Buddhist countries have higher levels of education-health gradient, while countries with ethnic religions have generally the lowest levels of education-health gradient.

On Figure 9 and 10 we can find ten countries with the highest and ten countries with the lowest education-health gradient. We see that the highest education health gradients are mostly in Islamic or Buddhist countries with status of former French colony. On the other hand, countries with the lowest education-health gradient are mostly protestant countries with the status of former British colony and spread ethnic religion.

On Figure 11 we can observe correlation matrix of education health gradient with cultural inputs and HIV prevalence. On this figure we can see that cultural diversity index, Islamic religion and status of former French colony have strongest positive correlation with education health gradient. The strongest negative correlation can be noted for ethnic religion, status of former French colony and religion fractionalization. In addition, we put on this graph correlation coefficient of prevalence of HIV with education-health gradient to show that negative effect of education in several countries likely can be explained by weak effect or even positive relationship of education and HIV prevalence.

Therefore, we can conclude that health policy implementation through development of educational process should be based on cultural analysis of recipient country. We can recommend for policy makers to pay attention at Islamic countries with status of former French colony. For these countries we estimated the highest level of education-health gradient. In addition, such factors as cultural diversity, level of cultural globalization, level of religion and ethnic fractionalization, former colonial status and extend, to which ethnic

religion is spread, are of large importance in distinguishing education-health gradient.

Possible problems with estimation

To explain fact, that some cultural characteristics has not predicted relationship with education we can note mentioned above cognition factor of relationship between education and cultural capital. According to the fact that both education and culture can influence not only information received, but productivity of information reception we can have additional force, which will move informational inputs to not predicted complementary relationship. The second thing that can cause education and cultural capital to be compliments is increasing marginal return of informational factor. It means that additional unit of information is more productive if person knows more. This situation is unlikely to happen as health knowledge is very diverse and can help mostly only if it is specific to the problem.

Another explanation of controversial empirical evidence can be omitted variable bias. For example, representatives of ethnic religion can have state benefits (ethnic minorities often have such benefits) for receiving of education. Then benefits enforce higher enrolment rates and, therefore, lower marginal returns of education on health. At the same, direct influence of religion on health can be still unchanged and negative. Therefore, if on average effect of ethnic religion through benefits is higher than through mechanism described in chapter 3 and 4, econometric analysis will reflect unpredicted effect. Similar problem of estimation is endogeneity problem connected with mutual causality of education and health. This problem is widely described in literature; however, there was not find clear solution to it. Both omitted variable bias and mutual causality theoretically can be solved by instrumental variable approach. Studies, which used this approach on microeconomic level, showed that nature of correlation between education

and health at least partially has direction from education to health. In addition, instrumental variable approach rarely resulted in coefficients, which were significantly different from OLS estimates (Oreopoulos, 2007; Cutler & Lleras-Muney, 2006). For minimizing of effect of omitted variable bias and mutual causality problem we used fixed effect approach.

Chapter 7

CONCLUSSIONS

In conclusion, we can say that cultural impact on relationship between education and health is worth to be taken in account, when health macroeconomic policy is implemented. As educational-health gradients differ across cultures so much, that effect of education can be both positive and negative.

As empirical analysis has showed about half of all cultural indicators are compliments and half are substitutes to the education in health production function. Cultural diversity, Islam and status of former French colony revealed the highest positive effect on health. Ethnic religion, status of former British colony and religion fractionalization index revealed the highest negative effect on health

Overall recommendation for policymakers is to take in account cultural factor for evaluation of investments in education. Specific program of educational development can have similar results only if it is implemented in similar cultural environments. Taking in account relatively low level of health in Muslim countries it should be noted relatively large positive effect of education on health in this group of countries. In addition, higher levels of cultural diversity, status of former French colony and cultural stability index are related to higher education-health gradient.

In addition, it should be noted that educational programs in countries with high levels of HIV prevalence should be planned very specifically, so that to minimize negative effect of education on health in these countries.

For further research we can propose replication of our model using microeconomic data, which will allow for receiving of more precise coefficients, as aggregate data could introduce bias (connected to measurement errors and averaging of characteristics of heterogeneous agents) into estimation. Other aspects of culture can be added into the model, other types of education and health measures can be used. In addition, behavioral tests of introduced theoretical motivation can be provided. In general culture is economical aspect, research on which currently is swiftly developing; study of its interaction with education can become important part of general economic theory.

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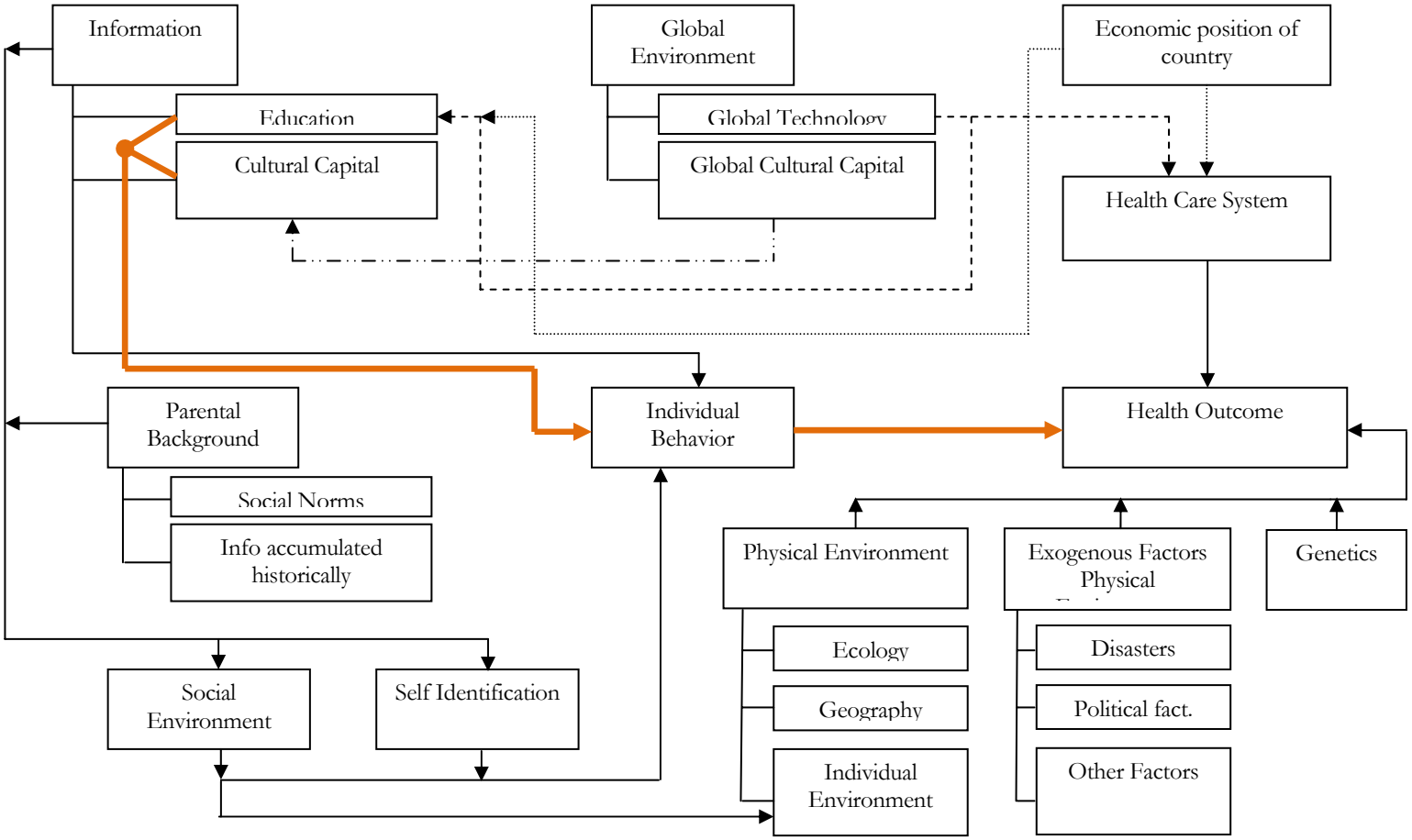


Figure 1: Mechanism of health formation

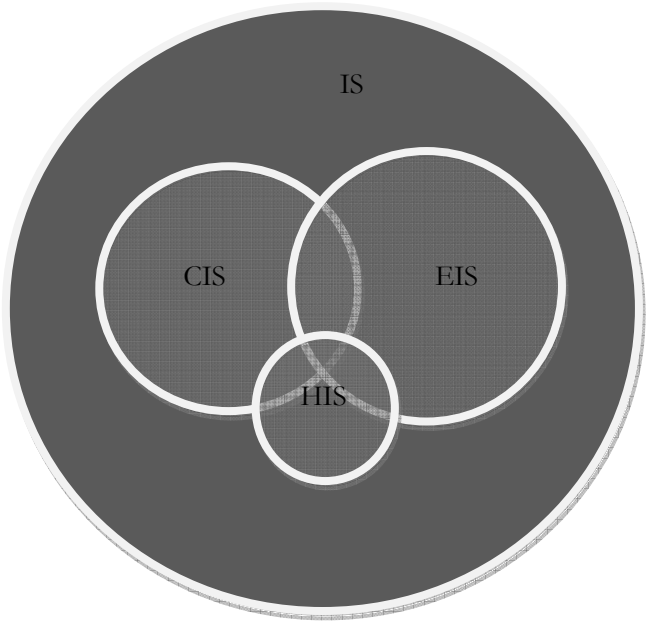
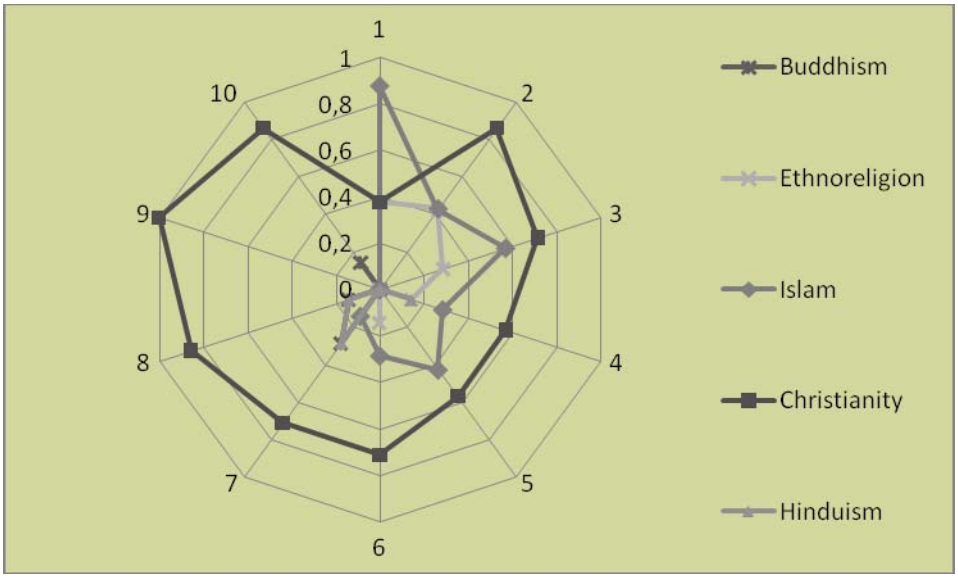
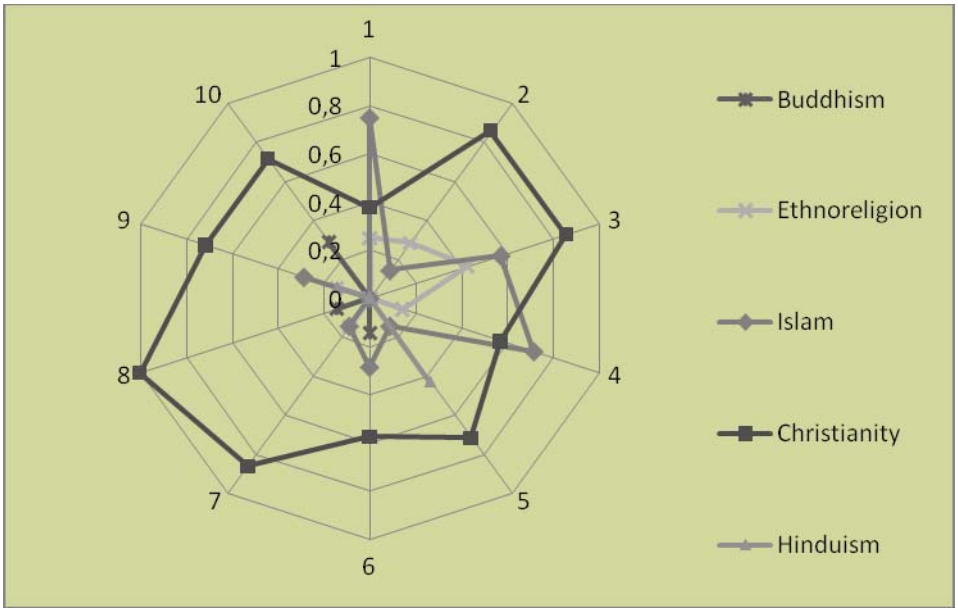


Figure 2: Scheme of Informational Sets

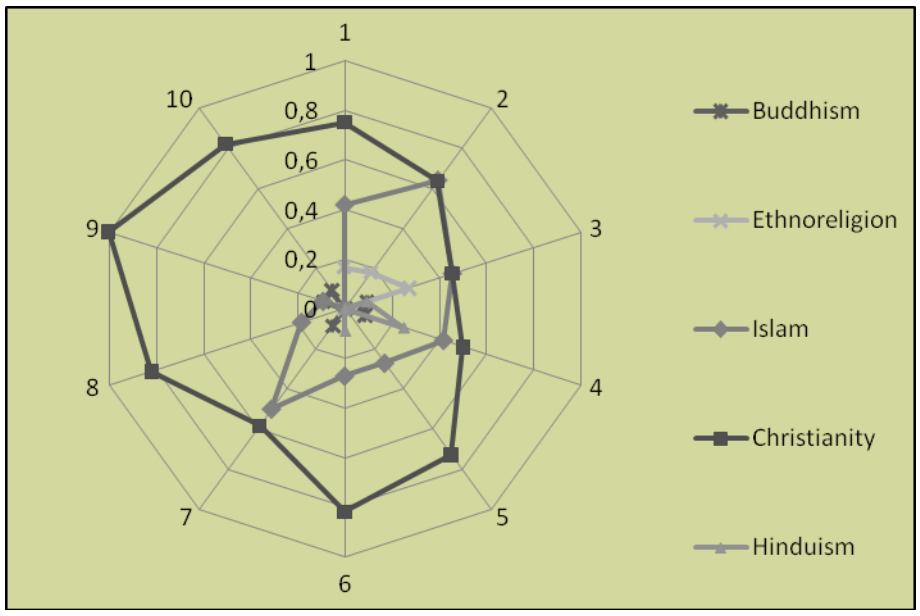


a) Adjusted for income and education



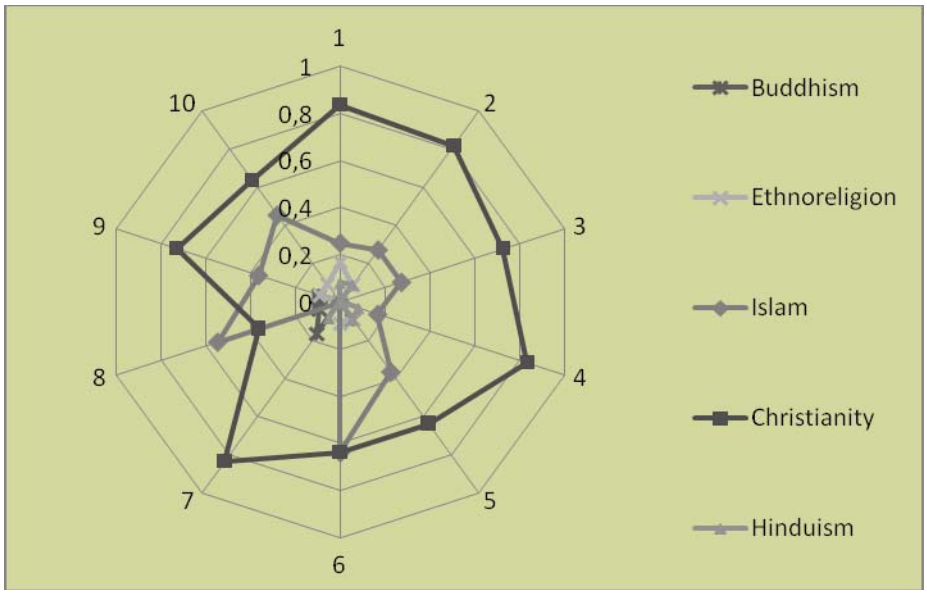
b) Adjusted for income and education

Figure 3: Deciles of life expectancy adjusted (b) and unadjusted (a) for income and education across different types of religion (1971)



a) U

nadjusted for income and education



b) Adjusted for income and education

Figure 4: Deciles of life expectancy adjusted (b) and unadjusted (a) for income and education across different types of religion (2007)

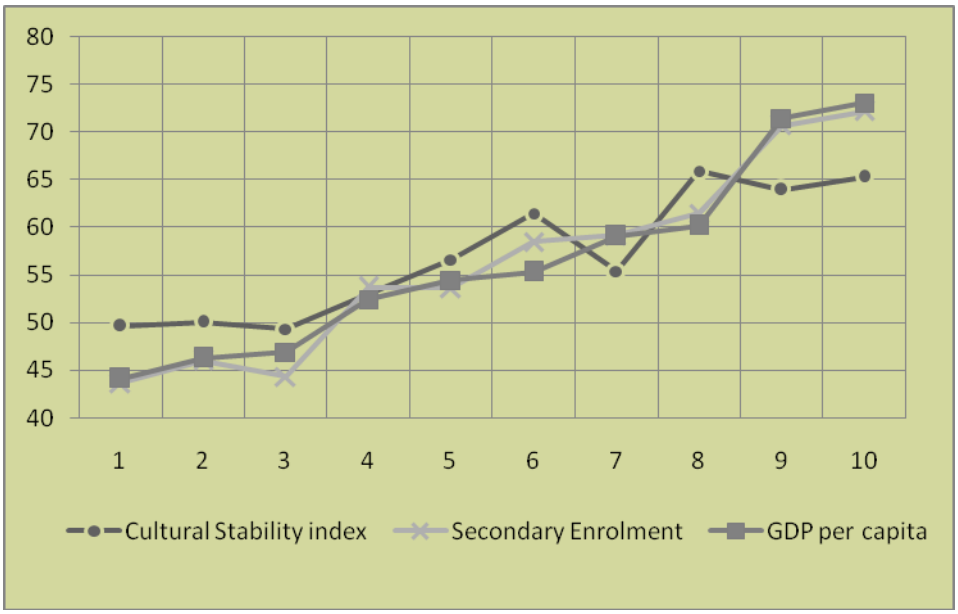


Figure 5: Life expectancy across influential factors of main interest and GDP per capita (1971)

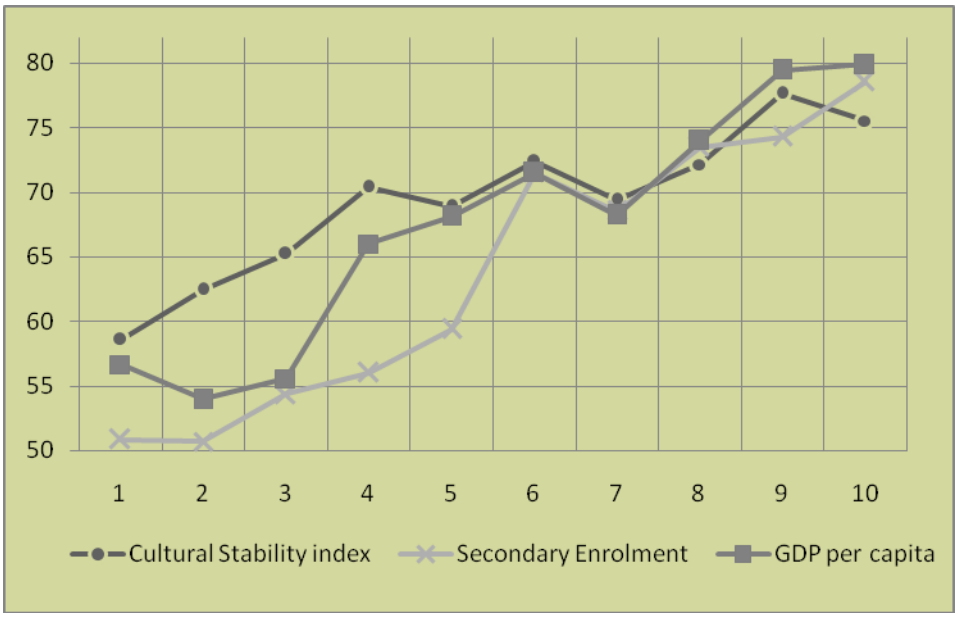


Figure 6: Life expectancy across influential factors of main interest and GDP per capita (2007)

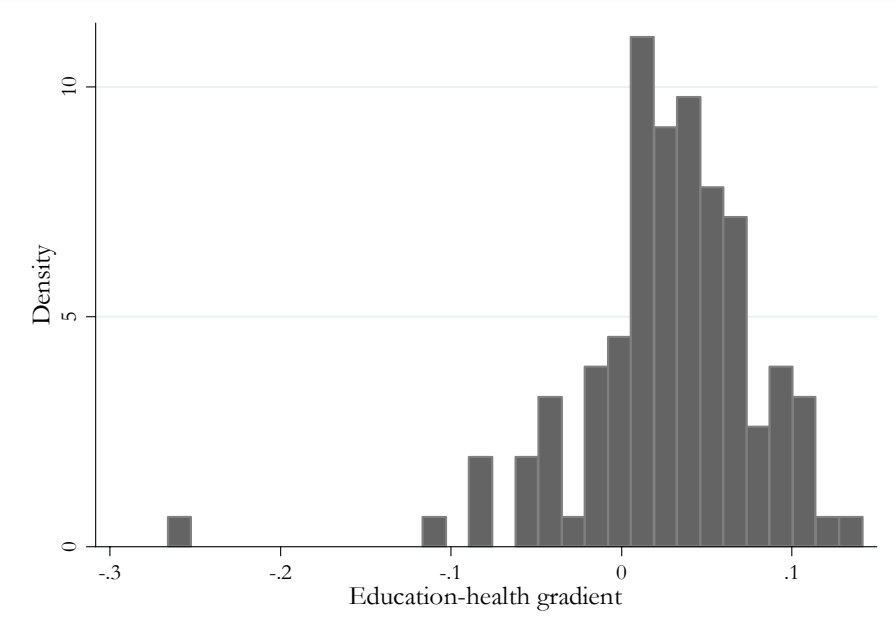


Figure 7: Histogram of education-health gradient density function

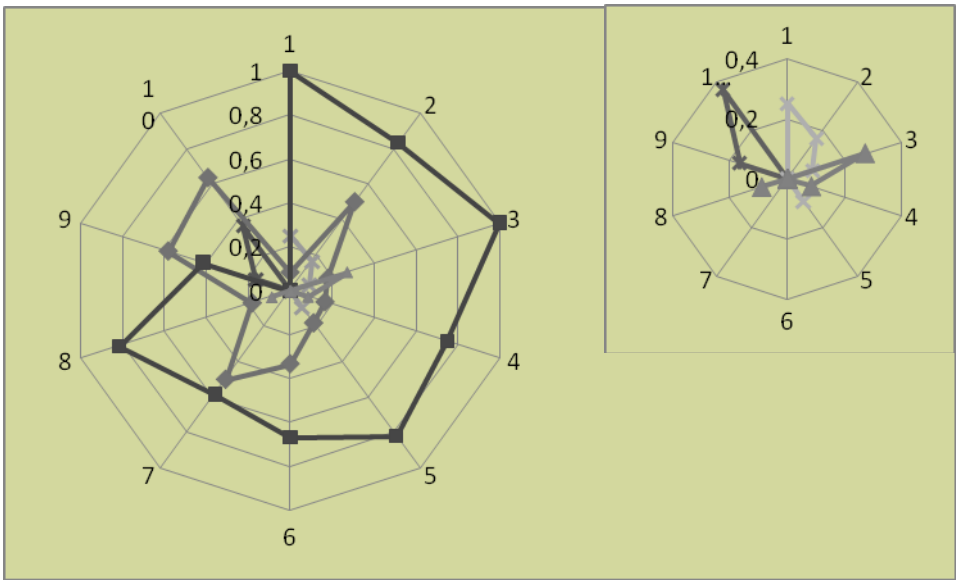


Figure 8: Education-health gradient across countries (2007)

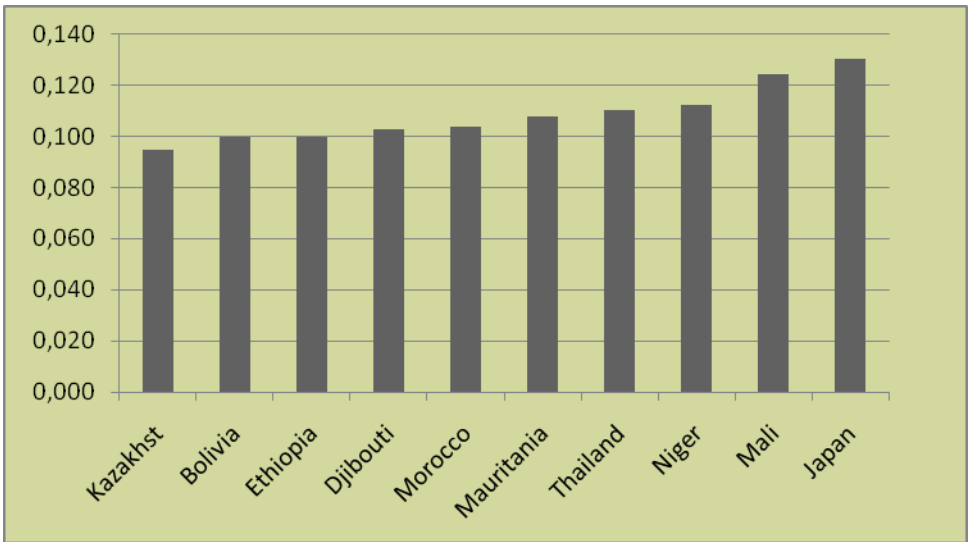


Figure 9: Top ten education-health gradient in the world (2007)

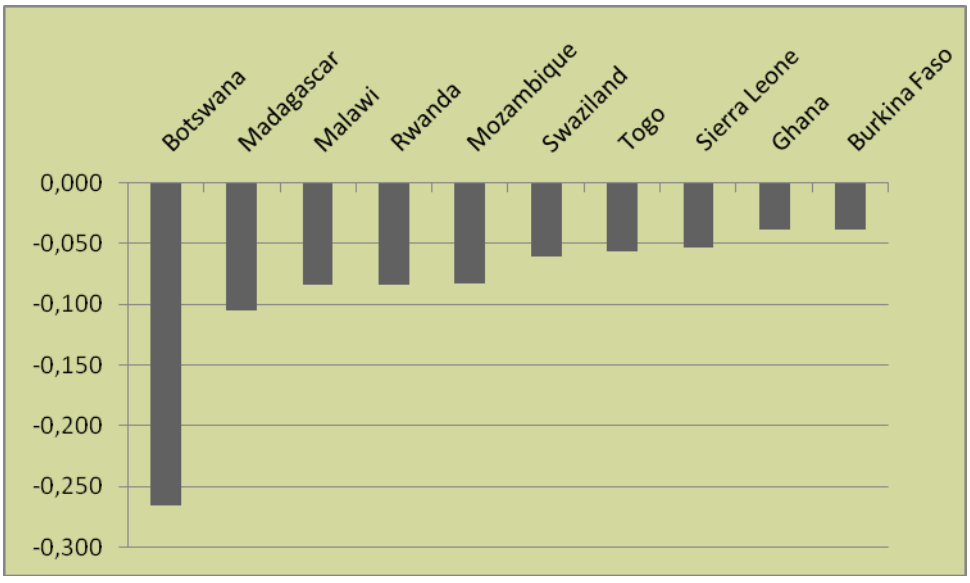


Figure 10: The worst ten education-health gradients (2007)

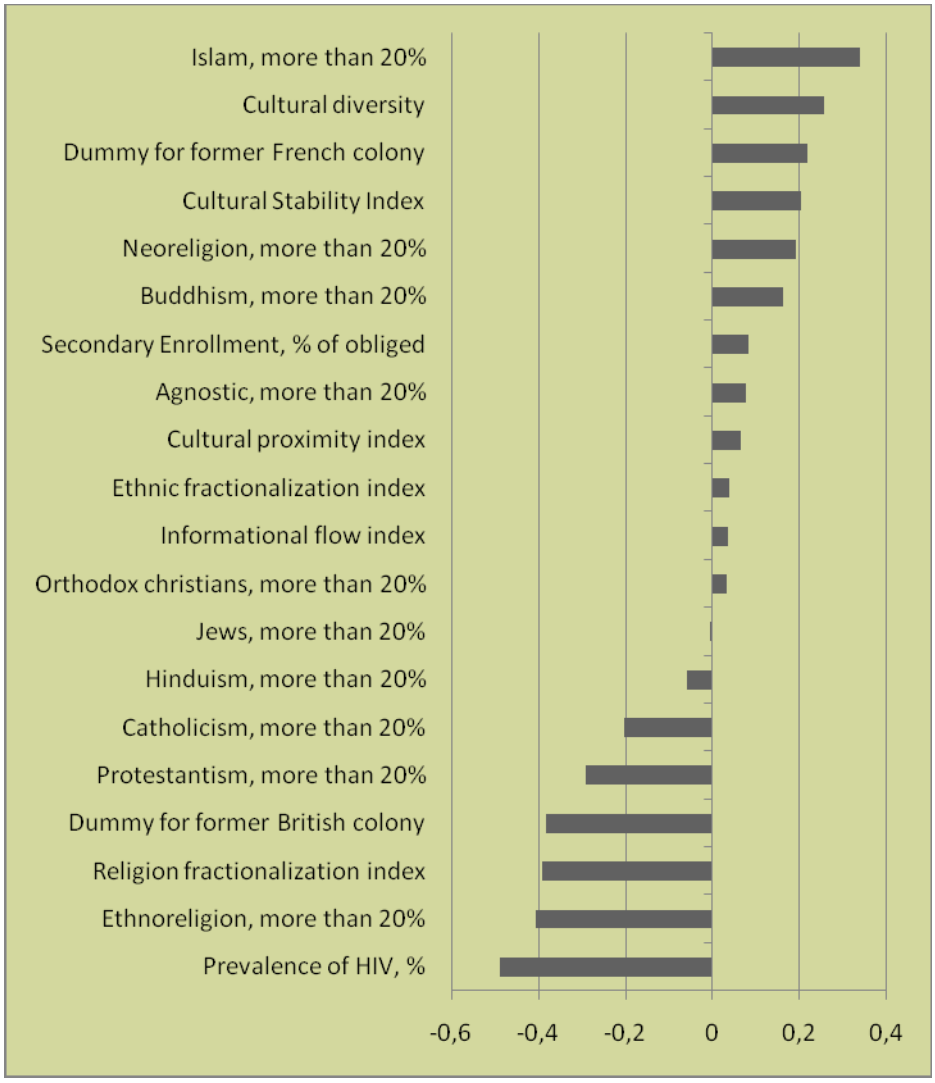


Figure 11: Correlation coefficients of cultural inputs and HIV prevalence with estimated education-health gradient (2007)

Table 1: Summary statistics

Summary Statistics	Average (Standard deviation, frequency for dummy)	Average (Standard deviation, frequency for dummy)
Variables of interest	Year: 1971	Year: 2007
Life expectancy at birth total years	56.17	68.5
	(10.99)	(10.43)
School enrollment secondary gross	32.28	75.47
	(28.96)	(29.56)
GDP per capita constant 2000(logarithm of thousands USD)	7.13	7.83
	(1.43)	(1.60)
Historical Stability of Culture	0.67	0.68
	(0.89)	(0.88)
Cultural Proximity	1.11	3.72
	(1.34)	(2.94)
Agnostic, more than 20%	0.03	0.08
	(2.00)	(9.00)
Buddhism, more than 20%	0.06	0.04
	(4.00)	(5.00)
Catholicism, more than 20%	0.48	0.38
	(34.00)	(43.00)
Ethnoreligion, more than 20%	0.14	0.06
	(10.00)	(7.00)
Hinduism, more than 20%	0.06	0.04
	(4.00)	(5.00)
Jews, more than 20%	0.00	0.01
	0.00	(1.00)
Islam, more than 20%	0.31	0.33
	(22.00)	(37.00)
Neoreligion, more than 20%	0.01	0.01
	(1.00)	(1.00)
Orthodox Christians, more than 20%	0.00	0.14
	0.00	(16.00)
Protestantism, more than 20%	0.62	0.5
	(44.00)	(57.00)
Chinuni religion, more than 20%	0.01	0.01
	(1.00)	(1.00)
Index of social globalization	30.19	52.64
	(14.59)	(20.87)
Cultural diversity	0.34	0.31

Table 1: Summary statistics (continued)

Summary Statistics	Average (Standard deviation, frequency for dummy)	Average (Standard deviation, frequency for dummy)
Variables of interest	Year: 1971	Year: 2007
	(0.21)	(0.20)
Dummy for former British colony	0.31	0.28
	(22.00)	(32.00)
Dummy for former French colony	0.23	0.13
	(16.00)	(15.00)
Information Flows	0.37	0.69
	(0.19)	(0.19)
Index of religion fractionalization	0.38	0.38
	(0.21)	(0.22)
Control variables	Year: 1971	Year: 2007
Average yearly effect of disaster (mln of people)	0.001	0.01
	(0.004)	(0.07)
Average yearly thd of deaths due to disaster	0.33	0.11
	(2.87)	(0.66)
Political regime in country (score)	2.07	5.34
	(18.32)	(10.87)
Durability of political regime	18.49	28.23
	(27.90)	(33.19)
Thds of deaths in war	2.45	0.09
	(17.82)	(0.37)
Distance from Equator	21.65	28.6
	(17.10)	(17.13)
Longitude	49.05	46.95
	(43.56)	(38.13)
Urban population of total	37.46	56.17
	(21.23)	(21.90)
Population density thd of people per sq km	0.06	0.12
	(0.08)	(0.15)
Index of political globalization	44.83	74.88
	(21.76)	(15.87)
Population Ages 0-14 of total	40.37	28.44
	(7.82)	(10.84)
Population Ages 15-64 of total	54.61	63.39
	(4.97)	(6.58)
Population total, (mln of people)	26.50	50.83

Table 1: Summary statistics (continued)

Summary Statistics	Average (Standard deviation, frequency for dummy)	Average (Standard deviation, frequency for dummy)
Control variables	Year: 1971	Year: 2007
	(72.55)	(165.82)
Overall globalization index	36.25	62.25
	(14.21)	(15.87)
Population female of total	50.23	50.39
	(1.09)	(2.37)
Total Natural Resources Rents % of GDP	5.42	9.09
	(8.30)	(15.19)

Table 2: Results of regression analysis

	(1) OLS	(2) Fixed effect	(3) GLS
Variables of interest			
GDP per capita constant 2000(thd USD)	1.062***	0.273***	1.082***
	(0.144)	(0.097)	(0.095)
School enrollment secondary gross	0.259***	0.050***	0.115***
	(0.061)	(0.015)	(0.018)
Secondary enrolment squared (% of obliged)	-0.178***	-0.030***	-0.072***
	(0.034)	(0.010)	(0.011)
Cultural Proximity	0.124	0.026	-0.032
	(0.096)	(0.042)	(0.048)
Hystorical Stability of Culture	1.382***	-4.408***	0.344***
	(0.140)	(1.116)	(0.094)
Interaction of Cultural Globalization and Stability	-0.035	-0.012*	-0.012#
	(0.034)	(0.007)	(0.008)
Information Flows	0.523	0.128	-0.568
	(1.219)	(0.505)	(0.596)
Interaction of Schooling and Informational Flow	-0.348***	-0.057***	-0.126***
	(0.049)	(0.019)	(0.025)
Ethnic fractionalization	-2.842***	4.126#	-3.995***
	(0.592)	(2.834)	(0.605)
Interaction of Schooling and ethnic fractionalization	0.258***	-0.015	0.032
	(0.060)	(0.042)	(0.041)
Interaction of Schooling and Cultural Stability	-0.072***	-0.000	-0.014**
	(0.014)	(0.007)	(0.007)
Interaction of Schooling and Global Culture	-0.010**	-0.001	-0.008***
	(0.005)	(0.002)	(0.002)
Index of religion fractionalization	0.783*	8.079***	1.811***
	(0.443)	(2.197)	(0.411)
Interaction of Schooling and religion fractionalization	-0.055	-0.308***	-0.045
	(0.048)	(0.035)	(0.033)
Interaction of Schooling and agnostic	0.203	0.179**	0.052
	(0.144)	(0.077)	(0.069)
Interaction of Schooling and buddhism	-0.006	0.071*	0.140***
	(0.055)	(0.037)	(0.042)
Interaction of Schooling and catholicism	-0.033*	0.020*	0.016
	(0.017)	(0.012)	(0.012)
Interaction of Schooling and cultural diversity index	-0.342***	0.223***	0.016
	(0.075)	(0.050)	(0.051)
Interaction of Schooling and colonial status (Britain)	-0.161***	-0.016	-0.060***

	(0.021)	(0.014)	(0.015)

Table 2: Results of regression analysis (continued)

	(1)	(2)	(3)
	OLS	Fixed effect	GLS
Interaction of Schooling and colonial status (France)	-0.042	-0.019	-0.016
	(0.031)	(0.015)	(0.021)
Interaction of Schooling and ethnoreligion	0.136***	0.041*	-0.021
	(0.039)	(0.022)	(0.027)
Interaction of Schooling and hinduism	0.301***	0.043	0.121***
	(0.060)	(0.035)	(0.046)
Interaction of Schooling and jews	-0.160	-0.719	0.218
	(3.030)	(0.860)	(0.976)
Interaction of Schooling and islam	0.022	0.055***	0.080***
	(0.028)	(0.016)	(0.019)
Interaction of Schooling and neoreligion	3.277	-0.769	0.492
	(4.418)	(0.790)	(0.995)
Interaction of Schooling and orthodox	-0.143***	0.100**	-0.172***
	(0.043)	(0.040)	(0.031)
Interaction of Schooling and Protestantism	-0.116***	0.006	-0.017
	(0.019)	(0.012)	(0.013)
Interaction of Schooling and chinuni religion	-0.445	-0.126	-0.180*
	(0.458)	(0.102)	(0.103)
Interaction of schooling squered and global culture proximity index	-0.000	-0.000	0.004***
	(0.004)	(0.001)	(0.001)
Interaction of schooling squered and cultural stability index	0.041***	0.002	0.008*
	(0.010)	(0.004)	(0.004)
Interaction of schooling squered and informational flow index	0.302***	0.041***	0.080***
	(0.042)	(0.014)	(0.019)
Interaction of schooling squered and Agnostisism	-0.072	-0.075*	-0.016
	(0.073)	(0.038)	(0.034)
Interaction of schooling squered and Buddhism	0.035	-0.004	-0.060*
	(0.047)	(0.028)	(0.032)
Interaction of schooling squered and Catholisism	0.056***	-0.008	0.002
	(0.015)	(0.009)	(0.009)
Interaction of schooling squered and Ethnic religion	-0.301***	-0.170***	-0.090***
	(0.042)	(0.028)	(0.030)
Interaction of schooling squered and Hinduism	-0.225***	-0.027	-0.098***
	(0.053)	(0.026)	(0.037)
Interaction of schooling squered and Judaism	0.180	0.414	-0.097
	(1.793)	(0.504)	(0.569)
Interaction of schooling squered and	0.048**	-0.021*	-0.023#

Islam	

Table 2: Results of regression analysis (continued)

	(1)	(2)	(3)
	OLS	Fixed effect	GLS
	(0.024)	(0.011)	(0.014)
Interaction of schooling squered and Neoreligion	-1.789	0.421	-0.227
	(2.316)	(0.420)	(0.530)
Interaction of schooling squered and Orthodox Christianity	0.082**	-0.054**	0.103***
	(0.036)	(0.024)	(0.020)
Interaction of schooling squered and Protestantism	0.126***	0.005	0.025**
	(0.017)	(0.008)	(0.010)
Interaction of schooling squered and Chinuni	0.369	0.013	0.074
	(0.403)	(0.068)	(0.073)
Interaction of schooling squered and Cultural diversity	0.295***	-0.095***	0.008
	(0.070)	(0.036)	(0.040)
Interaction of schooling squered and British colony status	0.080***	-0.009	0.019*
	(0.017)	(0.009)	(0.011)
Interaction of schooling squered and French colony status	0.004	0.031*	-0.004
	(0.035)	(0.017)	(0.021)
Interaction of schooling squered and ethnic fractionalization index	-0.172***	0.037	0.003
	(0.054)	(0.029)	(0.030)
Interaction of schooling squered and religion fractionalization index	-0.046	0.133***	0.004
	(0.039)	(0.023)	(0.024)
Agnostic, more than 20%	-3.966**		-2.351**
	(1.928)		(1.005)
Buddhism, more than 20%	1.722***		1.303**
	(0.493)		(0.552)
Catholicism, more than 20%	0.371**		0.571***
	(0.172)		(0.176)
Ethnoreligion, more than 20%	-5.189***		-3.343***
	(0.516)		(0.549)
Hinduism, more than 20%	-1.133**		-2.035***
	(0.491)		(0.481)
Jews, more than 20%	5.202		1.833
	(31.191)		(10.307)
Islam, more than 20%	0.996***		0.043
	(0.266)		(0.255)
Neoreligion, more than 20%	-38.894		-8.374
	(56.226)		(12.323)
Orthodox christians, more than 20%	2.909***		3.101***
	(0.312)		(0.340)
Protestantism, more than 20%	-1.728***		-0.798***
	(0.185)		(0.190)
Chinuni religion, more than 20%	11.050**		9.541***

	(4.744)		(1.529)

Table 2: Results of regression analysis (continued)

	(1)	(2)	(3)
	OLS	Fixed effect	GLS
Cultural diversity	-0.736		0.911
	(0.649)		(0.653)
Dummy for former British colony	-0.027		1.690***
	(0.217)		(0.213)
Dummy for former French colony	2.644***		2.523***
	(0.476)		(0.329)
Average yearly effect of disaster (mln of people)	-0.015	-0.000	0.000
	(0.012)	(0.001)	(0.001)
Average yearly thd of deaths due to disaster	0.019	0.001	0.001
	(0.035)	(0.003)	(0.005)
Thds of deaths in war	-0.009	-0.000	-0.000
	(0.014)	(0.002)	(0.002)
Area of Territory in mln sq km	-0.180***		-0.186***
	(0.046)		(0.043)
Distance from Equator	0.009		0.002
	(0.009)		(0.007)
Longitude	0.024***		0.005#
	(0.003)		(0.003)
Population total, (mln of people)	-0.008***	-0.002#	-0.004***
	(0.001)	(0.001)	(0.001)
Population density thd of people per sq km	-0.818*	17.296***	-0.970**
	(0.476)	(0.981)	(0.470)
Urban population of total	0.018***	0.087***	0.065***
	(0.006)	(0.008)	(0.006)
Population female of total	-0.502***	-0.427***	-0.173***
	(0.045)	(0.064)	(0.034)
Population Ages 0-14 of total	-0.412***	0.054*	-0.159***
	(0.050)	(0.032)	(0.033)
Population Ages 15-64 of total	-0.352***	0.035	-0.082**
	(0.060)	(0.033)	(0.036)
Overall globalization index	0.052***	-0.006	-0.015*
	(0.016)	(0.007)	(0.008)
Index of political globalization	-0.004	0.005**	0.007**
	(0.006)	(0.002)	(0.003)
Index of social globalization	0.034	0.009	0.047***
	(0.025)	(0.013)	(0.014)
Durability of political regime	0.027***	-0.000	0.003#
	(0.003)	(0.002)	(0.002)
Total Natural Resources Rents % of GDP	-0.032***	-0.004**	-0.006***
	(0.006)	(0.002)	(0.002)
Constant	98.823***	66.572***	69.460***
	(7.217)	(5.481)	(4.334)

Table 2: Results of regression analysis (continued)

	(1)	(2)	(3)
	OLS	Fixed effect	GLS
Observations	3,382	3,382	3,382
R-squared	0.943		
Number of countries		134	134

Footnote: OLS is abbreviation for ordinary least squares, GLS is abbreviation for generalized least squares.
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, # p<0.15

Table 3 Analysis of interaction nature between education and culture in health production function

	Level	Interaction with education	Conclusions	Bariers for substitution of cultural information
School enrollment secondary gross	+	-	DMR	
Cultural Proximity	0	-	s	+
Hystorical Stability of Culture	+	-	s	-
Ethnic fractionalization	-	+	c	-
Index of religion fractionalization	+	-	s	-
Agnostic, more than 20%	-	0	ps	-
Buddhism, more than 20%	+	+	C	n/p
Catholicism, more than 20%	+	+	C	n/p
Ethnoreligion, more than 20%	-	-	S	+
Hinduism, more than 20%	-	0	ps	-
Jews, more than 20%	0	0	n/s	n/s
Islam, more than 20%	0	+	C	n/p
Neoreligion, more than 20%	0	0	n/s	n/s
Orthodox christians, more than 20%	+	-	S	-
Protestantism, more than 20%	-	+	C	-
Chinuni religion, more than 20%	+	-	S	-
Cultural diversity	+	+	C	n/p
Dummy for former British colony	+	-	S	-
Dummy for former French colony	+	-	S	-

Footnote: n/s – not significant, n/p – not predicted (means that this result was not predicted by the model), s – substitute, c - compliment

Table 4 Extreme estimates of education-health gradient (continued)

Country	Education-health gradient (standard error)	Country	Education-health gradient (standard error)
Botswana	-0.266***	Kazakhstan	0.095***
	(0.038)		(0.027)
Madagascar	-0.105***	Bolivia	0.100***
	(0.023)		(0.021)
Malawi	-0.084***	Ethiopia	0.100***
	(0.019)		(0.029)
Rwanda	-0.084***	Djibouti	0.103***
	(0.017)		(0.017)
Mozambique	-0.083***	Morocco	0.104***
	(0.021)		(0.017)
Swaziland	-0.061***	Mauritania	0.108***
	(0.012)		(0.019)
Togo	-0.057***	Thailand	0.110***
	(0.019)		(0.02)
Sierra Leone	-0.054***	Niger	0.112***
	(0.02)		(0.025)
Ghana	-0.039***	Mali	0.124***
	(0.015)		(0.016)
Burkina Faso	-0.039*	Japan	0.130*
	(0.023)		(0.074)

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, # p<0.15

APPENDIX A: DERIVATION OF THE PROBABILISTIC VERTION OF HEALTH PRODUCTION FUNCTION

As we know number of clusters in each informational set we can find probability of CIS to be interacted with HIS, EIS to be interacted with HIS and EIS, CIS, HIS to be interacted.

$$\mathbf{Pr(HIS \cap EIS)} = \Pr(\mathbf{EIS}|\mathbf{IS}) * \Pr(\mathbf{HIS}|\mathbf{IS}) = \frac{\mathbf{k_{eis}} * \mathbf{k_{his}}}{\mathbf{k_{is}^2}} \quad (4)$$

$$\mathbf{Pr(HIS \cap CIS)} = \Pr(\mathbf{CIS}|\mathbf{IS}) * \Pr(\mathbf{HIS}|\mathbf{IS}) = \frac{\mathbf{k_{cis}} * \mathbf{k_{his}}}{\mathbf{k_{is}^2}} \quad (5)$$

$$\Pr(\mathbf{HIS \cap CIS \cap EIS}) = \Pr(\mathbf{CIS}|\mathbf{IS}) = \Pr(\mathbf{HIS}|\mathbf{IS}) * \Pr(\mathbf{EIS}|\mathbf{IS}) = \frac{\mathbf{k_{cis}} * \mathbf{k_{eis}} * \mathbf{k_{his}}}{\mathbf{k_{is}^3}} \quad (6)$$

Knowing these probabilities and using assumption six we can write down the equation of health production function, which is equal to the multiplication of the number of productive units in the general information set by the probability of the health benefitting informational set to be digested by channels of formal education and accumulation of cultural capital (taking into account that according to probability theory we need to subtract the interaction of sets for omitting of double counting):

$$\mathbf{H} = \mathbf{AP} * \left[\left(\frac{\mathbf{k_{eis}} * \mathbf{k_{his}}}{\mathbf{k_{is}^2}}\right) * \mathbf{k_{is}} + \left(\frac{\mathbf{k_{cis}} * \mathbf{k_{his}}}{\mathbf{k_{is}^2}}\right) * \mathbf{k_{is}} - \left(\frac{\mathbf{k_{cis}} * \mathbf{k_{eis}} * \mathbf{k_{his}}}{\mathbf{k_{is}^3}}\right) * \mathbf{k_{is}}\right] \quad (7)$$

As we assumed that the health benefiting set is growing at the same rate as the general informational set (assumption 5), then is constant, and we can rewrite our equation;

$$\frac{k_{his}}{k_{is}} = l = const \quad (8)$$

(9)

As can be seen in the equation of health production, our health production depends on the size of the general informational set, which in the static model can be considered constant. However, for the dynamic models IS can increase due to technological progress. Therefore, the technological progress increases the volume of information, which can be digested in general and decreases the probability of the same information to be taught from different sources.

From assumption 4 we can write:

$$k_{eis} = qE$$

(10)

Amount of information received by means of education is function of the amount of education received;

(11)

Amount of information received is positively related to the amount of education received;

(12)

Amount of information received by means of cultural capital accumulation is function of amount of accumulated cultural capital received

If we take derivative by E on both sides by Young theorem:

(13)

Marginal product of education on amount of information received by education does not depend on level of cultural capital;

$$k_{cis} = r(C) \tag{14}$$

Amount of information received by means of cultural capital accumulation is function of the amount of accumulated cultural capital;

(15)

Amount of information received is positively related to the amount of accumulated cultural capital;

(16)

Amount of information received by cultural capital accumulation does not depend on the amount of education received;

If we take derivative by C on both sides by Young theorem:

(17)

Marginal product of cultural capital on amount of information received by means of cultural capital accumulation does not depend on level of education;

Plugging in the equation of health production function, we can find the general functional form for our model:

(18)

Health is the function of education, cultural capital and their interaction corrected for the level of technological progress.

From assumptions (cultural capital and education has positive effect on health) and construction of the model:

$$\frac{dH}{} \quad qr$$

(19)

Health is positively related to the technological progress;

Using equation 10, 11, and 13 taking in account that according to construction overall volume of information (j) is bigger than volume of information that can be received by means of education (r):

$$\frac{dH}{dE}\Big/_{dC} = \frac{\left(\frac{dq}{dE} - \frac{dq * r}{dE * j}\right)}{dC} = \frac{\left(1 - \frac{r}{j}\right) * \frac{dq}{dE}}{dC} = -\frac{dq * dr}{dE * dC * j} \leq 0 \quad (20)$$

Effect of education on health is a decreasing function of the accumulated cultural capital;

$$\frac{dH}{dC}\Big/_{dE} = \frac{\left(\frac{dr}{dE} - \frac{dq * r}{dE * j}\right)}{dE} = -\frac{dq * dr}{dE * dC * j} \leq 0$$

(21)

Effect of cultural capital on health is a decreasing function of the education received;

Therefore, from equations 20 and 21 we can conclude that our inputs are substitutes (in case if marginal products of inputs are positive).

Relaxing of assumption about positive marginal product of information received by means cultural capital accumulation

We can easily relax assumption of positive marginal product of culture. We assume that unit of educational information produce "AP" as before, while unit of cultural information produce "–AP". Using Assumption 7 we can conclude that interaction will have productivity of "AP" which is additional

return of education due to defending of health from negative impact of cultural information. Then equation 9 will change to:

(22)

And equation 18 to:

(23)

Health is the function of education, cultural capital and their interaction corrected for the level of technological progress.

From assumptions (education has positive effect on health) and construction of the model:

$$\frac{dH}{} \quad qr$$

(24)

Health is negatively related to the technological progress;

Using equation 10, 11, and 13 taking in account that according to construction overall volume of information (j) is bigger than volume of information that can be received by means of education (r):

$$\frac{dH}{dE}\Big/_{dC} = \frac{\left(\frac{dq}{dE} + \frac{dq * r}{dE * j}\right)}{dC} = \frac{\left(1 + \frac{r}{j}\right) * \frac{dq}{dE}}{dC} = \frac{dq * dr}{dE * dC * j} \geq 0$$

(25)

Effect of education on health is an increasing function of the accumulated cultural capital;

$$\frac{dH}{dC}\Big/_{dE} = \frac{\left(\frac{dr}{dE} + \frac{dq * r}{dE * j}\right)}{dE} = \frac{dq * dr}{dE * dC * j} \geq 0$$

(26)

Effect of cultural capital on health is an increasing function of the education received;

Therefore, from equations 25 and 26 we can conclude that our inputs are complements if marginal product of culture is negative.

Case of informational rigidity

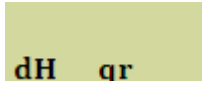
If we consider negative marginal product of cultural input as disinformation (not decrease in information, that can be received from accumulated cultural capital), we will see another possible mechanism of interaction between education and culture. We can imagine situation, when cultural capital provides information that has negative product (disinformation), but which cannot be substituted to information with positive effect from educational source. Such case of information set formation further we will call information rigidity. In this situation interaction will not change sign as in simple case with negatively productive cultural capital due to Assumption 8.

Therefore, using Assumption 8 we get:

(27)

as cultural capital keeps clusters, which could produce "AP" by means of education, therefore, in calculation of interaction we use "AP" as marginal product of cultural information, however, for calculation of direct impact of cultural information on health we use "–AP".

From assumptions (education has positive effect on health) and construction of the model:



(28)

Health is positively related to the technological progress;

Using equation 10, 11, and 13 taking in account that according to construction overall volume of information (j) is bigger than volume of information that can be received by means of education (r):

$$\frac{dH}{dE}\Big/_{dC} = \frac{\left(\frac{dq}{dE} - \frac{dq * r}{dE * j}\right)}{dC} = \frac{\left(1 - \frac{r}{j}\right) * \frac{dq}{dE}}{dC} = -\frac{dq * dr}{dE * dC * j} \leq 0 \quad (29)$$

Effect of education on health is a decreasing function of the accumulated cultural capital;

$$\frac{dH}{dC}\Big/_{dE} = \frac{\left(\frac{dr}{dE} - \frac{dq * r}{dE * j}\right)}{dE} = -\frac{dq * dr}{dE * dC * j} \leq 0$$

(30)

Effect of cultural capital on health is a decreasing function of the education received;

Therefore, from equations 29 and 30 we can conclude that our inputs are substitutes (in case if marginal products of information received from cultural capital accumulation is negative and informational rigidity is present). We should note that in case of informational rigidity interaction will always have negative sign, even if cultural information provides zero direct impact on health interaction will be either negative or zero and conclusions will be same as for information rigidity case with negative impact of cultural information.

Therefore, we can conclude that if effect of cultural capital has opposite sign to effect of interaction then we have no information rigidity. If both signs are negative or if effect of cultural information is negligible and interaction has negative sign then we can have information rigidity. The only possible case that was not described is when both interaction and effect of cultural capital is positive. This case is possible, when we have increasing marginal return of informational clusters (violation of assumption 3).

APPENDIX B: TESTS FOR ECONOMETRIC MODEL SPECIFICATION

Table 5: Tests for econometric model specification

Type of test	Subject of test	Statistics	P-value	Results
F test	Fixed effect vs OLS	F(111,1936): 84.03	0.0000	Fixed effect estimation is more efficient than OLS
Modified Wald test	Test for groupwise heteroskedasticity	chi2 (109) $2.1*10^{25}$	0.0000	Presence of heteroskedasticity
Wooldridge test	Test for autocorrelation in panel data	F(1, 105) 204.786	0.0000	Presence of autocorrelation

Footnote:

Therefore, we can conclude, that fixed effect model (corrected for autocorrelation and heteroskedasticity) will result in more precise estimates than OLS and random effect regression.