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**KNOWLEDGE, CAPABILITIES AND THE POVERTY TRAP:
THE COMPLEX INTERPLAY BETWEEN TECHNOLOGICAL, SOCIAL
AND GEOGRAPHICAL FACTORS**

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Knowledge, Capabilities and the Poverty Trap:

The complex interplay between technological, social and geographical factors

by

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Abstract

This paper explores the possibility that technological capabilities, to lead to development, need to be accompanied by a broader set of “social capabilities”, reflecting not only the quality of governance but also the spread of values, beliefs and institutions that encourage members of society to actively contribute to the development process. To investigate this issue, a set of empirical indicators, reflecting the capabilities that have been emphasized in the literature as being important for development, was identified. We also take into account the possibility that these capabilities (and their impact) may be conditioned by historically given factors (related to, for example, geography, demography and history). The paper uses factor analysis to analyse the question of how these indicators interrelate and explores their relationship with economic development. We find that technological and social capabilities are indeed strongly related and, moreover, strongly correlated with economic development. The same does not apply for the second factor suggested by the analysis, which mainly reflects the character of countries’ political systems. Thus it is more important economically what countries do than how they decide on it. A strong negative relationship with development was found for the third factor, reflecting the combined effect of high fertility rates, low education and high frequency of serious disease. Arguably, this contributes to a “vicious circle” that makes it difficult for some very poor countries, especially in the tropics, to escape from poverty.

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1. Introduction

For a long time many economists believed that economic catch-up was mainly a question of investing sufficiently in machinery and other tangible factors. At least this was the main message that could be derived from the dominant theory of economic growth, the so-called neoclassical theory, developed in the 1950s by Robert Solow and others (Solow 1956, see Fagerberg 1994 for an extended discussion). Moreover, the theory was based on the assumption that the returns to capital accumulation would be higher in poor than in rich environments, leading to the prediction that poor countries under otherwise equal conditions would have higher rates of investment and economic growth than rich countries. Hence, following this approach economic development should be easy.

In reality it wasn't so easy, as evidenced by the fact that there has been very little convergence in GDP per capita between rich and poor countries during the last few decades (Fagerberg and Srholec 2005). In fact the distance in levels of productivity and income between the poorest and the richest countries in the world are much higher today than a few centuries ago (Landes 1998). As this evidence became more widely acknowledged, the received wisdom about the subject started to be questioned and new theories emerged focusing on intangibles, such as knowledge, learning, innovation and human capital, as the drivers of growth and development (Lucas 1988, Romer 1990, Aghion and Howitt 1992). Following these approaches the failure of many poor countries to develop and catch up with the rich ones should not primarily be seen as the result of too low investments in physical capital. Rather, the problem was assumed to relate to a lacking ability in these countries to exploit the worldwide pool of knowledge to their own benefit.

Arguably, this change of focus gave birth to more questions than answers. For example, why is it that many poor countries do not succeed in exploiting knowledge to increase productivity and welfare? What are the critical capabilities that poor countries need to develop in order to succeed? Our hunch is that there is no "quick technological fix" to the development puzzle. It is for example not sufficient to have access to knowledge about, say, the principles behind a certain technology, because this knowledge needs to be exploited to make a difference for economic development. Such exploitation requires command of other types of knowledge or capabilities as well, the development of which may be costly and take time.

In the next section we consider some of the existing literature on this issue and outline a strategy for how to deal with it empirically. This leads in the third section to the detection of a set of empirical indicators reflecting the capabilities that have been recognized in the literature as important for development. We also take into account the possibility that these capabilities (and their impact) may be conditioned by historically given factors related to, for example, geography, demography and history. The paper applies factor analysis to analyse the question of how these variables interrelate and explores the relationship with economic development. The final section considers the lessons from this exercise.

2. Lessons from the literature¹

¹ The discussion in this section draws on Fagerberg and Srholec (2008a,b).

Some of the first systematic attempts to study the relationships between technology, capabilities and development were made by economic historians who wanted to understand why some countries managed to catch up with the richer ones while other countries continued to be poor. Half a century ago Alexander Gerschenkron pointed out that technological catch up, although potentially highly lucrative, is also extremely challenging (Gerschenkron 1962). He saw this as the result of the cumulative nature of technological advance: With time technology became more sophisticated and the scale of operation larger, making entry more demanding. Based on a study of the performance of a number of European countries relative to the then leading country – Great Britain – he concluded that to succeed in technological catch up, less advanced countries had to develop what he called “new institutional instruments”, e.g., organizations capable of identifying the most promising options ahead and muster the necessary resources for exploiting these opportunities.²

More recently the view that technological catch-up by late-comers is far from easy has received further backing from a series of empirical studies of industrialization processes in Asia and Latin-America (Kim 1980, Fransman 1982, Fransman and King 1984, Dahlman et al. 1987, Lall 1987). One case which received much attention was the rise of Korea from being one of the poorest countries in the world to a first world technological powerhouse in just three decades. Linsu Kim, who made the authoritative study on the subject, suggested the concept “technological capability” (Kim 1980, 1997) as an analytical device to interpret the Korean evidence. He defined it as “the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies.” (Kim 1997, p. 4).³ Hence, the concept includes not only organized R&D, which arguably is a small activity in many developing countries, but also other capabilities needed for the commercial exploitation of technology. As has become common in the literature he considered three aspects of it: production capability, investment capability and innovation capability. Kim’s assessment was that the requirements should be expected to become more stringent, in particular with respect to innovation capabilities, as countries climb up the development ladder. Thus, for a firm or country in the process of catching up, the appropriate level of technological capability is a moving target, in constant need of improvement.

The concept “technological capability” has since been used in a large number of studies at various levels of aggregation (see Romijn 1999 and Figueiredo 2006 for overviews). Although initially developed for analyses of firms, it has also been applied to industries and countries. Sanjaya Lall, in a survey (Lall 1992), emphasized three aspects of “national technological capability” as he phrased it; the ability to muster the necessary (financial) resources and use them efficiently; skills, including not only general education but also specialized managerial and technical competence; and what he called “national technological effort”, which he associated with measures such as R&D, patents and technical personnel.⁴

² Gerschenkron’s work is often associated with his focus on investment banks, which he saw as critical in mobilizing resources for development. However, as Shin (1996) points out, it is possible to see his writings as an attempt to arrive at a more general understanding of the conditions for catch-up, focusing on the instruments - or capabilities to use a more recent term - that need to be in place for successful catch-up to take place.

³ Other concepts used in the literature to characterize these requirements include “technological mastery” (Dahlman and Westphal 1981, Fransman 1982), “technological effort” (Dahlman and Westphal 1982), “technological capacity” (Bell 1984), “innovative activity” (Fagerberg 1987), “innovation capability” (Dahlman et al. 1987), “absorptive capacity” (Cohen and Levintal 1990), “innovation system” (Lundvall 1992, Nelson 1993, Edquist 1997) and “innovative capacity” (Furman et al. 2002).

⁴ Lall also noted that national technological capability does not only depend on domestic technological efforts but also on foreign technology acquired through imports of machinery or foreign direct investments. This argument is also emphasized by advocates of the so-called “new growth theory” according to which small

Other writers have broadened the perspective to include a wider set of economic, social, cultural, institutional and political variables. Abramovitz (1986), building on earlier work by Ohkawa and Rosovsky (1974), used the term “social capability” as a shorthand for such factors. What he had in mind was not only individual skills, important as these may be, but also what organizations in the private and public sector are capable of doing and how this is supported (or hampered) by broader societal factors. Abramovitz (1994a,b) particularly emphasized the importance of managerial and technical competence; a stable and effective government capable of supporting economic growth; financial institutions and markets capable of mobilizing capital on a large scale; and the spread of honesty and trust in the population.

The fact that social and cultural factors such as, for example, trust may matter for economic development has been widely accepted for a long time.⁵ More than forty years ago Irma Adelman and Cynthia Morris (1965, 1967), on the basis of an in-depth study of a number of indicators on development for a large number of countries, concluded that “the purely economic performance of a community is strongly conditioned by the social and political setting in which economic activity takes place” (p. 578). They saw economic development as contingent on broader social and political changes accompanying the transition from a traditional (rural) ways of life, based on high degree of self-sufficiency, to a modern industrialized society characterized by market-relationships and new forms of institutions and governance. More recently, in an analysis aimed at explaining the development gap between two Italian regions, Robert Putnam (1993) put forward the argument that this gap had to do with different capacities for responding to social and economic challenges through appropriate forms of collective action, or “social capital” as he put it, using an already established sociological term.⁶ This contributed to a rapidly increasing body of research on the role of social capital in development (see Woolcock and Narayan 2000).

Although the importance of such broader social and cultural factors is generally acknowledged, how to approach this issue empirically remains a great challenge. Adelman and Morris (1965, 1967), in their initial take on the issue, set out to identify (and measure) a wide set of indicators (twenty-two in total) of economic, social and political modernization, drawing on a number of different sources. The relationships between these various indicators were then explored through factor analysis. It was shown that the variation in the data could be reduced to four common factors. The most important consisted of an amalgam of structural factors (share of agriculture, urbanization etc.), socio-economic characteristics (role of middle class, social mobility, literacy etc.) and the development of mass communication (measured through the spread of newspapers and radios in the population). Temple and Johnson (1998), who replicated the Adelman-Morris study on more recent data, suggested to use this factor as a measure for what they called “social capability” (which in their view embraced “social capital”). They demonstrated that the measure has considerable explanatory

countries are at a disadvantage in innovation and depend on free trade and a liberal stance towards international capital flows in order to overcome this problem (Grossman and Helpman 1991, Coe and Helpman 1995). However, the empirical support for the view that “openness” to trade and FDI is an important factor behind developing country growth is weak (Rodrik et al. 2004, Görg and Greenaway 2004, Fagerberg and Srholec 2008), and we are not going to consider this issue further here.

⁵ For instance, Kenneth Arrow pointed out long ago that “It can plausibly be argued that much of the economic backwardness in the world can be explained by lack of mutual confidence” (Arrow 1972, p. 357).

⁶ For classical texts on the subject see Bourdieu (1985) and Coleman (1990). In sociology the term is often used as an attribute of individuals, not as a characteristic of communities, as in the tradition from Putnam (1993). For an overview and discussion of different usages of the term see Portes (1998).

power for growth performance. The empirical support notwithstanding, the “SOCDEV” variable championed by Temple and Johnson clearly is a mixed bag, including several variables, such as for example indicators reflecting the structural composition of the economy, that has little to do with “social” factors. Furthermore, since Adelman and Morris did their selection of variables, many new data-sources on various aspects of development have become available including, for example, the “World Value Survey” (World Values Survey Association 2006). It seems reasonable to take these arguments into account when designing the analysis, which is what we wish to do in the following. We discuss this in more detail in the next section.

3. Data and Analysis

In this section we will first consider how the theoretical concepts discussed in the literature, e.g., technological capability, social capability and social capital, can be measured. Then we will go on to explore the interrelationships between technological, social, cultural, political etc. aspects of development through factor analysis.

For the purpose of the analysis we have collected data from various sources for 40 indicators and 80 countries at different levels of development. Since the time series for many relevant indicators are short, we focus on recent evidence. In an attempt to increase coverage across countries and limit influence of shocks and measurement errors occurring in specific years most indicators are measured as five-year averages over 2000-2004. In spite of this there were some missing data that had to be estimated. See the appendix for details on definitions, sources, estimation procedure and a full listing of the countries included.

What we need to do is to identify measureable aspects of the various capabilities discussed in the previous section and analyse how they interrelate. Technological capabilities we define, in the spirit of Kim (1997), as the ability to search for, create and use knowledge commercially. It thus includes not only the ability to create “new to the world inventions” (Furman, et al. 2002) but also minor improvements and adaptations to local conditions, which may not be equally glamorous but matter a lot economically. Therefore, this covers not only “innovation” capabilities but also abilities related to organization, production, and commercialization, e.g., what Kim and others had in mind with their emphasis on the “production” and “investment” aspects of “technological capability”.

The quality of a country’s research base is represented by publications in scientific journals, international patent applications (PCT) and R&D expenditure. However, as pointed out above, it is not enough to be aware of technological opportunities, these also need to be exploited in practice, and that requires competences in production, marketing, etc. Adherence to quality standards (ISO) may be a good indicator in this respect. Although ISO certification is mainly procedural in nature, it is increasingly seen as a requirement for firms supplying high quality markets, and is therefore likely to reflect a high emphasis on quality in production. We also include three indicators of ICT use: personal computers, internet users and fixed/mobile phone subscribers. Although earlier studies such as Lall (1992) did not place much emphasis on this dimension, nowadays a well-developed ICT infrastructure should be regarded as a must for a country that wish to catch up.

The important role that a country’s financial system may play in mobilizing resources for catching-up was pointed out already by Gerschenkron and is also emphasized by more recent

research (see, e.g., King and Levine 1993, Levine 1997, Levine and Zervos 1998). We capture this aspect by the amount of credit (to the private sector) and by capitalization of companies listed in domestic capital markets. Another important variable emphasized by for example Abramovitz, and for which there is also solid support in the literature, is skills (Nelson and Phelps 1966, Barro 1991, Benhabib and Spiegel 1994; for an overview see Krueger and Lindahl 2001). We include three indicators: gross rates of tertiary and secondary enrolment and the extent of public expenditure on education.⁷

The quality of governance and institutions, for furnishing economic agents with incentives for creation and diffusion of knowledge, is generally acknowledged as being important in the relevant literature. Although such factors often defy “hard” measurement, especially in a broad cross-country comparison, there exist some survey-based measures, often collected by international organisations that may throw some light on these issues. We find it useful to distinguish between, on the one hand, the “quality of governance” with respect to innovation and economic life more generally and the character of the political system on the other. For the former we use survey data reflecting whether property rights exist and are enforced, how widespread corruption is conceived to be, the extent to which law and order prevails, courts are seen as being independent and human rights, including women’s rights, are adhered to. To measure the character of the political system we include, in addition to the indicators mentioned above, variables reflecting the degree of democracy versus autocracy, checks and balances in the political system, degree of competition for posts in the executive and legislature, freedom of the press and the extent of political rights and civil liberties. Since Western democracies will tend to have high values on most of the latter, a possible interpretation might be that what is measured here is the degree of “Westernization” of a country’s institutions.

However, the impact of a government’s actions (as well that of private actors) may as pointed out by Abramovitz and others also depend on the prevailing social values in society. For example lack of trust may make many socially desirable initiatives extremely difficult to realize. To take this into account in the study we include data from the World Value Survey reflecting the degree of trust among the citizens of a nation and the willingness to participate in civic activities. In addition to such measures of “social capital” (see, e.g., Knack and Keefer, 1997)⁸ we also include variables measuring the openness of society to people with different characteristics. Arguably, the ability of a country to mobilize all parts of the population in economically useful activities should be seen as a very important factor in development.

In recent years, the extent to which economic development and factors associated with it are conditioned by exogenous factors beyond the control of people living today, has received increasing attention in the literature. Variables taken into account in such analyses include historical factors (Acemoglu et al. 2002), ethnic or religious diversity (Sachs et al. 2004, Masters and MacMillan 2001, Bloom et al. 2003, Alesina et al. 2003) and factors related to geography and/or nature, such as access to sea, climate, exposure to diseases (Gallup et al. 1999). It is difficult to deny that such exogenous factors may be important for development so

⁷ Despite detailed scrutiny we have not been able to find information on specialized managerial and technical skills that could be used in this study.

⁸ Knack and Keefer (1997) used data from the World Value Survey to analyze the relationship between trust, norms of civic behaviour and membership in groups on the one hand and economic growth on the other for a sample of 29 (mostly developed) countries. They found trust and civic behaviour (but not group membership) to be positively related to investment and economic growth.

it seems pertinent to try to take into account. Moreover it is of interest to see if such exogenous factors work through the technological, political, social etc. factors taken into account here (by affecting capability formation) or have a separate influence (in addition to other factors). We therefore include a selected set of indicators for such exogenous factors in the factor analysis. Historical factors refer to choices taken by people in the past that influence present outcomes whether people living today like it or not. We include the extent to which the country has experienced armed conflicts in recent decades and the demographic composition of its population. Another set of factors that also may be seen as historical in nature refers to religion. For this we include the shares of the major religions in the population. Regarding geography we include the average distance for a country's population to the sea or navigable rivers, the exposure to natural disasters and the share of its area in the tropics. We also include the prevalence of various serious diseases that are, at least to some extent, associated with a country's geography, nature and climate (malaria, tuberculosis and HIV).

Table 1 outlines the indicators taken into account and provides results of the factor analysis. Three principal factors emerge from the analysis, explaining together 61.8 % of the total variance of the indicators. The first of these is strongly correlated with indicators reflecting R&D, patenting & scientific publications, ICT access/use, a well developed financial sector, little corruption⁹, law and order, a well functioning legal system and a set of variables drawn from the World Value survey reflection the openness of society towards parts of population with diverging characteristics, trust and the propensity to take part in civic activities. It also loads highly on the share of Protestants in the population and moderately on education and human rights (see below). Hence this factor reflects both technological and social capabilities as traditionally defined, emphasizing the strong interdependence between technological, social and cultural factors in the process of development. We have chosen to continue to use the term "social capability" for this factor, noting, however, that this may be seen as a broadening of the definition.

The second factor correlates highly with the adoption of western-type institutions in the political sphere, a high share of Catholics, a low share of Muslims and moderately with women's rights. This factor clearly reflects the prevalence of Western values and institutions and we therefore call it "Western democracy". Finally there is a third factor that correlates strongly with the fertility rate, spread of malaria, tuberculosis and HIV and location in the tropics. It correlates moderately with a number of other factors too, the most important of which are (low shares of) tertiary and secondary school enrolment. This factor arguably reflects some of the mechanisms that continue to keep the poorest countries of the world at the bottom of the development ladder. We label this factor "the poverty trap".

⁹ Note that the corruption perception index, as explained in appendix, ranges from zero (high corruption) to ten (no corruption).

Table 1: Results of factor analysis (factor loadings)

	Factor 1: Social Capability	Factor 2: Western democracy	Factor 3: Poverty trap
Gross domestic expenditure on R&D	0.84	-0.03	-0.05
PCT international (patent) applications	0.90	-0.02	0.11
Science & engineering articles	0.92	0.05	-0.03
ISO 9000 certifications	0.59	0.10	-0.15
Personal computers	0.87	0.07	-0.07
Internet users	0.79	0.14	-0.15
Fixed line and mobile phone subscribers	0.64	0.22	-0.33
Tertiary school enrolment	0.41	0.16	-0.47
Secondary school enrolment	0.38	0.21	-0.51
Public expenditure on education	0.54	-0.01	-0.05
Domestic credit to private sector	0.75	-0.03	-0.01
Market capitalization of listed companies	0.78	-0.05	0.17
Corruption perception index	0.86	0.08	-0.13
Law and order	0.70	-0.20	-0.32
Impartial courts	0.89	-0.10	0.05
Property rights	0.69	0.26	-0.12
Physical integrity human rights	0.39	0.23	-0.41
Women's rights	0.46	0.47	-0.16
Equal rights to a job for immigrants	0.70	-0.04	0.03
Acceptance of homosexuality	0.61	0.35	-0.08
Tolerance and respect for other people	0.57	0.13	0.14
Trust	0.68	-0.43	-0.15
Civic action	0.61	0.13	-0.10
Political rights and civil liberties	0.23	0.79	-0.12
Freedom of the press	0.39	0.65	-0.07
Index of democracy and autocracy	0.03	0.88	-0.09
Political constraint	0.11	0.65	-0.05
Executive index of political competitiveness	-0.11	0.84	0.10
Legislative index of political competitiveness	-0.12	0.78	0.06
Protestant	0.81	0.10	0.43
Catholic	-0.26	0.56	-0.07
Muslim	-0.12	-0.61	-0.02
Fertility	0.11	-0.26	0.75
HIV prevalence	0.11	0.09	0.65
Tuberculosis prevalence	-0.14	0.02	0.80
Malaria fatal risk	0.06	-0.02	0.86
Land in geographical tropics	-0.12	0.12	0.67
Population within 100 km of ice-free coast	0.15	0.27	-0.32
Killed or affected by natural disasters	-0.31	0.00	0.42
Armed conflicts	-0.21	0.07	0.30

Note: Number of observations is 80; three factors with eigenvalue > 1 were detected, which explain 61.8% of total variance; extraction method: iterated principal factors; rotation: oblimin oblique.

Figures 1-3 show the relationships between the three synthetic measures and economic development. Figure 1 plots our social capability measure against GDP per capita (PPP). One observation follows more or less immediately: the very close correlation between the two. More than eighty per cent of the variation in GDP per capita can be “explained” by the broadly defined social capability measure. Arguably developing such capabilities must be seen as a “must” for countries that wish to catch up. Figure 2 presents the same for “Western democracy”. As is evident from the graph this relationship is non-linear.¹⁰ For the poorest countries there is either a negative or no relationship at all between the degree of westernization of institutions and economic development, depending on whether or not Saudi Arabia is included in the analysis. For the richer part of the sample the curve is almost vertical, indicating that they all have western-type institutions independent of the level of GDP per capita. Only for a relatively small number of medium-income countries we find evidence of a positive relationship. A possible explanation of this pattern could be that democratization is a consequence rather than a cause of economic development but this is not something that we can conclusively test for with the present data.

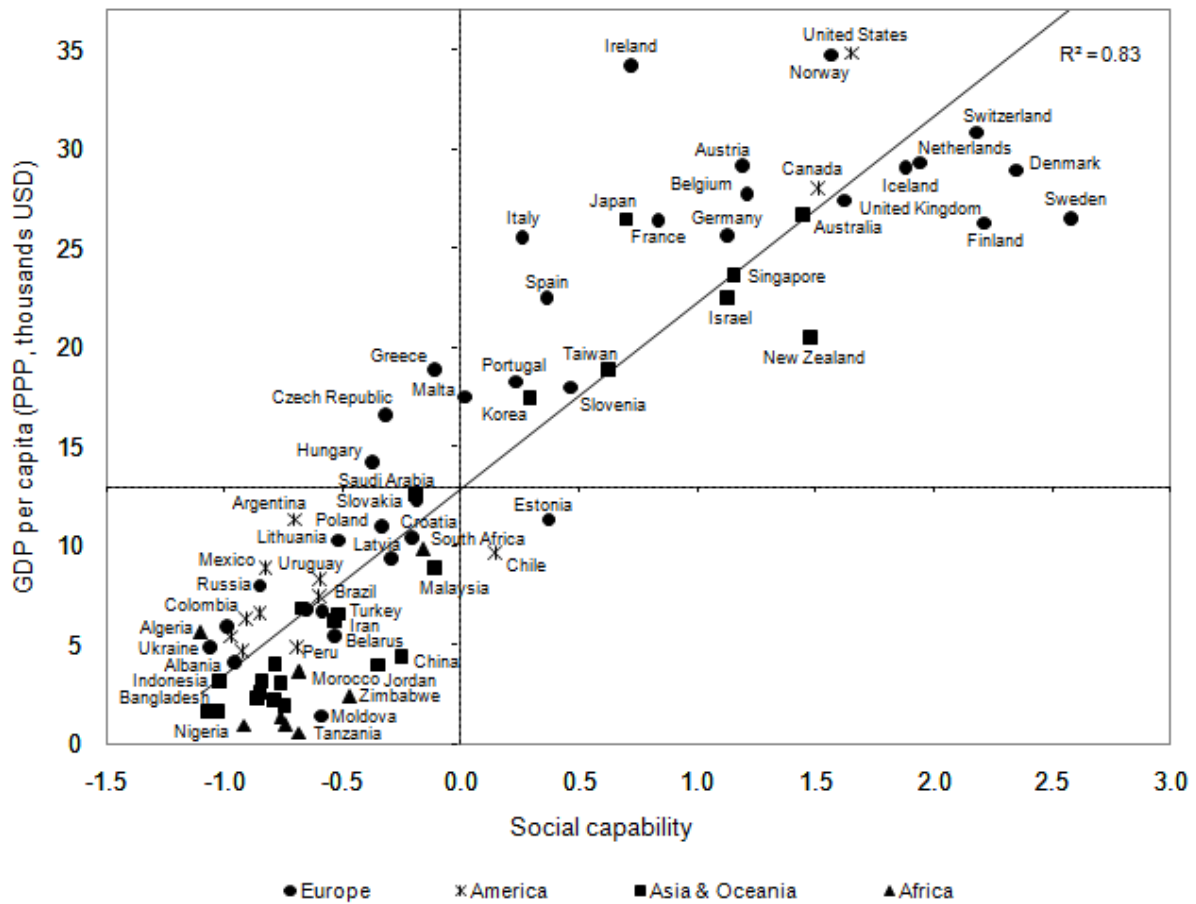
Finally Figure 3 reports the relationship between GDP per capita and “The poverty trap”. In this case too the best fit is a non-linear relationship.¹¹ As in the previous case this factor has no predictive power with respect to differences in GDP per capita among already developed countries. But it has considerable explanatory potential for a limited number of poor countries in Africa and Asia. Arguably these are countries caught in “the poverty trap”. The combined effect of high fertility rates, low education and high frequency of serious disease leads to a “vicious circle” that prevents these mostly tropical countries to escape from poverty.

Most of the eleven indicators referring to geography, demography and history factor out in the separate “The poverty trap” dimension. But this does not hold for religion, the influence of which is also notable for the two other principal factors. As pointed out, social capability – which has the strongest correlation with economic development – is strongly positively correlated with the spread of Protestantism. This seems to fit the arguments of Max Weber (1905/2002) regarding the important role that religious attitudes and beliefs may play for development (or lack of such). However, as the reader may have observed, Protestantism is also positively (though more moderately) correlated with factors associated with “The poverty trap”. Furthermore, the shares of Catholics and Muslims are both correlated with “Western democracy”, though in opposite directions. But since the economic significance of the spread of “Western democracy” seems small, this does not necessarily have big implications for development. Thus, while the results indicate that religion may be an important variable to take into account, further research is needed to determine the precise nature of these relationships.

¹⁰A quadratic function ($y = 10.00 + 9.21x + 2.98x^2$) comes out with a higher $R^2 = 0.37$ than a linear function ($y = 12.92 + 5.41x$) with $R^2 = 0.27$.

¹¹A quadratic function ($y = 10.85 - 9.37x + 2.21x^2$) comes out with a higher $R^2 = 0.39$ than a linear function ($y = 12.92 - 6.03x$) with $R^2 = 0.33$.

Figure 1: Social capability and GDP per capita (PPP)



Note: Korea (here and later) is the Republic of Korea (South)

Figure 2: Western democracy and GDP per capita (PPP)

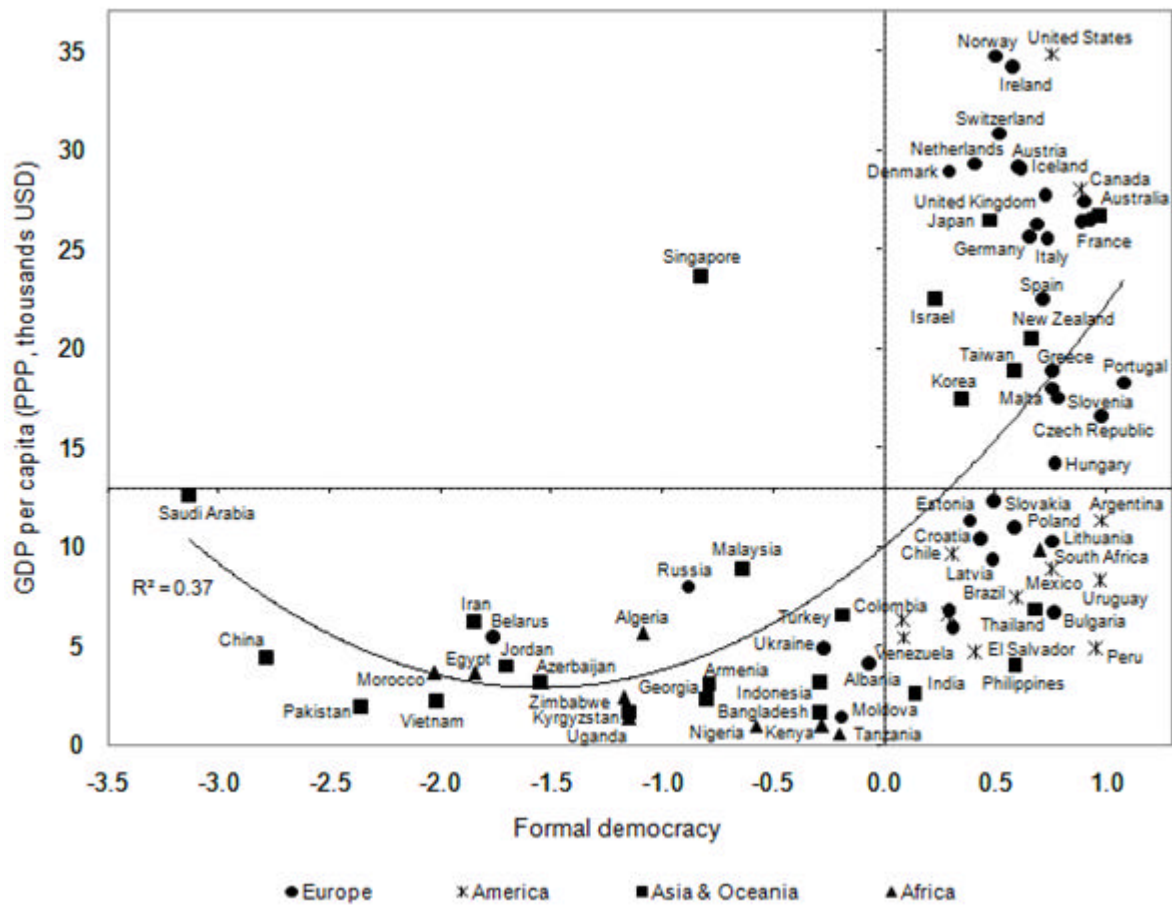
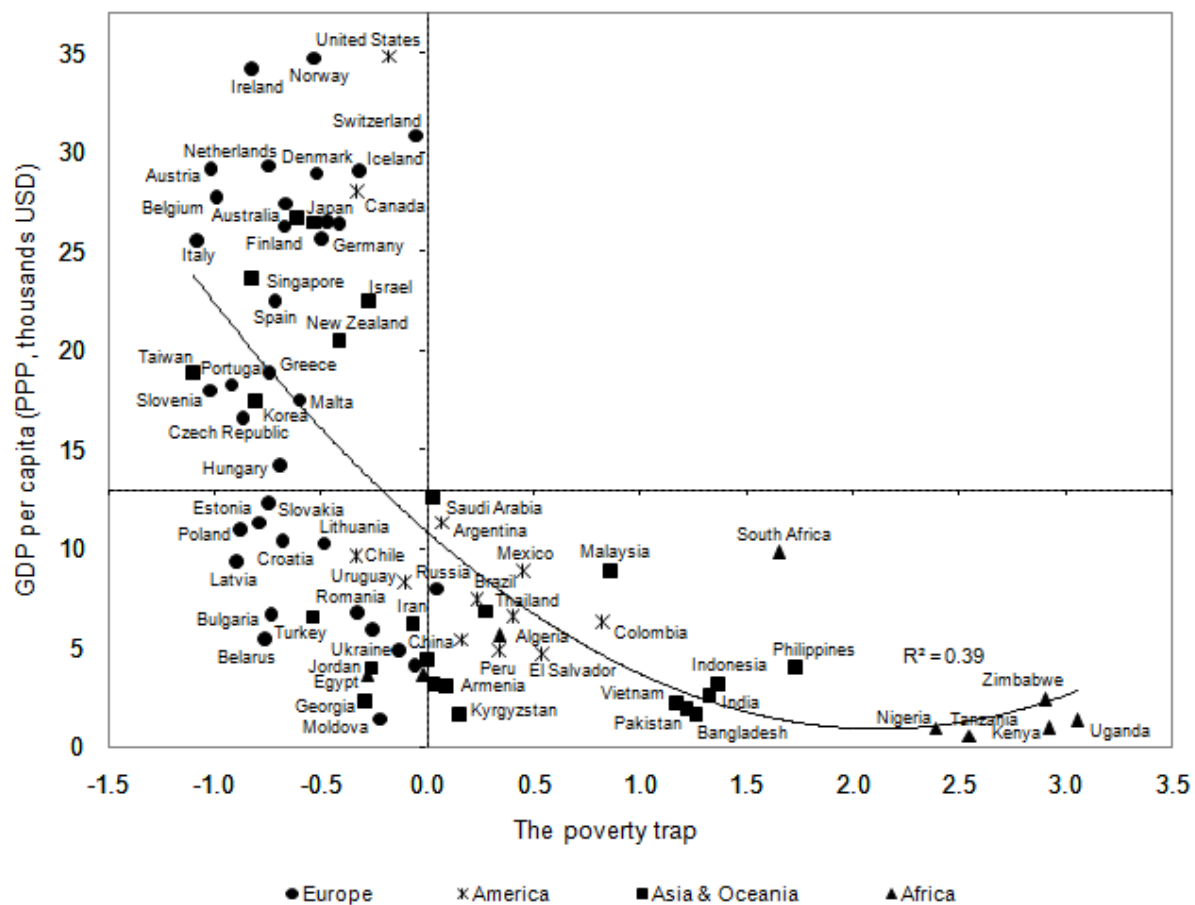


Figure 3: “The poverty trap” and GDP per capita (PPP)



4. Conclusions

While many writers over the years have emphasized the large potential for development by adopting more advanced technologies developed elsewhere, this potential has been slow to materialize. The natural question to ask, therefore, is why such catching up, which in the views of some should be easy, seems to be so difficult in practice. One possibility, which has received a lot of attention in the literature, is that catching up in technology does not come for free but requires the generation of what has been called “technological capabilities”, e.g., the ability of a country to acquire, exploit and develop new knowledge. In this paper we have taken the issue one step further by investigating the possibility that such technological capabilities, to lead to development, needs to be accompanied by a broader set of “social capabilities” reflecting not only the provision of education, quality of governance etc. but also the spread of values, beliefs and institutions that encourage members of society to actively contribute to the development process. As shown in the paper there are strong reasons to believe that this actually is the case. In addition, some (mostly tropical) countries are also negatively affected by a powerful “vicious circle” of high fertility rates, low education and high frequency of serious disease, which hamper capability building and contributes to perpetuate poverty. Hence, there is no “easy fix” to the problem of underdevelopment.

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Appendix 1: Data and sources

A brief overview of definitions, sources and coverage of the indicators is given in the table below. The main source of data is the World Bank (World Development Indicators 2005), which combines various sources of data for a large sample of countries. The database has been complemented by data from other organizations such as UNCTAD (FDI Database), UNESCO (Global Education Digest) OECD (MSTI and Patent Databases), International Organization for Standardization (ISO), Heritage Foundation, Transparency International, Freedom House, World Value Survey and others, and in addition datasets produced by research projects or scholars. National sources were only used for Taiwan if necessary and in a few cases for R&D data in developing countries.

Although the selected indicators have broad coverage, in many cases there were missing values for a few countries that had to be dealt with. We use the *impute* procedure in Stata 9 to fill in the missing values (see the Stata 9 Manual for details). In each case we based the estimation on data for other indicators in the dataset. The number of countries with estimated data for each indicator is given in the last column of the following table. It should be stressed that considerable care was taken to check the estimated data against observed figures. In some cases the estimated data would exceed the maximum (or minimum) observed value of an indicator elsewhere. In such cases we truncated the data by replacing the estimated values by the maximum (or minimum) observed figure. Note that we also reversed the scale, while keeping the original range, for some of the governance indicators in order to have the indicator in increasing order (with low value signalling weak governance and vice versa).

<i>Indicator & definition</i>	<i>Scaling</i>	<i>Source</i>	<i>Average over period</i>	<i>Estimated countries</i>
GDP per capita, PPP (constant 2000 international USD): Gross domestic product converted to international dollars using purchasing power parity rates.	USD	World Bank (World Development Indicators 2005)	2000-2004	0
Gross domestic expenditure on R&D (GERD): Total (public and private) intramural expenditure on research and experimental development (R&D) performed on the national territory.	% of GDP	World Bank (World Development Indicators 2005), OECD (MSTI Database), RICYT and national sources	2000-2004	9
PCT international (patent) applications: Number of applications for PCT (Patent Cooperation Treaty) patents.	per capita	WIPO	2000-2004	0
Science & engineering articles: Number of scientific and engineering articles published in journals covered by the Institute for Scientific Information's Science Citation and Social Sciences Citation Indexes.	per capita	U.S. National Science Foundation (Science and Engineering Indicators 2006)	2000-2003	0
ISO 9000 certifications: ISO 9000 is a family of standards approved by the International Standards Organization (ISO) that define a quality management and quality assurance program.	per capita	International Organization for Standardization (The ISO Survey, various issues)	2000-2003	0
Personal computers: Personal computers are self-contained computers designed to be used by a single individual.	per capita	World Bank (World Development Indicators 2005)	2000-2004	2
Internet users: Internet users are people with access to the worldwide network.	per capita	World Bank (World Development Indicators 2005)	2000-2004	0
Fixed line and mobile phone subscribers: Fixed lines are telephone mainlines connecting a customer's equipment to the public switched telephone network. Mobile phone subscribers refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology.	per capita	World Bank (World Development Indicators 2005)	2000-2004	0
Tertiary school enrolment: Number of tertiary students of all ages expressed as a percentage of the tertiary school-age population.	% gross	UNESCO (Global Education Digest 2005 CD-Rom)	2000-2002	1
Secondary school enrolment: Number of secondary students of all ages expressed as a percentage of the secondary school-age population.	% gross	UNESCO (Global Education Digest 2005 CD-Rom)	2000-2002	1
Public expenditure on education: Public spending on public education plus subsidies to private education at the primary, secondary, and tertiary levels.	% of GDP	UNESCO (Global Education Digest 2005 CD-Rom)	2000-2002	7
Domestic credit to private sector: Financial resources provided to the private sector that establish a claim for repayment.	% of GDP	World Bank (World Development Indicators 2005)	2000-2004	0

Market capitalization of listed companies: Market capitalization is the share price times the number of shares outstanding of domestically incorporated companies listed on the country's stock exchanges at the end of the year.	% of GDP	World Bank (World Development Indicators 2005)	2000-2004	5
Corruption perception index: The perceptions of well-informed people with regard to the extent of corruption, defined as the misuse of public power for private benefit, ranging from zero (corrupt) to ten (clean).	index (0-10)	Transparency International (Corruption Perceptions Index; various issues)	2000-2004	0
Law and order: Rule of law and order is the degree to which the citizens of a country are willing to accept the established institutions, to make and implement laws and adjudicate disputes.	index (0 to 10)	PRS Group (International Country Risk Guide, various issues)	2000-2004	3
Impartial courts: The variable indicates whether a trusted legal framework exists for private businesses to challenge the legality of government actions or regulation.	index (0 to 10)	World Economic Forum (Global Competitiveness Report, various issues)	2000-2003	6
Property rights: The degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. The scale of the indicator has been reversed into increasing order, while keeping its original range.	index (1 to 5)	Heritage Foundation (Index of Economic Freedom, various issues)	2000-2004	0
Physical integrity human rights: The variable is average score on a group of four rights known as the "physical integrity rights": rights to freedom from extrajudicial killing, disappearance, torture, and political imprisonment.	index (0 to 8)	Cingranelli and Richards (2004)	2000-2004	0
Women's rights: The variable is average score on women's economic, political and social rights.	index (0 to 9)	Cingranelli and Richards (2004)	2000-2004	0
Equal right to a job for immigrants: Agreement with the following statement: When jobs are scarce, employers should give priority to [nation] people over immigrants. Agree = 1, Neither = 2, Disagree = 3. The variable refers to the sum of the weighed proportions of the answers, which has been rescaled to a range between 0 and 100.	index (0 to 100)	World Values Survey Association (2006)	1999-2003	6
Acceptance of homosexuality: Agreement with a statement whether homosexuality is justifiable. Answers on 10 points scale from "never justifiable" to "always justifiable". The variable refers to the sum of the weighed proportions of the answers, which has been rescaled to a range between 0 and 100.	index (0 to 100)	World Values Survey Association (2006)	1999-2003	5
Tolerance and respect for other people: Agreement with the statement that tolerance and respect for other people is an important quality that children should be encouraged to learn at home.	%	World Values Survey Association (2006)	1999-2003	3
Trust: Agreement with the following statement: Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?	%	World Values Survey Association (2006)	1999-2003	3

<p>Civic action: Answer on a question about signing a petition. Would never do = 1, Might do = 2, Have done = 3. The variable refers to the sum of the weighed proportions of the answers, which has been rescaled to a range between 0 and 100.</p>	index (0 to 100)	World Values Survey Association (2006)	1999-2003	6
<p>Political rights and civil liberties: Political rights enable people to participate freely in the political process. Civil liberties allow for the basic freedoms without interference from the state. The variable is the sum of the indexes of political rights and civil liberties. They have been reversed into increasing order, while keeping their original range.</p>	index (2 to 14)	Freedom House (Freedom in the World Comparative Rankings: 1973-2005)	2000-2004	0
<p>Freedom of the press: Freedom of the press consists of constitutional or statutory protections pertaining to the media and published materials. The scale of the indicator has been reversed into increasing order, while keeping its original range.</p>	index (0 to 100)	Freedom House (Freedom of the Press, various issues).	2000-2004	0
<p>Index of democracy and autocracy: Institutionalized autocracies sharply restrict or suppress competitive political participation. Institutionalized democracy is defined as one in which political participation is fully, competitive, executive recruitment is elective, and constraints on the chief executive are substantial. The variable ranges from autocracy to democracy in increasing order (Revised Combined Polity Score - POLITY2 variable)</p>	index (-10 to 10)	Marshall and Jaggers (2003) - Polity IV Dataset	2000-2003	2
<p>Political constraint: The extent to which a change in the preferences of any one actor may lead to a change in government policy. It identifies the number of independent branches of government with veto power over policy change. The measure is then modified to take into account the extent of alignment across branches of government and to capture the extent of preference heterogeneity within each legislative branch (POLCONIII variable)</p>	index (0 to 1)	Henisz (2002, 2005)	2000-2004	0
<p>Executive index of political competitiveness: Competitiveness for post in executive branches in government, which takes into account a balance of power between legislature and executive, e.g. the method of the electoral college appointing, whether military has significant influence, whether the political system is presidential vs. parliamentary, etc.</p>	index (1 to 7)	Beck, et al. (2001, 2005)	2000-2004	0
<p>Legislative index of political competitiveness: Competitiveness of elections into legislative branches. The highest score refers to countries in which multiple parties compete in elections and the largest party receives less than 75% of the vote. The lowest score refers to countries without or with unelected legislature. The score is supplemented by information on voting irregularities, whether candidate intimidation was serious enough to affect electoral outcomes, whether important parties boycott elections or the election results, etc.</p>	index (1 to 7)	Beck, et al. (2001, 2005)	2000-2004	0
<p>Protestant: The proportion of population affiliated to the Protestant church</p>	%	CIA World Factbook	Latest year available	0

Catholic: The proportion of population affiliated to the Catholic church	%	CIA World Factbook	Latest year available	0
Muslim: The proportion of population affiliated to Islam	%	CIA World Factbook	Latest year available	0
Fertility: Fertility rate (births per woman) represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with prevailing age-specific fertility rates.	%	World Bank (World Development Indicators 2005)	2000-2004	0
HIV prevalence: The percentage of people ages 15-49 who are infected with HIV.	%	World Bank (World Development Indicators 2005)	2001 and 2003	0
Tuberculosis prevalence: The percentage of people ages 15-49 who have developed tuberculosis.	%	United Nations (2005)	2000-2003	0
Malaria fatal risk: The estimated proportion of population at risk of contracting falciparum malaria.	%	Earth Institute (Jeffrey D. Sachs Malaria Dataset)	1996	0
Land in geographical tropics: The proportion of land area in geographical tropics.	%	Gallup et al. (1999) - CID Geography Datasets	1998	0
Population within 100 km of ice-free coast: The proportion of population within 100 km from ice-free coast or navigable river buffer.	%	Gallup, Sachs and Mellinger (1999) - CID Geography Datasets	1994	0
Killed or affected by natural disasters: Number of persons killed or affected by disasters of natural origin (droughts, earthquakes, extreme temperatures, floods, slides, waves, wind storms, etc.) over 1980-2004. Unity has been added before the transformation to avoid logs of zero.	Logs of victims per capita	UNEP (The GEO Data Portal) – based on the OFDA/CRED International Disaster Database 2004	1980-2004	0
Armed conflicts: The proportion of years when the country is location of a war; war refers to at least 1000 battle-related deaths per year.	%	Strand, et al. (2005)	1980-2004	0

Appendix 2: Overview of the factor scores by country

Country	Social Capability	Formal democracy	Poverty trap
Albania	-0.95	-0.08	-0.01
Algeria	-1.12	-1.04	0.36
Argentina	-0.67	0.88	0.01
Armenia	-0.79	-0.73	0.07
Australia	1.46	0.94	-0.60
Austria	1.18	0.62	-1.08
Azerbaijan	-0.86	-1.52	0.04
Bangladesh	-1.06	-0.30	1.22
Belarus	-0.57	-1.71	-0.80
Belgium	1.20	0.74	-1.07
Brazil	-0.60	0.63	0.34
Bulgaria	-0.59	0.77	-0.73
Canada	1.51	0.91	-0.28
Chile	0.14	0.32	-0.29
China	-0.25	-2.77	0.14
Colombia	-0.92	0.13	0.87
Croatia	-0.21	0.43	-0.67
Czech Republic	-0.33	1.01	-0.82
Denmark	2.33	0.30	-0.55
Dominican Republic	-0.84	0.27	0.45
Egypt	-0.68	-1.88	-0.25
El Salvador	-0.93	0.41	0.46
Estonia	0.36	0.41	-0.79
Finland	2.20	0.69	-0.65
France	0.84	0.89	-0.43
Georgia	-0.88	-0.78	-0.44
Germany	1.14	0.64	-0.57
Greece	-0.10	0.73	-0.84
Hungary	-0.39	0.80	-0.70
Iceland	1.90	0.56	-0.36
India	-0.82	0.11	1.38
Indonesia	-1.02	-0.22	1.49
Iran	-0.55	-1.82	-0.14
Ireland	0.74	0.53	-0.77
Israel	1.15	0.16	-0.27
Italy	0.23	0.78	-1.17
Japan	0.70	0.48	-0.58
Jordan	-0.33	-1.79	-0.32
Kenya	-0.74	-0.27	3.03
Korea	0.31	0.34	-0.68
Kyrgyzstan	-1.02	-1.17	0.01

Latvia	-0.30	0.49	-0.93
Lithuania	-0.51	0.75	-0.52
Macedonia	-0.99	0.32	-0.19
Malaysia	-0.09	-0.64	0.88
Malta	0.04	0.75	-0.59
Mexico	-0.83	0.76	0.33
Moldova	-0.59	-0.20	-0.26
Morocco	-0.70	-1.98	0.02
Netherlands	1.96	0.36	-0.71
New Zealand	1.49	0.63	-0.39
Nigeria	-0.87	-0.67	2.55
Norway	1.56	0.49	-0.61
Pakistan	-0.75	-2.36	1.27
Peru	-0.67	0.92	0.37
Philippines	-0.78	0.61	1.76
Poland	-0.36	0.64	-0.87
Portugal	0.22	1.09	-0.93
Romania	-0.65	0.29	-0.32
Russia	-0.85	-0.86	0.09
Saudi Arabia	-0.13	-3.26	0.20
Singapore	1.16	-0.80	-0.70
Slovakia	-0.21	0.54	-0.73
Slovenia	0.47	0.74	-0.99
South Africa	-0.16	0.71	1.72
Spain	0.35	0.75	-0.73
Sweden	2.55	0.96	-0.59
Switzerland	2.17	0.54	-0.08
Taiwan	0.66	0.53	-1.01
Tanzania	-0.69	-0.19	2.48
Thailand	-0.69	0.77	0.48
Turkey	-0.53	-0.17	-0.42
Uganda	-0.75	-1.19	2.94
Ukraine	-1.07	-0.26	-0.16
United Kingdom	1.63	0.86	-0.79
United States	1.64	0.77	-0.17
Uruguay	-0.59	0.94	-0.21
Venezuela	-0.96	0.05	0.16
Vietnam	-0.82	-1.94	1.08
Zimbabwe	-0.52	-1.12	2.58