Personality and Individual Differences 53 (2012) 108–113

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Intellectual classes, technological progress and economic development: The rise of cognitive capitalism

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ARTICLE INFO

Article history:
Available online 23 July 2011

Keywords:
Intelligence
Economic growth
Wealth
GDP
Technology
Smart fraction theory

ABSTRACT

Cognitive ability theory claims that peoples' competences are decisive for economic wealth. For a large number of countries Lynn and Vanhanen (2002) have published data on mean intelligence levels and compared them to wealth and productivity indicators. The correlation between intelligence and wealth was supported by studies done by different authors using different countries and controls. Based on their pioneering research two research questions were developed: does intelligence lead to wealth or does wealth lead to intelligence or are other determinants involved? If a nation's intelligence increases wealth, how does intelligence achieve this? To answer them we need longitudinal studies and theoretical attempts, investigating cognitive ability effects at the levels of individuals, institutions and societies and examining factors which lie between intelligence and growth. Two studies, using a cross-lagged panel design or latent variables and measuring economic liberty, shares of intellectual classes and indicators of scientific-technological accomplishment, show that cognitive ability leads to higher wealth and that for this process the achievement of high ability groups is important, stimulating growth through scientific-technological progress and by influencing the quality of economic institutions. In modernity, wealth depends on cognitive resources enabling the evolution of cognitive capitalism.

1. Introduction: The wealth of nations

Since Adam Smith many scholars have tried to explain why some nations are richer than others. Two principal paradigms could be distinguished: in the first the causes are found *in a nation itself*, e.g. in the behavior of the people or the quality of institutions. In the second paradigm, factors *outside a nation* are decisive, like terms of trade or colonialism.

In the important *libertarian approach* going back to Smith (1994/1776) and the Austrian school (Hayek, 1994/1944) economic freedom – an internal attribute – is the essential prerequisite for growth. Economic freedom should allow a nearly optimal allocation of labor and capital and result in a system of peaceful trade (instead of suppression and violence). Empirical–statistical research is supportive: economically free countries are richer ($r = .76$, $N = 88$ nations; Rindermann, 2008a) and economic freedom increases wealth: moving from a closed to an open economy adds about 1.5% to annual growth rates (Jamison, Jamison, & Hanushek, 2007). But the success of East Asian countries with large governmental influences on the economy contradicts the libertarian theory.

A second approach assumes that behind economic liberty, but also behind working patterns and the quality of institutions lie *cultural orientations* supporting hard and systematic work, education towards useful knowledge and thinking, meritoric principles, and efficiency. Such orientations are stressed in religious traditions (Protestantism, Confucianism, Judaism), in enlightenment and in a burgher culture (Weber, 2001/1905; Mokyr, 2010). Nevertheless, cultural theories have rarely been tested with adequate statistical models.

Dependency theories – belonging to the second paradigm of factors outside a nation – try to explain wealth differences as a result of asymmetric power structures. This theory with roots in the works of Marx (1992/1867) has a descriptive value, but cannot explain large differences in economic development within (formerly) developing countries, like between Southern Korea and Ghana. Some countries after the end of colonialism even suffered a decline in development in the form of a decay in infrastructure (Landes, 1998). Second, advantages of backwardness are not considered, meaning the possibility of faster growth for poorer countries by adopting and copying advanced technological countries.

Geographic theories which stress the relevance of mineral resources or of other advantages (like having access to overseas trade; the possibility of cross-continental exchange of goods and ideas along similar latitudes; few infectious diseases; good climate; domesticable animals; Diamond, 1997) also emphasize external factors. Of course, mineral resources (and the exploitation of people) can increase wealth, but they have not lead to sustainable development, even worse, they have lead to a decline in

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0191-8869/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.paid.2011.07.001

development and after the rush of exploitation countries can be even poorer than before (Landes, 1969, p. 36). Other disadvantages like tropical climates, no access to oceans, mountainous geography or earthquakes could be overcome by *intelligent* leadership and organization (e.g. Singapore, Switzerland, Taiwan, and New Zealand).

2. Intelligence and wealth

Lynn and Vanhanen (2002) were the first to develop a theory of "*intelligent wealth*": they propose that cognitive ability is a major causal component of national wealth. Studies at the level of individuals within countries show an important impact of intelligence on income, which is more important than parents' socioeconomic-status (intelligence vs. SES metaanalysis: $r_{Int} = .23$ vs. $r_{SES} = .15$, Strenze, 2007; sibling comparison within families: one IQ point higher as a child is equivalent to around 810 US $ higher yearly income around age 35, Murray, 2002). At the level of countries the correlations are much higher between cognitive competence (including knowledge) and Gross Domestic Product (per capita; purchasing power parity/ppp: transformed across countries and currencies in comparable monetary units). GDP measures productivity not income, but it is highly correlated with national income per capita ($r > .95$) and a good indicator of the standard of living. Lynn and Vanhanen (2002) reported for 185 countries a correlation of $r = .62$ between intelligence test results and GDP 1998, Lynn and Vanhanen (2006) similarly for Gross National Income (2002, $r = .60$, $N = 192$). Other researchers have studied international data sets using different variables and came to similar conclusions (Hanushek & Woessmann, 2008; Ramirez, Luo, Schofer, & Meyer, 2006; Weede, 2004).

3. Criticisms

3.1. Data quality

The most frequent criticism was *data quality* (e.g. Barnett & Williams, 2004; Hunt, 2010). Indeed, there were serious problems in the intelligence data: for many countries data do not exist, so IQs have to be estimated. Data measurements were taken at different times, IQs have to be Flynn-corrected. Samples are not always large and representative, further data are needed. In many samples there are problems of representativity, not all test results can be used. Equatorial Guinea's results were based on an incorrect sample. In different countries different tests were used, results have to be made comparable. Tests include culturally loaded crystallized measures, results are not free of school effects.

But studies using other data produced similar results for wealth (including student assessment studies: Hanushek & Woessmann, 2008, $r = .63$ with GDP, $N = 72$; Rindermann, 2008a, $r = .63$ with GDP, $N = 185$). There are high correlations of IQ data with student assessment data (Rindermann, 2007) and Richard Lynn has presented updated data, corrected for detected errors and containing new samples, correlating highly with older and estimated measures (Lynn, 2010; Lynn & Meisenberg, 2010). Using these new combined data sets also results in higher correlations with GDP (1998, logged): $r = .77$, $N = 96$ (only measured IQs), $r = .68$, $N = 185$ (including estimated IQs).

3.2. Causes of cross-country differences in intelligence

Lynn and Vanhanen (2002, 2006); also Lynn (2008) proposed a genetic theory of cross-country differences in intelligence. Their assumption is based on an *evolutionary theory of intelligence* and development of human subgroups (races/subspecies/ancestries) depending on different environmental challenges (see also Hart, 2007; Rushton, 2004). There is a strong, somewhat political debate on this assumption with many regrettable side effects in relation to science (Nyborg, 2003), but also scientific criticisms have been raised (e.g. Wicherts, Borsboom, & Dolan, 2010). Extremely high correlations of skin-color (precisely: skin brightness as a rough indicator of evolutionary history) with intelligence across nations seem to support an evolutionary theory (Templer & Arikawa, 2006: $r = .92$; Meisenberg, 2009: $r = .90$), but the biologically more convincing correlations at the individual level are much lower ($r = .20$; Jensen, 2006, p. 130).

However, up to now no genes for intelligence have been found (Johnson, 2010). So the assumed causal path from genotype to intelligence, through brain size (Rushton, 2004), neurological efficiency (Haier et al., 1988), mental speed (Jensen, 2006; Rindermann & Neubauer, 2000) or through shaping of environment and learning finally leading to fluid and crystallized intelligence, at the level of individuals or nations, is not testable. And of course, if a more or less strong impact of identified genes is eventually found further causes are not excluded, like culture stimulating diligence, learning and thinking (Rindermann, 2009; Steppan, 2010). The same is true for reciprocal effects (e.g. from culture and intelligence to genes by inbreeding; Woodley, 2009).

Most important, we do not need to know the causes of cognitive ability differences between countries to know that these differences influence wealth, democracy or even health (Rindermann & Meisenberg, 2009). But maybe the effect is converse?

3.3. The direction: Does intelligence lead to wealth or wealth to intelligence? Longitudinal analyses

Hunt and Wittmann (2008) using different samples and measures support the existence of a correlation between ability and wealth as found by Lynn and Vanhanen, but they *question the direction of causality*. Cross-sectional studies can never answer this. Leaving aside unworkable country-wide experiments, it would be best to use a cross-lagged panel design with data for many countries investigating reciprocal effects (from former intelligence to wealth, controlled for former wealth and the most important further determinant of growth, economic freedom). Unfortunately we have no data sets with cognitive ability levels from say 1950 or 1960 for many countries; but there are results from some student assessment studies around and before 1970. Additionally, there are large data sets for educational level, and education is the best proxy for cognitive competence (see Fig. 1). For $N = 88$ nations economic development was longitudinally analyzed for its dependency on education (years at school), economic freedom and former wealth (data and procedure are similar to Fig. 4 in Rindermann, 2008a, except for using log GDP and for 2000). A detailed data and method description can be found in the Supplementary data file.

In concrete numbers (not logged), one added year of school education raises GDP three decades later by US $1614. In the poorer half of the world, a $1000 higher GDP 1970 has increased school attendance in 2000 by about one and half years, in the richer half by 8 months. A similar result could be found using cognitive competence measures (see Fig. 2; data and procedure are the same as for Fig. 5 in Rindermann, 2008a, except for using log GDP and GDP 2000, last from Penn World Table Version 6.3, and except for the second cognitive competence measure, taken updated from Rindermann, Sailer, & Thompson, 2009). Each IQ point increase in the nineteen sixties has raised wealth in 2000 by US $279. Each $1000 GDP increase in 1970 has increased cognitive competence in 2000 by 0.23 IQ-points.

The effect of one year of education on GDP was larger than the effect of one IQ point. This is not astonishing, as one year at school

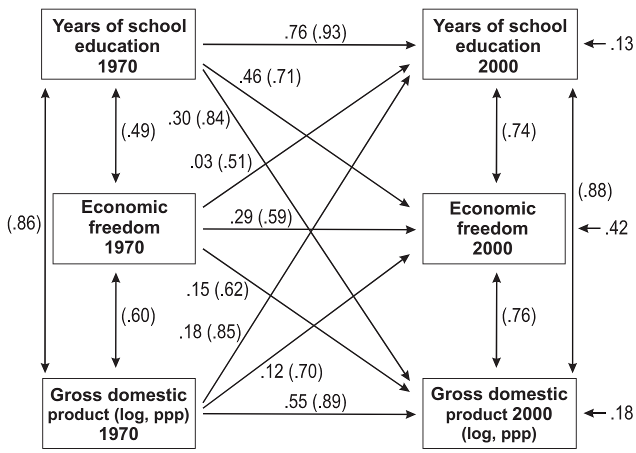

Fig. 1. Longitudinal effects. Standardized path coefficients (and correlations in parentheses) between average schooling years in the total population over age 25, economic freedom and GDP (error terms as unexplained variance on the right; SRMR = .03, CFI = .96), N = 88 nations.

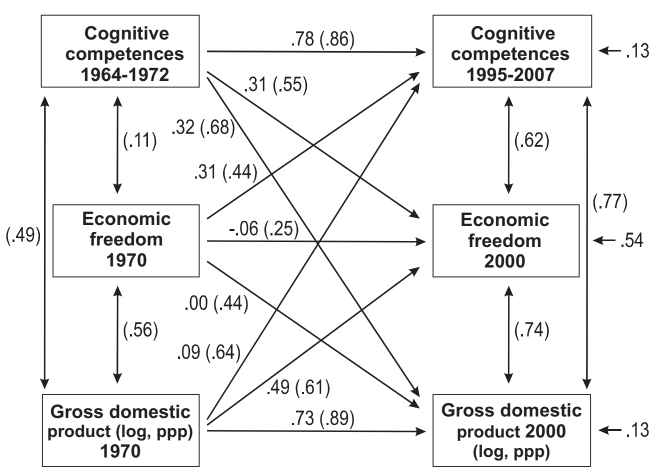

Fig. 2. Longitudinal effects. Standardized path coefficients between cognitive abilities (students' assessment studies from 1964 to 1972 and 1995 to 2007), economic freedom and GDP (SRMR = .03, CFI = .98), N = 17 nations.

corresponds internationally to two IQ points in 1970 or 3.5 IQ points in 2000, an amount similar to results at the individual data level (pure school year effect: 3 IQ points; Winship & Korenman, 1997; 60–80% of the average age increase of 5.6 IQ points, Rindermann, 2011). The 88 nations sample for educational effects also comprises nations at a lower wealth level (mean GDP 2000 US $11,289) than the 17 nations for cognitive competence effects (mean GDP in 2000 US $21,024).

Taken together the results of these analyses and of the older ones (Rindermann, 2008a) show that cognitive competence (measured by tests or education as a proxy) is more important for wealth (mean of 4 coefficients: $\beta = .33$) than vice versa ($\beta = .11$), cognitive competence is more important for wealth development ($\beta = .33$) than economic freedom ($\beta = .12$), and cognitive competence even has a positive effect on the development of economic freedom ($\beta = .39$ vs. wealth on freedom: $\beta = .33$, vs. freedom on competence: $\beta = .15$). There are reciprocal effects between intelligence and GDP ($\beta = .33$ and .11), but the effect of intelligence is stronger. But how could intelligence achieve this? A *theory* is necessary, dealing with behavior of individuals and with performance at the level of institutions, societies and cultures, and backed by results of empirical studies.

4. Development of a theory: Cognitive capitalism

At the *individual data level*, many studies show that intelligence predicts job performance (Schmidt & Hunter, 2004: k = 425 studies, majority from the US, not corrected $r = .28$, corrected $\rho = .53$) and in Europe the findings are similar (Salgado et al., 2003: k = 69 studies, $r = .25$, $\rho = .56$). Especially in complex jobs, cognitive ability predicts performance (Schmidt & Hunter, 2004, complex vs. less: $\rho = .58$ vs. .23; Salgado et al., 2003: $\rho = .64$ vs. .51). This is due to a necessary minimum cognitive level for success in highly complex jobs – smart people can be found in cognitively easier jobs, but hardly unintelligent people are found in complex ones. Some argue that this relationship is due to the filter and signal function of the educational system, allowing only persons with good grades (indirectly high intelligence) to enter universities and the job market for professional jobs. This could be one reason, but more important is the cognitive load in complex jobs and in work more generally (Gottfredson, 2003): more intelligent persons can better cope with difficult cognitive demands, they make fewer errors, they are more innovative and generally more productive. Such an assumption is backed by research: for instance, immigrants are more successful as entrepreneurs and workers in their new country depending on their home country's mean intelligence (Jones & Schneider, 2010; Vinogradov & Kolvereid, 2010). Discipline and conscientiousness are also important in being successful (e.g. Heckman, 2000), and this holds at the level of societies (Rindermann & Ceci, 2009), but cognitive ability is the most important single factor explaining success in complex jobs, which are increasingly part of the global job market.

Such job performance aggregated at the country level is not irrelevant for wealth differences between nations, but genuine national level effects are even more important:

First, *cognitive ability of the political class* is crucial to *governmental competence*. According to Simonton (2006) cognitive ability has an important influence on the performance of US presidents ($r = .33–.56$). Rindermann et al. (2009) showed that cognitively more competent politicians lead longitudinally to increases in the intelligence of nations ($\beta = .21$).

Second, *institutions* benefit from the cognitive ability of their founding fathers and their members working in them, both maintaining and developing institutional quality and functionality. Institutions include government and administration, attorneys and courts, companies and trade, police and military, especially schools and universities. In cross-country-analyses, government effectiveness (Singapore in the lead) correlates with cognitive ability ($r = .61$).

Third, as cognitive development benefits from the intelligence level of one's social environment (Rindermann & Heller, 2005), *intelligence of others* is important for nurturing individuals' intelligence. During youth the intelligence of parents, teachers and classmates is important, in adulthood that of colleagues and neighbors, at the level of society the competence of politicians, entrepreneurs, scientists, and intellectuals.

Fourth, intelligence has an impact on citizens' *political orientations and behavior* (Deary, Batty, & Gale, 2008). Intelligence contributes to a general pattern of *cognitive rationality* including the formation of more reasonable worldviews (Meisenberg, 2004). Thus intelligence of a society has a positive impact on development of *democracy, political liberty and rule of law*, which all again have a positive impact on a nations' wealth (mean of seven cross-lagged path analyses on GDP: $\beta = .20$; Rindermann, 2008b).

Fifth, intelligence and knowledge are important for shaping *culture*: intelligence interacting with education furthers *rational and autonomous thinking* (Piaget, 1947; Oesterdiekhoff & Rindermann, 2007).

However, cognitive ability is not the single determinant of all these outcomes. There are additional factors behind and beneath ability, and between ability and the positive outcomes. And of course, intelligence has no deterministic effect, in the sense that intelligence always leads to the aforementioned results. Intelligence only increases the probability of these outcomes.

One decisive aspect has been ignored up to now: the *cognitive ability level of intellectual classes*. This could be defined by the intelligence level of the brightest 5%, 1% or 1‰ of a country (“level of an intellectual class”; Rindermann & Thompson, 2011) or by the size of a stratum operating above a certain threshold, e.g. from IQ 106, 115, 130 or 145 on (La Griffe du Lion, 2002; Hanushek & Woessmann, 2008). In the past, writers and philosophers have assumed that *technological development* and more generally the *development of a society* benefits from a cognitive elite (e.g. Rand, 1992/1957). Highly able intellectual classes are necessary to *manage growing complexity* in technology, economy and everyday life. Especially in modern times wealth depends mainly on technological progress (Reich, 1991) and this depends on cognitive ability – in particular of the smartest members within a society. Hanushek and Woessmann (2008, table 4) found that the level of “rocket scientists” is more important for growth than the mean level of a society or the percentage of people above a low threshold (around IQ 85). But “rocket scientists” as category would be too narrow because for a functioning society not only exceptional scientists and engineers are necessary, but also “normal” scientists and engineers maintaining daily business, also officials, politicians, teachers, and – as Schumpeter (1939) mentioned – entrepreneurs and their primarily cognitively based abilities of economic process innovations and economically successful use of inventions shifting the conventional ways of production, trade and consumption.

Here it is less the individual’s cognitive competence which is relevant, but more the cognitive competence of social networks, institutions and societies in their interplay (engineers and entrepreneurs, scientists and engineers, politicians and officials, consumers and producers, scientists and editors, universities and companies; e.g. studied as “absorptive capacity”; Cohen & Levinthal, 1990). Cognitive competence increases with use, and becomes the main capital in the modern production process – this position is also held even by traditionally left wing thinkers in the Marxist tradition (Virno, 2001).

The theory, that cognitive ability is crucial – especially the cognitive ability level of an intellectual class – through innovation leading to wealth has been empirically tested several times (Gelade, 2008; Hanushek & Woessmann, 2008; Rindermann et al., 2009), but always with some methodological weaknesses, such as no assessment of cognitive ability of an high ability group or its size (Gelade), no use of mediating variables (Hanushek) or selective and overly small country samples (Hanushek, Rindermann).

Thus we have done a reanalysis using the Hanushek and Woessmann data (student assessment studies from 1964 to 2003, percentage of students with student assessment scores SAS = 400 or higher, equivalent to IQ $\geqslant$ 85, vs. percentage of students with SAS = 600 or higher, equivalent to IQ $\geqslant$ 115) for 77 nations using FIML (full-information-maximum-likelihood, no listwise deletion in the case of missing data). It is assumed that cognitive ability influences scientific-technological excellence (STEM) as indicated by rates in patents, Nobel Prizes, scientists and high tech exports and that it influences economic liberty as indicated by two economic freedom measures and both together increase wealth, indicated by two GDP measures (from 1998 to 2003, per capita, ppp, logged). A detailed data and method description for the intellectual class effect analysis could be found in the Supplementary data file.

In a former analysis with other data and fewer countries (Rindermann et al., 2009, p. 17) the cognitive ability level of an upper ability group was more important for scientific-technological excellence. Here (Fig. 3) the share of an upper ability group (SAS = 600/IQ = 115 or higher) is more relevant than the share of the population above a rather low level (SAS = 400/IQ = 85 or higher), mean of both: $\beta_{U/95}$ = .42 vs. $\beta_{L/50}$ = .34. The effect difference for economic freedom is even larger: β_U = .60 vs. β_L = .01. Wealth depends more on scientific-technological excellence (β = .57) than on economic freedom (β = .40). The message is double: scientific-technological excellence and economic freedom depend more on the size of a smart fraction. Wealth depends more on scientific-technological excellence than on economic freedom. Both results are backed by former studies, by the relevance of the cognitive level of a high ability group for scientific-technological excellence (Rindermann et al., 2009) and by the stronger impact of cognitive ability than of economic freedom on wealth (see Figs. 1 and 2). Economic freedom, the rules and institutions enabling a free

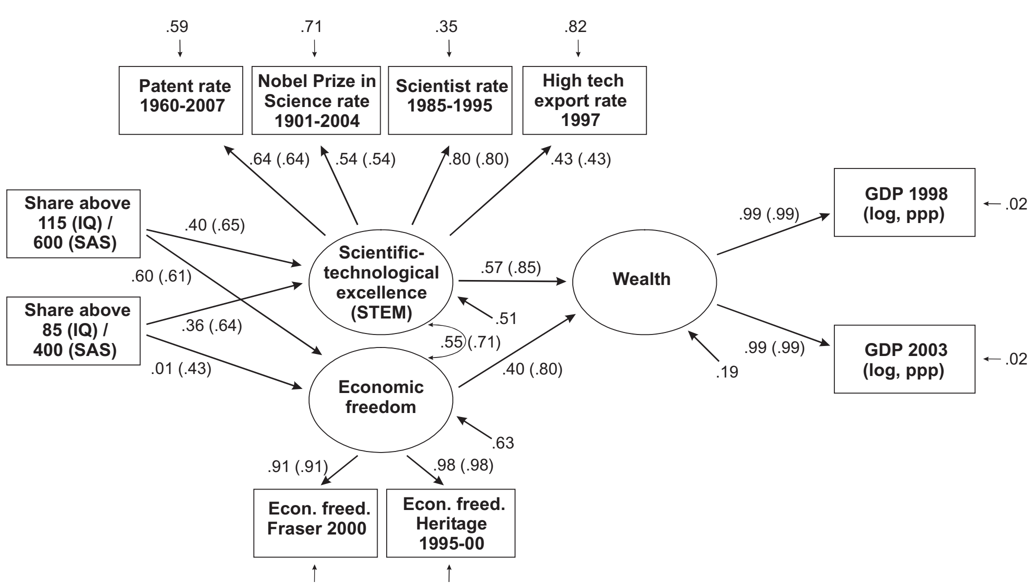

Fig. 3. Intellectual class effect analysis. Effect of different large ability fractions through STEM and economic freedom on wealth (Hanushek and Woessmann data; FIML, CFI = .97, SRMR = .06), *N* = 77 nations.

economy, depends also on an intellectual class. It seems that not only wealth, but even capitalism depends on the size and cognitive level of a high ability group within society. Capitalism in modernity is a cognitive one!

Cognitive capitalism has a fourfold meaning: the cognitive demands of jobs, and more generally of economics and every day life in modernity are growing – *physical work changes to cognitive work*. The modern economy is built up on the cognitive resources of its labor force from all workers to some developers – *wealth is cognitive wealth*. The functionality of capitalist institutions and their development depend on cognitive ability – *institutions are built on intelligence and knowledge*. Wealth in modernity depends largely on technological progress and this progress depends on the ability level of the intellectual class – *wealth becomes high ability wealth*.

5. Future work

Further studies should take a more detailed look at the process of *how cognitive ability works*. It could be shown to have a positive impact through accomplishment in science, technology, engineering and math. It is immediately reasonable that high intelligence, extensive knowledge and the intelligent use of this knowledge are not only necessary, but a prerequisite for high achievement in these cognitive demanding tasks. But how does cognitive ability create economic freedom and even lower the government spending ratio (Rindermann, 2008b)? How does it improve quality and outcomes in institutions? To understand how ability works it is also necessary to have a closer look at its historical development within countries. Cross-sectional designs cannot study backward effects of wealth and economic freedom on ability and STEM. Longitudinal approaches are necessary.

The *double effect of demographic change on innovation* has not been analyzed: an aging society means that in future a smaller fraction of a society will be in its innovative age range. A society in which the well educated and intelligent have few children will have in future (without noteworthy further progress in cognitive-development-furthering environmental conditions) a smaller intellectual class and at a lower cognitive level – independent of genetic or environmental theories of cognitive ability.

Further variables like *government effectiveness*, *quality and speed of bureaucracy*, and *meritoric principles* should be acknowledged in modeling of cognitive ability effects on wealth. On the one hand the top 5% level (equivalent to IQ $\geqslant$ 125) seem to be too low to capture the real "rocket scientists" or pioneering engineers. Thus a *higher threshold* (top 1%, top 1‰, IQ $\geqslant$ 130, 140, 150) would be useful. On the other hand "rocket scientists" and pioneering engineers need colleagues, editors, and contributors. Intellectual classes alone are not sustainable and empirical research (see Fig. 3) has shown the *positive impact of average smart groups* and the mean competence levels on societies' success. All this knowledge could lead into *governmental consulting* to improve the future of nations.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.paid.2011.07.001.

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