Intelligence: A Measure of Human Capital in Nations

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"Human capital" is a key requirement for the establishment and maintenance of effective institutions. It is the ultimate requirement for innovation, efficient use of resources, and economic growth. This contribution describes two measures of cognitive human capital: the average IQ of the population, and the performance of school children on international scholastic assessment tests in mathematics, science, and reading. These two measures are shown to be closely correlated at the country level, and distinct from traditional measures of education. A measure of human capital is described that is derived from IQ and school achievement. Data based on measured IQ and/or school achievement are given for 168 countries and territories, and estimates based on neighboring countries with similar population, culture and economy are provided for 28 additional countries.

Key Words: Intelligence; IQ; TIMSS; PISA; School achievement; Human capital.

Japan is a rich country, and Nigeria is a poor country. There is no lack of explanations for this discrepancy. Some authors have offered geography as an ultimate explanation for economic disparities between countries and world regions (Diamond, 1997; Hibbs & Olsson, 2004; Nordhaus, 2006). Everything else being equal, countries with greater natural resources and greater proximity to world markets should be richer. Nigeria has more natural resources than Japan and is closer to the old industrial centers of Europe. Therefore Nigeria should be richer than Japan.

History and culture fare not much better than geography as

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explanations for macroeconomic trends and developmental disparities. For example, the backwardness of African countries today has been blamed on the trans-Atlantic slave trade of the 18th and early 19th centuries (Nunn, 2008). This, however, begs the question of why Europeans enslaved Africans but Africans did not enslave Europeans.

Economic institutions are a more proximal explanation for worldwide economic disparities. For example, the current poverty of formerly rich countries has been blamed on Europeans who "introduced or maintained already-existing extractive institutions to force the local population to work in mines and plantations" (Acemoglu et al, 2002, p. 1279) during the colonial age. When geography is pitted against institutions as explanation for economic disparities in today's world, institutions are the more immediate predictor (Easterly & Levine, 2003; Rodrik et al, 2002).

Institutions are made by people. Therefore the immediate causes of institutional quality and economic outcomes are to be sought in the physical, cognitive or attitudinal traits of the human actors. According to this view, Japan is rich and Nigeria is poor because the Japanese possess more "human capital" than the Nigerians. The importance of human capital at the country level is supported by the observation of large differences in labor productivity between countries (Hall & Jones, 1999).

Human capital includes both cognitive and non-cognitive resources. Value systems have been stressed by many writers, from Max Weber's (1930) "spirit of capitalism" to Gregory Clark's notion that the industrial revolution was triggered not by new incentives, but by people responding differently to incentives that had been in place for ages (Clark, 2007). There is ample evidence for associations of non-cognitive traits with prosperity and economic growth (e.g., Knack & Keefer, 1997; McCauley et al, 1999), but the direction of causality is difficult to ascertain.

In addition, the measurement of non-cognitive traits is fraught with conceptual and psychometric ambiguities. Perhaps for this reason, cognitive traits have received the greater attention, as is evidenced by the inclusion of measures for literacy, school enrolment and related measures in the Human Development Reports of the United Nations, the World Development Indicators of the World Bank, and similar compilations. Primary school enrolment (Sala-i-Martin et al, 2004), secondary school enrolment (Mankiw et al, 1992), and the average years of schooling of the adult population (Barro & Lee, 1993) have all been proposed or used as measures of human capital. Many authors consider the introduction of mass education an essential condition for economic growth (e.g., Easterlin, 1981).

However, educational degrees and years spent in school are not directly relevant for economic outcomes because they do not guarantee that children have successfully acquired important cognitive or non-cognitive skills. Attained skills, abilities and knowledge are measured more directly in international school achievement tests that assess skills in curricular subjects such as mathematics, science, and/or reading.

Therefore the results of school achievement tests have been proposed as measures of human capital (Lee & Barro, 1997), and they have been used for the country-level prediction of economic growth (Hanushek & Kimko, 2000; Hanushek & Wößmann, 2007, 2009; Rindermann, 2008a), democracy and rule of law (Rindermann, 2008b) and the spread of AIDS (Rindermann & Meisenberg, 2009). In an extension of this approach, national differences in the high reaches of the ability distribution have been implicated as especially important for economic wealth, patents, democracy, and rule of law (Rindermann et al, 2009).

Intelligence tests ("IQ tests") provide an alternative measure of cognitive skills. Data quality varies widely. In many countries, major intelligence tests have been standardized with representative population samples. In other cases, IQ tests have been applied to convenience samples that may or may not be representative of the general population. The results of these studies have been surveyed in Lynn & Vanhanen (2002, 2006) and Lynn (2006). IQ was found to be a reasonably close correlate of GDP (Lynn & Vanhanen, 2002) and several other economic outcomes (Lynn & Vanhanen, 2006). Also at the level of population groups within countries, higher IQ is related to more education, greater prosperity, less criminal involvement, and reduced fertility (Lynn, 2008a).

IQ and school achievement are closely related. At the individual level within countries, correlations between IQ tests and school achievement tests are typically between 0.5 and 0.7 (Jencks, 1972; Jensen, 1998; Mackintosh, 1998), but can be as high as 0.8 (Deary et al, 2006). At the country level, correlations between the results of IQ tests and scholastic assessments are in the vicinity of 0.9 (Lynn & Mikk, 2007; Lynn et al., 2007; Lynn & Meisenberg, 2010). Therefore the two types of test appear to measure identical or closely related constructs.

The study of cognitive differences between countries is a rapidly developing field. The present paper updates the country-level data for IQ and school achievement. It further investigates the relationship between these two cognitive measures, and compares the correlates of IQ with those of school achievement. We finally integrate both types of data into a composite measure of human capital for 168 countries, and demonstrate some economic, political and cultural correlates of this measure. Thus we provide an overview of the range of country-level traits that appear to be related more closely to intelligence than to per-capita GDP and other conditions.

Methods and Data Sources

1. International school assessments

General strategy

The most important international school assessment studies are TIMSS (Trends in International Mathematics and Science Study) and PISA (Program for International Student Assessment). TIMSS assessments of 8^{th} graders in mathematics and science were conducted 1995, 1999, 2003 and 2007, and PISA assessments of 13-year-olds were done 2000, 2003, 2006 and 2009. 74 countries participated in at least one TIMSS assessment, and 18 participated in all four. 65 countries participated in at least one PISA assessment, and 30 participated in all four. 47 countries have data for both TIMSS and PISA, and 92 have data for either TIMSS or PISA or both.

Several other international student assessments have been performed, some dating back to the 1970s. More recently, regional scholastic assessments have been performed in the less developed countries of Latin America and Africa. Together with TIMSS and PISA, these additional sources provide quantitative data for 131 countries.

Because TIMSS and PISA appear to be the most reliable assessments, and because adult intelligence is expected to be more closely related to cognitive ability at age 13 or 14 than at younger ages, we adopted the strategy of calculating the average of PISA and 8th-grade TIMSS scores for those countries participating in at least one assessment. Missing data were extrapolated into this data set from the other assessments, producing a total of 131 countries with information about scholastic achievement.

TIMSS and PISA

TIMSS is organized by the IEA (International Association for the Evaluation of Educational Achievement), and assessments are performed in a 4-year cycle. Tests of mathematics and science are administered in grades 4 and 8, with a larger number of countries participating in grade 8 than in grade 4. The results are publicly available at:

http://timss.bc.edu/timss2003.html, and:

http://nces.ed.gov/timss/tables07.asp. Further information is available in Gonzalez et al (2004), Martin et al (2004, 2008), and Mullis et al (2004, 2008).

PISA is organized by the OECD in a 3-year cycle. Children aged 13 are tested in mathematics, science and reading. The results are available at:

http://www.oecd.org/dataoecd/30/18/39703566.pdf,

http://nces.ed.gov/pubs2002/2002116.pdf, and:

http://pisacountry.acer.edu.au/.

Both TIMSS and PISA are graded with methods based on item response theory, which models student proficiency as a latent variable. In both assessments the results are published separately for each tested subject and are reported on a 500/100 scale. In TIMSS the mean score of 500 is the average of the countries participating in the first TIMSS assessment in 1995, and in PISA it is the average of the participating OECD countries. The individual-level, within-country standard deviation is about 85 in TIMSS and 95 in PISA.

Within each assessment the scores of the different subjects were highly correlated at the country level, as expected from the results of earlier studies (Rindermann, 2006, 2007). They were averaged separately for each of the four TIMSS and four PISA assessments. Minor trend adjustments were made based on the countries participating in TIMSS 2007 and PISA 2009, respectively. For example, 27 countries participated both in TIMSS 1995 and TIMSS 2007. Mean and standard deviation of these 27 countries in TIMSS 1995 were adjusted to the same mean and standard deviation that these countries had in TIMSS 2007, and all other countries in TIMSS 1995 were adjusted accordingly. The averaged TIMSS scores and the averaged PISA scores were brought to the same mean and standard deviation of 500 ± 50 for those 47 countries that participated in at least one TIMSS and one PISA assessment. These adjusted scores were averaged based on the number of assessments in which each country participated. Regressions in which the score was predicted by IQ and age at testing (which varied slightly among countries) showed no consistent age-effect in either TIMSS or PISA.

These scores are somewhat biased measures for the average cognitive ability in the country because they measure only the proficiency of children who are still in school in grade 8 (TIMSS) or at age 13 (PISA). Therefore the proportion of children still in school in grade 8 or at age 13 was estimated from the Barro-Lee data set for years of schooling obtained from:

http://www.barrolee.com/data/dataexp.htm. The TIMSS and PISA scores were adjusted assuming that those not in school would score 40 points (about 7 IQ points) lower than those in school.

Other assessments scored with methods of item response theory

Several assessments other than TIMSS and PISA were graded with modern methods of item response theory and published on a 500/100 scale. Those used for the extrapolation of data points missing in the original TIMSS/PISA data set were:

TIMSS 2007, 4th grade included Yemen, which did not participate in any of the PISA and 8th-grade TIMSS assessments.

PIRLS Reading, 2001 was organized by the IEA to assess reading literacy of 4th-graders. 34 countries participated. Data are available at http://nces.ed.gov/surveys/pirls/. This study provides data for Belize.

IAE Reading 1991 assessed reading literacy of 9 and 14 year olds in 30 countries. The results are published in Elley (1992). This assessment provided data for Venezuela at age 9 and 14, and Nigeria and Zimbabwe at age 14.

The raw scores were adjusted for age at testing in those assessments that showed non-trivial age effects. This was followed by adjustment for the approximate proportion in school at the age/grade of testing. To make the scores numerically equivalent to the TIMSS/PISA scale, the mean and standard deviation for each assessment were equalized with those of the TIMSS/PISA score for the countries participating in both kinds of assessment.

Older studies

Some older scholastic assessments are available for which the results were published as "percent correct" scores:

IAEP Mathematics 1990/91 assessed mathematics in 13-year-olds. 19 countries participated, of which Mozambique did not participate in TIMSS or PISA. Results are published in Lapointe (1992).

The *Second International Science Study 1983/84* tested children from 23 countries at age 14 and from 17 countries at age 10. The age 10 test provided data for Nigeria, and the age 14 test for Nigeria, Papua New Guinea and Zimbabwe. The results are published in Keeves, 1992.

The *Second International Mathematics Study 1981* was organized by the IEA to assess mathematics in 13-year-olds. 17 countries participated, including Nigeria and Swaziland. The raw scores are published in Medrich & Griffith (1992).

The results of these assessments show nonlinear relationships with IQ and TIMSS-PISA score, and therefore nonlinear model fitting was employed after adjustments for age (if applicable) and proportion in school had been made.

Regional assessments

The *SACMEQ* (Southern and Eastern Africa Consortium for Monitoring Educational Quality) assessments of 2000/01 and 2007 tested mathematics and reading of 6th graders in the countries of South and East Africa. The results are available at http://www.sacmeq.org/indicators.htm and:

http://www.sacmeq.org/downloads/sacmeqIII/WD01_SACMEQ_III_Results_Pupil_Achievement.pdf. The math-reading average was used for each assessment, and adjustments were made for the proportion of children in school in grade 6. Correlations with IQ were .570 with SACMEQ II (p = .067) and .722 with SACMEQ III (p = .012) for the 11 countries having both measures. SACMEQ provides data for Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, Swaziland, Tanzania, Uganda, Zambia, Zanzibar and Zimbabwe. Results are published on a 500/100 scale.

Only two of the countries in SACMEQ (Botswana, South Africa) participated also in TIMSS, and none in PISA. For these two countries, the SACMEQ scores were 177.1 points (SACMEQ II) and 184.5 points (SACMEQ IIII) higher than the TIMSS/PISA scores (weighted by the number of times they participated in TIMSS). SACMEQ scores for all participating countries were adjusted accordingly, without changing the standard deviation.

The *PASEC* (Programme d'Analyse des Systèmes Éducatifs de la CONFEMEN) assessments for Francophone African countries (Conference des Ministres, 2008) include 11 countries, none of whom have participated in TIMSS or PISA. French and mathematics were tested in 5th grade, but only the math scores were used because of large differences between countries in the proportion of children speaking French at home. Only 5 of the countries have an IQ score, and the PASEC-IQ correlation is a non-significant .254. For scaling, the means and standard deviations of the PASEC math scores were brought to the same mean and standard deviation with IQ for the 5 countries having both measures, followed by rescaling from the 100/15 IQ metric to the 500/100 school assessment metric and adjustment for the proportion of children still in school at 5th grade. This study provides data for Benin, Burkina Faso, Burundi, Cameroon, Chad, Comoros, Congo (B), Cote d'Ivoire, Gabon, Madagascar and Senegal.

The 1999 *MLA* (Monitoring Learning Achievement) assessments of UNESCO/UNICEF assessed reading/writing, mathematics and life skills in 4th grade. Results are reported for 11 African countries in Chinapah et al (2000). 3 of these countries (Botswana, Morocco, Tunisia) had participated in TIMSS and/or PISA. Correlations with IQ were .006 for life skills, .767 for literacy (p = .010) and .639 for numeracy (p = .047) for the 10 countries having both kinds of measure. Consequently, a composite of literacy and numeracy was used as the measure of school achievement. This composite was scaled to the 500/100 metric. For those 9 countries in MLA that also had school achievement data from other sources, the standard deviation of the MLA measure was adjusted to the standard deviation of the other measures. This measure was adjusted for the proportion of children in school in grade 4, and finally adjusted to the TIMSS/PISA mean for the 3 countries with scores from TIMSS and/or PISA. MLA provides data for Madagascar, Malawi, Mali, Mauritius, Niger, Senegal, Uganda and Zambia.

SERCE (Second Regional Comparative and Explanatory Study) was performed in 16 Latin American countries between 2002 and 2008. Children in grades 3 and 6 were tested in mathematics and reading. Results are published on a 500/100 scale (Valdés et al, 2008). The average of the 6th grade mathematics and reading scores was used. This measure was adjusted for the proportion of children in school. The final measure was created by adjusting the SERCE scores to the mean and standard deviation of the TIMSS/PISA scores for the 9 countries having both measures. The SERCE scores correlate at r = .965 (p<.001) with TIMSS-PISA (N = 9) and r = .442 (p = .131) with IQ (N = 13). They provide data for Costa Rica, Cuba, the Dominican Republic, Ecuador, Guatemala, Nicaragua and Paraguay.

Additional sources

The only school achievement data for India are from the First International Science Study in 1970 (Comber & Keeves, 1973), and a recent study with a subset of the 2007 TIMSS study in the states of Rajasthan and Orissa (Das & Zajonc, 2010). The school achievement score of India was averaged from these two sources.

2. IQ

Compilations of national IQs have been published by Lynn (2006) and Lynn & Vanhanen (2002, 2006). The current data set is based on Lynn & Vanhanen (2006), with amendments and additions published in Lynn (2010). Measured IQs are available for 136 countries. The IQ for Northern Ireland is taken from Lynn (1979).

3. Estimates of data quality

The quality of the IQ data was defined based on the number of independent studies available for each country and the total sample size in all studies combined. The following scores were given for total sample size:

1	<200
2	200-500
3	500-999
4	1000-1999
5	2000-4999
6	5000-9999
7	>10,000

The IQ quality score was calculated by adding this score to the number of independent IQ studies available for the country, with the maximum capped at 25.

For school achievement, countries were awarded 2 points for each PISA or 8th-grade TIMSS study in which they participated. Those that did not participate in PISA or 8th-grade TIMSS were awarded 1 point for each of the other assessments in which they participated. The maximum score was 16 for countries participating in all four PISA and all four TIMSS studies.

4. Properties of IQ and school achievement compared.

The correlation between IQ and school achievement is .889 for the 99 countries having both measures, and both have virtually the same correlates (Table 1). However, the relationship between the within-country and between-country standard deviations is different. For IQ, the within-country standard deviation is 15 by definition, at least for Britain. For school achievement, the individual-level standard deviation in TIMSS is set at 100 for those countries that participated in the 1995 assessment, and in PISA it is 100 for the participating OECD countries. Within-country standard deviations in Britain and other advanced nations are approximately 85 in TIMSS and 95 in PISA, and these standard deviations are not changed substantially during the scaling procedure. Therefore school achievement was scaled directly to the IQ metric, assigning a score of 100 to Britain and assuming a within-country standard deviation of 90 for school achievement:

$$\text{SA absolute} = (\text{SchAch} - 521.9) \times 15/90 + 100$$

The between-country standard deviation is 38.6% higher for this measure of school achievement (*SA absolute* in the appendix) than for IQ: 15.18 versus 10.95 (N = 99). The discrepancy is best attributed to the generally low quality of schooling in low-scoring countries, which depresses school achievement to a greater extent than IQ. In this sense, school achievement is more "culturally biased" than IQ.

5. Calculation of a measure of "human capital."

For construction of a combined measure of (cognitive) human capital, school achievement was not scaled directly to the IQ metric. We instead adjusted the international mean and standard deviation for school achievement to those of IQ, based on the 99 countries having both measures (*SA relative* in the appendix). The resulting scores were averaged with weighting for data quality. For countries having only IQ data or only school achievement data, these scores were used (*Human capital* in the appendix).

In all there are 101 countries and territories (including England

and Scotland in addition to the United Kingdom) whose human capital score is based on school achievement and IQ. For 37 countries it is based on IQ alone, and for 30 on school achievement alone. Scores for 28 additional countries and territories were estimated from the scores of neighboring countries with similar population, culture, and economic development, as described for IQ in Lynn & Vanhanen (2002, 2006). Provincial data were used in two cases: The estimate for Afghanistan was derived from the measured IQ in the Northwest Frontier Province of Pakistan (Ahmad et al., 2008), which is inhabited by ethnic Pashtuns living under conditions similar to Pashtuns in Afghanistan; and the estimate for Bhutan was the average of Nepal, India and Tibet (Lynn, 2008b). Estimates are included in the last column of the appendix as numbers in parentheses.

6. Other country-level measures

lgGDP is the logarithm of gross domestic product adjusted for purchasing power, averaged for the years 1995-2005. Data are from the Penn World Tables (Heston et al., 2009). Missing data were extrapolated into this data set from the World Development Indicators of the World Bank. The logarithmic transformation was used because of the highly skewed nature of GDP worldwide, which approximates to a normal distribution in the logarithmic form.

Education measures length of schooling for adults 25+ years old, based on the Barro-Lee data set for 143 countries (http://www.barrolee.com/data/dataexp.htm). Missing data points were extrapolated from World Bank and United Nations sources.

No Corruption was averaged from Transparency International's Corruption Perception Index for the years 1998-2003 (http://www.transparency.org) and the "no corruption" index from the Governance Indicators of the World Bank for 1996 or earliest available date:

(http://info.worldbank.org/governance/wgi/mc_countries.asp).

Economic Freedom was averaged from the unrotated first factors of maximum-likelihood factor analyses of areas 2-5 of the Fraser Institute's Economic Freedom Index for the periods 1995-2005 (Gwartney et al., 2010), and domains 1, 2, and 5-8 of the Heritage

Foundation Index for 1995-2005 (http://www.heritage.org/research/). This measure indexes the extent of business regulation and red tape.

Big Government is calculated from area 1 of the Fraser Institute's Economic Freedom Index for the periods 1995-2005 (size of government), and domains 3 and 4 of the Heritage Foundation Index for 1995-2005 (fiscal freedom and government spending). These measures are factorially and conceptually different from the other components of the Fraser Institute and Heritage Foundation indices for "economic freedom."

Gini index: The primary data source is the World Income Inequality Database (WIID2a) of the United Nations University at www.wider.unu.edu/wiid/wiid.htm, as described in Meisenberg, 2007. Missing data points were extrapolated from the World Bank's World Development Indicators of 2005, the Human Development Report 2005 (United Nations, 2005), and the CIA's World Factbook of 2009.

Political freedom is the average of political rights + civil liberties from Freedom House at:

http://www.freedomhouse.org/research/freeworld, average 1985-2005.

Democracy is defined as Vanhanen's democracy index (average 1985-2004), from the Finnish Social Science Data Archive at:

http://www.fsd.uta.fi/english/data/catalogue/FSD1289/.

Suicide is the average of the standardized male and female suicide rates, average of available years since 1985, reported by the World Health Organization at:

http://www.who.int/mental_health/prevention/suicide/country_reports/en/index.html.

Life expectancy is life expectancy at birth for the years 2000-2005, as reported in the 2005 Human Development Report (United Nations, 2005).

Infant mortality is from the 2004 Human Development Report (United Nations, 2004).

TFR is the Total Fertility Rate, averaged for the years 1990 to 2005, from the World Development Indicators of the World Bank.

Religiosity is the average of three measures: (1) the average of four questionnaire items about belief in God and emotional involvement with religion from the World Values Survey, 1981-2008 combined data file v.20090901, 2009, available at www.worldvaluessurvey.org; (2) A question about the importance of religion from the Gallup World Poll:

(https://worldview.gallup.com/signin/login.aspx?ReturnUrl=%2f), accessed February 10, 2011; and (3) reverse scored atheism rate according to Zuckerman (2005). Missing data points were extrapolated from the available measure(s).

Table 1. Correlations of human capital measures with some other country-level variables. Human capital (HC) is the composite of IQ and school achievement. N, number of countries; *, $p<0.05$; **, $p<0.01$; $_{NS}$, non-significant. All other correlations are significant at $p<0.001$.

	IQ	SA	HC	Education	lgGDP	N
School achievement (SA)	0.889	1				99
Human capital (HC)	0.981	0.949	1			99
Education	0.757	0.747	0.774	1		99
lgGDP 1995-2005	0.745	0.717	0.759	0.711	1	99
Econ. Growth 1985-2009	0.426	0.467	0.451	0.108_{NS}	0.215_{NS}	82
Corruption 1996-2003	-0.599	-0.576	-0.606	-0.582	-0.751	99
Econ. Freedom 1995-2005	0.635	0.607	0.648	0.621	0.761	98
Big Government 1995-2005	0.258*	0.359	0.299**	0.378	0.248*	98
Gini index	-0.614	-0.638	-0.646	-0.489	-0.468	87
Democracy 1985-2005	0.684	0.611	0.667	0.675	0.609	95
Pol. Freedom 1985-2005	0.557	0.464	0.544	0.593	0.526	97
Suicide	0.557	0.595	0.598	0.498	0.241*	68
Life Exp. 2000-2005	0.838	0.761	0.833	0.648	0.782	98
Infant Mortality 2002	-0.834	-0.777	0.838	-0.755	-0.837	99
TFR 1995-2005	-0.839	-0.837	-0.862	-0.774	-0.754	99
Religiosity 1981-2008	-0.779	-0.788	-0.797	-0.739	-0.586	97
Happiness	-0.047_{NS}	-0.058_{NS}	-0.067_{NS}	-0.120_{NS}	0.214_{NS}	73
Life satisfaction	0.576	0.503	0.568	0.471	0.753	96

Happiness is a question in the World Values survey (*Are you happy?*).

Life satisfaction is averaged from a question about overall life satisfaction in the World Values Survey, and a question about the best possible life (Cantrill ladder) in the Gallup World Poll, 2006-2009 average. These two measures correlate at $r = .830$.

Properties of the measures

Table 1 shows the correlations of alternative human capital measures and of log-transformed GDP with a number of country-level variables. A number of observations can be made:

1. All "development indicators," including log-transformed GDP, education, school achievement, intelligence, freedom and democracy, form a positive manifold. However, the correlations between school achievement and IQ are higher than any of the other correlations in the table. This high correlation justifies the averaging of these two cognitive measures into a single measure of (cognitive) human capital, or intelligence.

2. The correlates of IQ and school achievement are very similar. In addition to their high intercorrelation, this observation provides further justification for averaging of these two measures into a combined measure of cognitive human capital, or intelligence.

3. The cognitive measures are nearly as highly correlated with lgGDP as with education (measured as years in school). This shows that the cognitive outcomes are more than the predictable outcomes of prolonged schooling.

4. Economic growth is related more closely to the cognitive measures than to education. This suggests a causal role of intelligence for economic growth, confirming earlier reports about such a relationship (Hanushek & Wößmann, 2007, 2009; Jones & Schneider, 2006; Meisenberg, in press; Weede, 2004; Weede & Kämpf, 2002).

5. In addition to economic growth, variables that are related more closely to intelligence than to length of schooling and lgGDP include the Gini index of income inequality, suicide, life expectancy, total

fertility rate, and religiosity. Other outcomes, however, including corruption, economic freedom and life satisfaction, are related more closely to education and/or lgGDP than to intelligence.

Tables 2 and 3 show the results of regression models in which various outcomes are predicted by the combined measure of human capital (average of IQ and school achievement, without estimates), schooling, log-transformed GDP, and a dummy variable for countries with communist history. Because small countries are more likely than larger ones to be atypical in many ways, the regressions were limited to countries with a population of more than 250,000.

The results of Tables 2 and 3 confirm that some outcomes are related more closely to intelligence than to schooling or lgGDP. These include economic growth (positive), Gini index (negative), suicide (positive), life expectancy (positive), and religiosity (negative). In this larger sample, the total fertility rate is predicted to similar extents by intelligence, schooling, and lgGDP.

Other variables are related more closely to education or lgGDP than to intelligence. They are likely to correlate with intelligence mainly because intelligence correlates highly with education and lgGDP. Length of schooling (in addition to communist history) appears to be the most important predictor of democracy, economic freedom and political freedom. Outcomes that clearly are related most closely to lgGDP (in addition to communist history) rather than intelligence are corruption and life satisfaction.

Table 2: Regression models predicting economic and political outcomes with human capital, schooling, log-transformed GDP, and history of communist rule. * <.05; **. <.01; ***, <.001.

Predictor	Growth	Corruption	Economic freedom	Big govt.	Gini index	Democracy	Political Freedom
Human capital	0.659***	-0.228*	0.181*	0.124	-0.566***	0.411***	0.126
Schooling	-0.445**	-0.239*	0.405***	0.087	0.142	0.608***	0.702***
lgGDP	0.163	-0.378***	0.319**	0.076	-0.073	-0.118	-0.060
Communism	0.214*	0.345***	-0.376***	0.104	-0.191	-0.402***	-0.353***
N	124	150	145	145	129	143	147
Adj. R^2	0.324	0.606	0.684	0.068	0.339	0.625	0.482

Table 3. Regression models predicting quality of life measures with human capital, schooling, log-transformed GDP, and history of communist rule. * <.05; **. <.01; ***, <.001.

Predictor	Suicide	Life Expectancy	Infant mortality	TFR	Religious	Happy	Satisfied
Human capital	0.387**	0.471***	-0.327***	-0.289***	-0.506***	-0.156	0.186
Schooling	0.160	0.042	-0.248**	-0.238***	-0.265**	-0.019	0.069
lgGDP	-0.053	0.396***	-0.383***	-0.392***	-0.012	0.339	0.556***
Communism	0.298*	-0.007	0.003	-0.218***	-0.174**	-0.570***	-0.255***
N	89	147	150	150	140	93	138
Adj. R^2	0.345	0.704	0.763	0.823	0.656	0.458	0.601

Proposed uses of human capital measures

Country-level data on school achievement and IQ can be used for a number of purposes:

1. Studies of educational quality. Although our measure of schooling is about equally related to IQ and school achievement, prolonged, intensified, or more efficient schooling is expected to raise school achievement to a greater extent than it raises IQ. Therefore the difference between school achievement and IQ can be used as a measure for the quality of the educational system. However, these studies need to take account of the fact that the between-country standard deviation, relative to within-country standard deviations, is greater for school achievement than for IQ. Because this difference is best attributed to systematic differences in schooling quality between high-scoring and low-scoring countries, the comparison between school achievement and IQ should be based on school achievement scaled directly to the IQ metric (*SA absolute* in the appendix).

2. Studies of economic outcomes. Earlier studies have shown that high scores on cognitive measures predict faster economic growth (Hanushek & Kimko, 2000; Hanushek & Wößmann, 2007, 2009; Jones and Schneider 2006; Rindermann, 2008a; Weede 2004; Weede and Kämpf, 2002) and lower levels of income inequality (Meisenberg, 2007, 2008, in press). These results are confirmed by the correlations and regression coefficients in Tables 1 and 2. Presumably, high intelligence promotes economic growth because technical skills and "managerial capital" (Bruhn et al., 2010) are required for economic growth. The reasons for the relationship of high intelligence with low income inequality are uncertain. Possibly, high-IQ societies are more efficient at restraining the exploitation of the poor by the rich or at redistributing resources from the rich to the poor. Another possibility is that high average intelligence in the population reduces income inequality by market forces. Where cognitive skills are abundant, the skill premium is expected to be low; and where highly skilled individuals are rare, the skill premium is expected to be high.

3. Studies of cultural traits. Tables 1 and 3 show that high cognitive ability is associated with lower religiosity. Conversely, happiness and life satisfaction rise with rising prosperity, not with rising intelligence, confirming earlier results that had been obtained with less complete data (Meisenberg, 2004). The suicide rate is increased by high intelligence, confirming earlier work (Voracek, 2005). The ways in which cognitive ability interacts with these cultural and psychological traits remain to be determined.

4. Studies of the determinants of human capital. There is no generally accepted theory to explain why, for example, the level of human capital (a.k.a. intelligence) is so much higher in Japan than in Nigeria. Genetic theories have been proposed by some (e.g., Lynn, 2006). These theories have been attacked by others (e.g., Wicherts et al., 2010), but without convincing alternative explanations. Precise knowledge about the current level of intelligence in different countries is required for these investigations.

5. Studies of temporal trends. Measured intelligence has been rising through most of the 20th century in advanced industrialized societies (Flynn, 1987). It seems to be stagnating in advanced societies today (Cotton et al., 2005; Shayer & Ginsburg, 2009; Sundet et al., 2004; Teasdale & Owen, 2008), but is rising in at least some of the less developed countries (Batterjee, in press; Colom et al., 2006; Khaleefa et al., 2009; Meisenberg et al., 2006). At this time, only the periodic scholastic assessment tests, including PISA and TIMSS, are sufficiently accurate to allow close tracking of cognitive skills for a substantial number of countries on a time scale of about one decade. Together with standardization studies of major IQ tests, these can be used to study both the determinants of trends in cognitive ability, and their consequences.

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Appendix

Measures of human capital by country:
SchAch, school achievement on the 500/100 scale.
SA absolute, SchAch scaled to a mean of 100 and within-country standard deviation of 15 for the United Kingdom, assuming a within-country standard deviation of 90 for SchAch.
SA relative, SchAch scaled to the IQ metric by equalizing mean and standard deviation with IQ.
SAq and *IQq*, quality of data for school achievement and IQ.
Human capital, weighted average of SA relative and IQ. Estimates are in parentheses.

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Afghanistan							(75.0)
Albania	390.7	78.1	82.9	2			82.9
Algeria	389.9	78.0	82.8	2			82.8
Andorra							(97.2)
Angola							(69.9)
Argentina	400.6	79.8	84.1	4	96.0	9	92.3
Armenia	487.7	94.3	94.5	4	92.0	3	93.5
Australia	532.5	101.8	99.9	16	98.0	10	99.2
Austria	521.0	99.9	98.5	10	99.5	4	98.8
Azerbaijan	406.6	80.8	84.8	4			84.8
Bahamas							(84.0)
Bahrain	432.0	85.0	87.8	4	81.0	2	85.6
Bangladesh					81.0	4	81.0
Barbados					80.0	2	80.0
Belarus							(95.1)
Belgium	526.9	100.8	99.3	14	99.0	7	99.2

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Belize	339.0	69.5	76.7	1			76.7
Benin	264.1	57.0	67.7	1			67.7
Bermuda					90.0	4	90.0
Bhutan							(84.2)
Bolivia					87.0	6	87.0
Bosnia	464.6	90.4	91.8	2	94.0	4	93.3
Botswana	369.7	74.6	80.4	4	72.15	2	77.2
Brazil	403.4	80.2	84.4	8	87.0	13	86.0
Brunei							(88.9)
Bulgaria	480.4	93.1	93.7	12	92.5	6	93.3
Burkina Faso	292.2	61.7	71.0	1			71.0
Burundi	325.7	67.3	75.1	1			75.1
Cambodia							(92.0)
Cameroon	339.4	69.6	76.7	1	64.0	2	68.2
Canada	538.0	102.7	100.6	16	100.0	6	100.4
Cape Verde							(76.0)
Centr. Afr. R.					64.0	5	64.0
Chad	259.3	56.2	67.1	1			67.1
Chile	431.4	84.9	87.8	8	91.0	9	89.5
China	605.6	113.9	108.7	2	105.5	16	105.9
Hong Kong	559.3	106.2	103.1	14	108.0	16	105.7
Macau	532.5	101.8	99.9	6			99.9
Tibet					92.0	2	92.0
Colombia	395.5	78.9	83.5	8	83.5	7	83.5
Comoros	288.3	61.1	70.6	1			70.6
Congo (B.)	288.0	61.0	70.5	1	73.0	7	72.7

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Congo (K.)					68.0	8	68.0
Cook Islands					89.0	2	89.0
Costa Rica	444.9	87.2	89.4	1	86.0		89.4
Cote d'Ivoire	230.9	51.5	63.7	1	71.0	2	68.6
Croatia	489.5	94.6	94.8	4	99.0	7	97.5
Cuba	500.1	96.4	96.0	1	85.0	5	86.8
Cyprus	462.8	90.2	91.5	8			91.5
Czech Rep.	526.8	100.8	99.2	14	98.0	7	98.8
Denmark	508.5	97.8	97.0	10	98.0	5	97.4
Djibouti							(74.8)
Dominica					73.0	5	73.0
Dominican R.	315.4	65.6	73.8	1	82.0	6	80.8
East Timor							(85.4)
Ecuador	349.8	71.3	78.0	1	88.0	5	86.3
Egypt	407.0	80.8	84.8	4	81.0	5	82.7
El Salvador	357.7	72.6	78.9	2			78.9
Equ. Guinea							(72.3)
Eritrea					75.5	4	75.5
Estonia	539.0	102.8	100.7	6	99.0	7	99.8
Ethiopia					68.5	8	68.5
Fiji					85.0	3	85.0
Finland	555.6	105.6	102.7	10	97.0	5	100.8
France	516.1	99.0	98.0	10	98.0	9	98.0
Gabon	338.8	69.5	76.6	1			76.6
Gambia					62.0	4	62.0
Georgia	420.5	83.1	86.5	2			86.5

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Germany	516.1	99.0	98.0	10	99.0	16	98.6
Ghana	293.1	61.9	71.1	4	70.0	6	70.5
Greece	484.7	93.8	94.2	10	92.0	10	93.1
Guatemala	340.2	69.7	76.8	1	79.0	3	78.5
Guinea					66.5	6	66.5
Guinea-Bissao							(66.5)
Guyana							(86.0)
Haiti							(70.0)
Honduras					81.0	6	81.0
Hungary	525.2	100.6	99.0	16	96.5	8	98.2
Iceland	511.2	98.2	97.4	10	101.0	4	98.4
India	434.1	85.4	88.1	2	82.0	19	82.6
Indonesia	408.9	81.2	85.1	12	87.0	8	85.8
Iran	433.3	85.2	88.0	8	83.5	9	85.6
Iraq					87.0	6	87.0
Ireland	523.2	100.2	98.8	10	92.5	10	95.7
Israel	480.8	93.2	93.7	12	95.0	14	94.4
Italy	492.3	95.1	95.1	16	97.0	13	95.9
Jamaica					71.0	12	71.0
Japan	558.7	106.1	103.1	16	105.0	20	104.1
Jordan	438.6	86.1	88.6	10	84.0	7	86.7
Kazakhstan	406.3	80.7	84.7	2			84.7
Kenya	371.5	74.9	80.6	2	74.0	11	75.0
S. Korea	567.4	107.6	104.1	16	106.0	9	104.8
Kuwait	387.8	77.7	82.5	4	86.5	9	85.3
Kyrgyztan	320.4	66.4	74.4	4			74.4

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Laos					89.0	2	89.0
Latvia	500.3	96.4	96.1	14			96.1
Lebanon	425.8	84.0	87.1	4	82.0	4	84.6
Lesotho	273.2	58.5	68.7	2			68.7
Liberia							(66.4)
Libya					84.6	8	84.6
Liechtenstein	536.1	102.4	100.4	8			100.4
Lithuania	497.0	95.8	95.7	12	92.0	5	94.6
Luxembourg	494.0	95.4	95.3	8			95.3
Macedonia	453.7	88.6	90.5	4			90.5
Madagascar	322.3	66.7	74.7	2	82.0	2	78.3
Malawi	232.1	51.7	63.8	3	60.0	3	61.9
Malaysia	499.6	96.3	96.0	6	88.5	7	92.0
Maldives							81.0
Mali	270.8	58.2	68.5	1	69.5	8	69.4
Malta	477.7	92.6	93.3	2	97.0	2	95.2
Mariana Isl.					81.0	2	81.0
Marshall Isl.					84.0	3	84.0
Mauritania							74.1
Mauritius	388.1	77.7	82.6	3	89.0	5	86.6
Mexico	428.9	84.5	87.5	8	88.0	8	87.7
Micronesia							(84.0)
Moldova	470.8	91.5	92.5	4			92.5
Mongolia					100.0	6	100.0
Montenegro	415.0	82.2	85.8	4			85.8
Morocco	367.6	74.3	80.1	6	84.0	9	82.4

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Mozambique	322.9	66.8	74.7	3	64.0	2	70.4
Myanmar							(86.7)
Namibia	272.8	58.5	68.7	2	72.0	2	70.4
Nepal					78.0	4	78.0
Netherlands	539.2	102.9	100.7	12	100.0	10	100.4
Neth. Antilles					87.0	2	87.0
New Caledonia					85.0	2	85.0
New Zealand	528.5	101.1	99.4	14	99.0	11	99.3
Nicaragua	357.2	72.5	78.8	1			78.8
Niger	209.2	47.9	61.1	1			61.2
Nigeria	348.8	71.1	77.8	4	71.0	6	73.7
Norway	505.0	97.2	96.6	14	100.0	2	97.0
Oman	402.1	80.0	84.2	2	84.5	7	84.4
Pakistan					84.0	4	84.0
Palestine	394.0	78.7	83.3	4	86.0	4	84.6
Panama	371.0	74.9	80.5	2			80.5
Papua NG	486.6	94.1	94.4	1	82.5	4	84.9
Paraguay	357.0	72.51	78.8	1	84.0	6	83.3
Peru	370.7	74.8	80.5	2	85.0	9	84.2
Philippines	371.0	74.9	80.5	4	90.0	3	84.6
Poland	514.9	98.8	97.8	8	95.0	13	96.1
Portugal	487.0	94.2	94.5	10	94.5	6	94.5
Puerto Rico					83.5	8	83.5
Qatar	342.8	70.1	77.1	6	83.0	6	80.1
Romania	455.6	89.0	90.7	12	91.0	6	90.8
Russia	503.9	97.0	96.5	16	96.5	6	96.5

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Rwanda					76.0	2	76.0
St. Lucia					62.0	2	62.0
St. Vincent					71.0	2	71.0
W. Samoa					88.0	5	88.0
Sao Tome & P.							(70.0)
Saudi Arabia	369.0	74.5	80.3	4	79.0	6	79.5
Senegal	289.3	61.2	70.7	2	70.5	5	70.6
Serbia & M.	457.0	89.2	90.8	10	88.5	2	90.5
Seychelles	384.7	77.1	82.2	2			82.2
Sierra Leone					64.0	3	64.0
Singapore	584.4	110.4	106.2	10	108.5	5	106.9
Slovakia	514.4	98.8	97.8	12	98.0	4	97.8
Slovenia	524.2	100.4	98.9	12	96.0	7	97.8
Solomon Isl.							(84.9)
Somalia							(71.8)
S. Africa	289.0	61.2	70.7	6	72.0	14	71.6
Spain	499.5	96.3	96.0	14	97.0	8	96.3
Sri Lanka					79.0	2	79.0
Sudan					77.5	14	77.5
Suriname					89.0	4	89.0
Swaziland	370.9	74.8	80.5	3			80.5
Sweden	519.9	99.7	98.4	14	99.0	8	98.6
Switzerland	515.8	99.0	97.9	10	101.0	6	99.1
Syria	410.9	81.5	85.3	2	80.5	7	81.6
Taiwan	566.1	107.4	104.0	10	105.0	18	104.6
Tajikistan							79.6

	SchAch	SA absolute	SA relative	SAq	IQ	IQq	Human Capital
Tanzania	358.7	72.8	79.0	2	72.5	8	73.8
Zanzibar	308.1	64.4	73.0	2			73.0
Thailand	459.0	89.5	91.1	12	88.0	6	90.1
Togo							69.1
Tonga					86.0	2	86.0
Trinidad & T.	422.9	83.5	86.7	2			86.7
Tunisia	409.1	81.2	85.1	12	84.0	2	84.9
Turkey	446.2	87.4	89.5	10	88.5	8	89.1
Turkmenistan							(79.6)
Uganda	305.7	64.0	72.7	3	72.0	2	72.4
Ukraine	480.0	93.0	93.6	2	95.0	2	94.3
Un. Arab Em.	472.6	91.8	92.7	4	83.0	6	86.9
United K.	521.9	100.0	98.7	14	100.0	7	99.1
England	523.6	100.3	98.9	8	101.0	7	99.9
Scotland	500.7	96.5	96.1	6	97.0	7	96.6
N. Ireland							96.3
USA	512.4	98.4	97.5	16	98.0	11	97.7
Uruguay	442.2	86.7	89.1	6	96.0	2	90.8
Uzbekistan							(79.6)
Vanuatu							(84.0)
Venezuela	357.3	72.6	78.9	1	84.0	6	83.3
Vietnam					94.0	3	94.0
Yemen	239.2	52.9	64.7	1	83.0	6	80.4
Zambia	240.9	53.2	64.9	3	75.0	5	71.2
Zimbabwe	324.1	67.0	74.9	4	71.5	4	73.2