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Are entrepreneurship and cognitive skills related? Some international evidence

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Abstract Do national differences in cognitive skills (CS) predict a nation's likelihood of generating high-quality entrepreneurs who create and expand high-value businesses? We answer this question by estimating cross-country regressions that use the Acs and Szerb Global Entrepreneurship Development Index (GEDI) and a measure of national CS. After including conventional controls we find for a sample of 60 countries that our measure of CS robustly predicts the GEDI (unconditional correlation = 0.65, standardized beta = 0.42), an index that gives weight to both entrepreneurial attitudes within a nation and the institutional and economic prerequisites for creating high-value, high-growth firms. We find that this result also holds for an alternative measure of entrepreneurship.

Keywords Entrepreneurship · Cognitive skills · Economic freedom

JEL Classifications A1 · F2 · K00 · M2 · L26

1 Introduction and overview

The purpose of this paper is to explore the link between cognitive skills (CS) and entrepreneurship using data from a large sample of countries.[1] This research fits into a large and expanding literature that examines the relationship between general CS and various economic and social developments at the national level.

At the individual level, higher levels of cognitive skill have been found to be reliably associated with higher earnings (valuable reviews are found in Bowles et al. 2001; Strenze 2007; Jones 2011a, b). Of course, individual level relationships, even if causal, do not imply that the same relationships will hold in the aggregate—counterfeiting, for instance, creates wealth for one person but only redistributes in the aggregate—so investigating nation-level relationships is an important extension. Therefore, we address the question of whether differences in CS at the national level have a reliable relationship with nation-level outcomes.

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[1] We use the term "cognitive skills" because it is a widely used in the academic literature. It is frequently treated as a set of outcomes predicted in part by IQ scores. For instance, see Burks et al. (2009) and Heckman (2008). In this instance, cognitive skills encompass a wide array of mental skills, positively correlated with each other, which psychologists refer to as intelligence. For a useful survey of the relevant intelligence literature, see Deary (2001).

On the economic side there is substantial evidence that nations whose citizens have higher average scores on intelligence tests, one measure of cognitive skill, tend to be more successful (economically) and grow faster. Lynn and Vanhanen (2002, 2006) first tested the relationship at the national level by correlating their country-level estimates of cognitive skill (IQ) with measures of national economic performance. They found that CS and per capita real GDP are positively correlated. Finding that the correlation between this measure of CS and GDP is positive and significant spurred other researchers to use the Lynn–Vanhanen data in a series of papers investigating the role of human capital in economic growth models (among others, see Weede and Kämpf 2002; Jones and Schneider 2006; Ram 2007; Rindermann 2008a). Research in general has found that the Lynn-Vanhanen national measure of cognitive skill is a robust predictor of economic growth across a large sample of countries.

Cognitive skill also has been found to be an important factor in predicting observed differences in areas as diverse as health and politics. Oesterdiekoff and Rindermann (2007) and Rindermann and Meisenberg (2009), for example, found that countries with high cognitive skill also tend to be healthier, evidenced by slower spread of major diseases, such as HIV. After controlling for other covariates, Rindermann (2008b), Rindermann et al. (2009) and Potrafke (2012) reported that national measures of cognitive ability also predict political development, in particular the development of the rule of law, democracy and lower corruption.

Understanding the factors that give rise to entrepreneurial activity is important if we are to understand what leads some countries to succeed economically while others do not. It has long been recognized (Smith 1776; Knight 1921; Kirzner 1973, 1997) that profit-seeking entrepreneurs play a key role in an economy. Lazear (2004, 2005) suggested that the role of the entrepreneur may be second to none in the modern economy. Holcombe (1998) argued that understanding the role of the entrepreneur clarifies the process by which the factors of production, namely, capital, labor and technology, interact to create economic growth. Thinking about entrepreneurship in the context of economic growth makes it "apparent that the engine of economic growth is entrepreneurship" and that adding entrepreneurship to the usual factors of production "fills in the institutional details to help make the growth process more understandable." (Holcombe, p. 60) Entrepreneurship may not affect the inputs per se, but it surely must influence the *process* by which those inputs are combined to efficiently and profitably produce goods and services.[2]

At the individual level, cognitive ability has a positive relationship with successful entrepreneurship. Hartog et al. (2010) found using US data that "[g]eneral ability has a stronger impact on entrepreneurial incomes than on wages," (p. 948) so general cognitive ability appears to be even more important for entrepreneurs than for employees. And in a Dutch study of schoolchildren who went on to become entrepreneurs, Van Praag and Cramer (2011) found that childhood IQ was a significant, positive predictor of the size of the entrepreneurs' future firms. One path of causation suggested by this work is that individuals with higher-than-average cognitive skills are more adept at starting and running businesses, and at innovating in ways that expand products and markets (Meisenberg 2012; van Praag et al. 2013). In a study that has clear implications for the present investigation, Vinogradov and Kolvereid (2010) reported that among immigrants to Norway the average IQ in their country of origin is a significant predictor of self-employment rates. That is, self-employment rates—often used as a measure of entrepreneurial activity—are positively associated with the cognitive skill score of the immigrant's nation of origin.

A related literature expands on the work by Lucas (1978, 1988) by explicitly accounting for differential effects that educational attainment of workers and entrepreneurs/managers has on productivity and economic development. Gennaioli et al. (2013) showed that variations in years of schooling of entrepreneurs/managers help explain differences in productivity and cross-country incomes. That is, education of entrepreneurs has a greater effect on productivity and economic development than education of workers. In a study based on a sample of Dutch firms, Parker and van Praag (2006) found that the total return to entrepreneur education is significant and stems from

[2] The evidence, though mixed, suggests that entrepreneurship (in various forms) plays an important and positive role in economic growth models. Useful reviews of this can be found in Acs and Audretsch (2003), Caree and Thurik (2003), Acs and Armington (2006) and Audretsch et al. (2006).

not only a direct effect (e.g., as that found in Hartog et al. 2010) but also an indirect effect that comes through reduced capital constraints faced by entrepreneurs with more years of schooling.

This wide-ranging body of evidence suggests that higher levels of cognitive skill (i.e., higher levels of general intelligence) are associated with greater development across a wide spectrum of fields (economic, health, political) and may be an important part of the story why entrepreneurial activity is greater in some countries than others. This paper is an initial attempt to address this by testing the hypothesis: Do higher levels of cognitive skill help explain observed differences in entrepreneurial activity across countries?[3,4]

We test our hypothesis by employing the Global Entrepreneurship and Development Index (GEDI) created by Acs and Szerb (2010). The GEDI significantly extends the range of countries covered by alternative measures of entrepreneurship, like the Global Entrepreneurship Monitor (GEM). To measure national cognitive skill we use the updated version of the original Lynn-Vanhanen IQ series published by Lynn and Meisenberg (2010).[5] Included in our set of control variables we also consider the role of economic freedom. This serves two purposes: First, we can test whether CS and economic freedom are basically covering the same "good" institutional characteristics that identify economies with high levels of entrepreneurial activity. Second, we add evidence to the new institutional literature by assessing the relationship between economic freedom and entrepreneurship using the Acs–Szerb index. And finally, this paper adds to the emerging research agenda that explores the link between CS and institutions, or what Rindermann calls "cognitive capitalism."[6]

The remainder of the paper is as follows. Section 2 provides a brief description of the Acs–Szerb series on entrepreneurship and the CS measure. Section 3 contains our empirical analysis assessing the role of cognitive skill and economic freedom. Section 4 extends the analysis by examining the relationship between cognitive skill, economic freedom and component measures of the GEDI. Section 5 reports the results of testing CS against an alternative entrepreneurship measure. Section 6 closes the paper with implications of our findings and suggestions for further research.

2 Measures of entrepreneurship and cognitive skill

2.1 The global entrepreneurship and development index

Much previous research comparing international levels of entrepreneurial activity has relied on the Global Entrepreneurship Monitor (GEM). The GEM is based on a questionnaire survey of individuals aged 16 through 64 in 29 countries over time. The survey, which covers approximately 7,000 individuals, offers a valuable look into entrepreneurial actions and aspirations. A drawback of this rich data set is that it covers a relatively small number of countries. The GEM also only uses survey data and does not include concrete economic and institutional measures of the

[3] The ongoing debate concerning the causal direction between cognitive ability and educational attainment, whether in terms of year so schooling or in scores on standardized tests, is not resolved in this paper. For example, Hansen et al. (2004) found that increased schooling has a "small equalizing effect" on standardized test scores, but mostly for students with low initial levels of cognitive ability and schooling. Lynn and Meisenberg (2010) and Lynn and Vanhanen (2012) argued that while cognitive skill and test scores are highly correlated, individuals with greater cognitive skills are more likely to attain more education (years in school) since they are relatively more adept at it. A useful overview of the large set of empirical findings is found in Heckman (2008).

[4] Trying to answer the question of why some countries have a higher level of cognitive skill than others would take us far afield from our current purpose and outside of our area of expertise. We rely on the fact that, as amply demonstrated in Lynn and Vanhanen's (2012) extensive survey, cognitive skill appears to be a dominant, pervasive factor that helps explain why individuals and groups, other factors held constant, strive economically, enjoy better health and establish and maintain better functioning political structures. This is not to deny the fact that environmental influences on intelligence are well documented in the literature, especially the well-known Flynn Effect, which is the long-term rise in IQ scores documented around the world (*inter alia*, Deary 2001, Jones 2011b).

[5] Lynn and Vanhanen (2012) provided yet another data set that updates the Lynn and Meisenberg data. This data, which became available after completion of this paper, does not extend our sample of countries and, when comparing our data with the more recent vintage, there are only minor differences in the values. Consequently, we continue to use the Lynn–Meisenberg data.

[6] See Rindermann (2008b, 2012) and Rindermann and Thompson (2011) for more on this area of research.

potential for highly productive entrepreneurship. While some (e.g., Nystrom 2008) have tried to circumvent this constraint by using panel estimation techniques, it still remains that the entrepreneurial activity of only 29 different economies is being considered.

The Global Entrepreneurship and Development Index developed by Acs and Szerb (2010) is, like the GEM, a multi-dimensional index designed to capture many aspects of why individuals become entrepreneurs and the environments within which this decision occurs. This is, many would argue, a preferable approach to the use of single-dimension measures, such as statistics on business ownership or self-employment.[7] Acs and Szerb (2010) noted that such statistics do not "capture *quality* differences across entrepreneurial activity, such as opportunity recognition, skills, creativity, or innovation and high growth." (p. 6) The GEDI thus combines data from attitudinal surveys of at least a thousand individuals within each country (measured in recent years) along with data on economic, educational, and institutional factors that are likely drivers of productive, scalable entrepreneurship (Acs and Szerb 2010). The surveys provide evidence on the degree of entrepreneurial attitudes in the population, while the other factors assess whether the ease with which those attitudes can be converted into innovation and growth.[8]

The GEDI is based on a multi-layer approach that incorporates into one measure the quality differences that may affect entrepreneurial decisions along with the institutional and environmental factors that affect the social and economic context in which entrepreneurial activity occurs. These latter factors include the legal structure and property rights within which entrepreneurs operate, the size of government relative to the economy, and the regulatory burden faced by entrepreneurs. In this sense Acs and Szerb (2010) argued that any useful index of entrepreneurship must be "complex," reflecting the complexity of the process and the institutional environment within which economic agents engage in entrepreneurial activity.

In total there are 71 countries for which the GEDI measure is available.

2.2 National measures of cognitive skill

We use the IQ series published by Lynn and Meisenberg (2010) as our measure of cognitive skill. They tested whether the original Lynn and Vanhanen country-level IQ data are consistent with measures of educational attainment in the areas of math, science and reading comprehension. The scope of the available measures of educational attainment is quite wide. Two oft-cited measures of educational attainment are the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). The TIMSS assessment is carried out in grades 4 and 8, and there are 4 such assessments available to researchers.[9] The PISA assessment is done at age 15, and there are 3 available. Lynn and Meisenberg (2010) used the average of the 8th grade TIMSS and the PISA score for countries that participating in no less than one of the assessment studies.[10] Comparing their measure to measures of "educational attainment" (or EA as they term it) where both are available (86 countries), they found that the correlation is 0.917. And for those countries in which they used estimated IQ and available EA, the correlation is 0.907. The Spearman rank correlation for both measures also is large, greater than 0.90. Lynn and Meisenberg (2010) concluded that "[t]he high correlation between IQ and EA shows that these two measures are not merely two otherwise unrelated 'development indicators.' It rather shows that intelligence tests and scholastic achievement tests measure the same or nearly the same construct. To the extent that educational attainment is important for a country's economic or cultural destiny, IQ is important as well. We suggest that both can be used interchangeably as measures of 'human capital.'" (p. 359)[11]

[7] See Acs and Szerb (2010), footnote 17, for references. Acs et al. (2014) provide a further discussion of the GEDI measure within the context of alternative measures of entrepreneurship at the country level.

[8] The index consists of several sub-indexes, which we describe below.

[9] The TIMSS assessments occurred in 4-year cycles, including 1995, 1999, 2003 and 2007. These data are available at http://timss.bc.edu/timss2003html. The PISA assessments were carried out in 3-year cycles, including 2000, 2003 and 2006. These data are available at http://pisacountry.acer.edu.au.

[10] Lynn and Meisenberg (2010) also used several additional assessment tools in their analysis. To conserve space, we refer the reader to their paper, especially p. 356.

[11] For a related analysis, see Rindermann (2007).

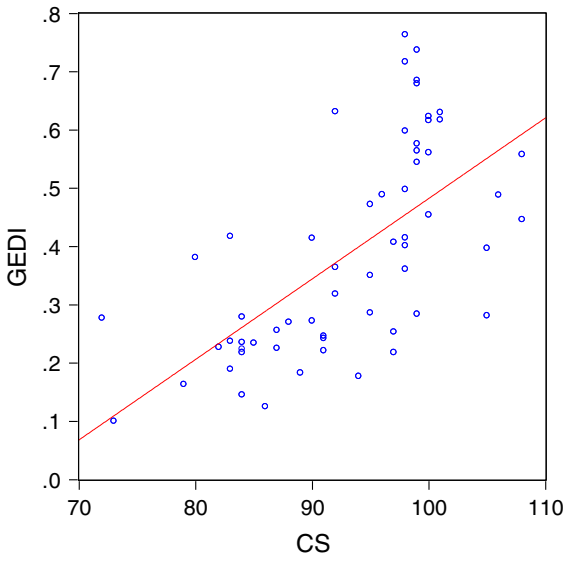

Fig. 1 Scatter plot of GEDI and cognitive skills

The Lynn-Meisenberg data were matched to the countries for which the GEDI measure is available creating a sample of 60 countries for which both overlap. Appendix Table 7 lists the countries along with their values for the GEDI and CS measures.

2.3 Correlations

As a first test for the relationship between entrepreneurship and CS, Fig. 1 is a scatter plot of the two series. It is readily apparent that the two measures are positively related: Countries with higher levels of cognitive ability also are those countries with higher values of the GEDI. This is verified by the simple correlation between the two series of 0.65, which is significant at greater than the 1 % level. Since this correlation could be spurious we turn to regression analysis.

3 Regression analysis

Although the positive and significant correlation between entrepreneurship and our cognitive skill measure is heartening, its usefulness is limited. To better understand the link we estimate a regression of the general form:

$$\text{GEDI}_i = \alpha + \beta 1(\text{CS}_i) + \beta_i(\text{Controls}) + \varepsilon_i \qquad (1)$$

where GEDI is the value of the Acs–Szerb index for the *i*th country, CS is the *i*th country's Lynn–Meisenberg IQ datum, "Controls" is a set of economic and institutional variables that may explain entrepreneurship in a country, α and the βs are coefficients to be estimated, and ε is the error term.

3.1 Data

Using previous studies as our guide, we include as controls several plausible drivers of cross-country differences in entrepreneurial activity. The set control variables includes measures of income, income distribution, manufacturing employment, and an encompassing institutional measure in the form of economic freedom.

The level of real GDP per capita, the work-horse in analyses like this, provides a relative standard of a country's economic success. It is arguable that income inequality, measured by the Gini coefficient, may prohibit individuals from taking entrepreneurial risks. Bjornskov and Foss (2008) used such a measure in their study of entrepreneurial activity. Meisenberg (2012) also found that after controlling for income, ethnic diversity and measures of economic and political freedom, higher CS reduces income inequality (measured using a Gini coefficient) across a large sample of countries.

We also include in our set of controls a labor market variable. Following Bjornskov and Foss (2008) the percent of labor employed in manufacturing is used to control for the effects that a country's distribution of labor may have on its level of entrepreneurial activity. For example, an economy in which employment in manufacturing is predominant may offer fewer entrepreneurial opportunities relative to one that is more heavily weighted toward services. Including this variable helps sort that question out.

This set of variables represents not only those that have been used in previous research, but also demonstrated at least some statistical relationship with GEDI.[12] We also include other "non-economic" controls. One such measure, referred to below as "Postcom" is a (0, 1) variable assigned to countries

[12] Other control variables tested were the Gender-related Development Index, a measure of government spending relative to GDP, life expectancy, the percent of labor in agriculture and the percent of the adult population with a bachelor's degree. In each instance the estimated coefficient never achieved statistical significance at a reasonable level (better than 10 %). More importantly, including these alternative measures did not affect the significance of the estimated coefficient on cognitive skill.

that have recently converted from Communist rule. Bjornskov and Foss (2008), using the GEM measure of entrepreneurship, found the estimated coefficient on this variable to be positive, though it often did not achieve statistical significance. We also include a set of regional dummy variables to capture any regional variation not accounted for by the other right-hand-side variables. For this purpose we use Sala-i-Martin's (1997) suggested demarcation of the world.

Finally, a portmanteau institutional measure is added to the set of controls. Doing so extends a related line of research and further tests the robustness of cognitive skill in explaining entrepreneurship. Our proxy for this broad range of institutional factors, a measure of economic freedom, is relevant since there is evidence linking government activity and entrepreneurial activity.[13] It is logical to infer that at least beyond some point, the larger the government's presence in the market the lower the incentives for entrepreneurial activity at the margin. Government activity eventually crowds out private activity: At the extreme of nationalized industries, the government's monopolization effectively precludes entrepreneurial activity. Increased provision of entitlement programs also can adversely affect the entrepreneurial spirit. Incentives for wealth creation are reduced if the government programs effectively raise the reservation wage that entrepreneurs face (Bjornskov and Foss 2008). And how these programs are financed may reduce the incentive to engage in new start up business or accrue wealth through new ventures. Entrepreneurial income is most often taxed as personal income. This means that for those services and products that are substitutes for household services, "higher rates of personal taxation discourage the market provision of goods and services." (Henrekson 2005, p. 15) An over-reaching government and a punitive tax system do not inspire entrepreneurial activity.

[13] Theoretical arguments linking entrepreneurship and institutions are found in Boettke and Coyne (2009) with Bjornskov and Foss (2008) providing supporting empirical evidence. Nystrom (2008) found that size of government and legal structure and regulation are negatively and significantly related to the rate of self-employment in a given country. Both studies indicated that a smaller government, a better legal structure within which property rights are secured, and an economy characterized by less regulation of credit, labor and business sectors are factors that increase the likelihood of entrepreneurship.

We use two empirical measures of economic freedom. One is the Fraser Economic Freedom of the World Index (EFWI) described in Gwartney et al. (2011). The other is the Index of Economic Freedom (IEF) published by the Heritage Foundation and the *Wall Street Journal* (Miller et al. 2012). Although there are some differences in construction, the gist of each measure is to capture the level of government intervention in an economy, in terms of the size of government (by how much it consumes relative to the total economy), how active it is in redistributing income through taxation or social entitlement programs, and in public investment. The two indexes also capture the degree of property right protection in an economy. According to most theories, established and protected property rights along with rule of law are positive determinants of entrepreneurship. The IEF measure runs from 0 to 100, the higher score indicating greater relative economic freedom. The EFWI ranges in value from zero—no economic freedom—to a high of 10.

Table 1 provides summary statistics for the variables used. Except for our cognitive skill variable, all data are for 2005. Sources of the data are provided in Appendix Table 8. Table 2 reports the bivariate correlations between the variables. As reported earlier, the correlation between CS and GEDI (0.65) is positive and significant. Note that CS and the Gini coefficient are negatively correlated, similar to the finding in Meisenberg (2012). We also find that cognitive skill and the two economic freedom measures are positively correlated. This is similar to

Table 1 Summary statistics

Variable	Mean	Std Dev
CS	93.10	8.39
GEDI	0.39	0.18
Gini	37.12	9.22
RGDP/cap	21,748.44	13,656.48
%Manufacture	22.95	7.92
Fraser EF	7.07	0.82
Heritage EF	64.21	10.50

%Manufacture is percent of labor force in manufacturing; Fraser EF is Fraser Economic Freedom of the World Index and Heritage EF is Heritage Index of Economic Freedom

Variable definitions: *CS* Cognitive Skill, *GEDI* Global Entrepreneurship Development Index, *RGDP/cap* Real GDP per capita

Table 2 Correlations

Variable	CS	GEDI	Gini	RGP/cap	%Man	FEF	HEF
CS	1.00						
GEDI	0.65***	1.00					
Gini	−0.39***	−0.43***	1.00				
RGDP/cap	0.64***	0.86***	−0.42***	1.00			
%Manufacture	−0.53***	−0.66***	0.22*	−0.71***	1.00		
Fraser EF	0.61***	0.73***	−0.21	0.68***	0.02	1.00	
Heritage EF	0.56***	0.77***	−0.10	0.68***	−0.06	0.93***	1.00

%Manufacture is percent of labor force in manufacturing, Fraser EF is Fraser Economic Freedom of the World Index, and Heritage EF is Heritage Index of Economic Freedom

Variable definitions: *CS* Cognitive Skill (IQ), *GEDI* Global Entrepreneurship Development Index, Gini is country Gini index, *RGDP/cap* Real GDP per capita

*** Significance at the 1 % level; ** the 5 % level; and * the 10 % level

previous findings (Rindermann 2008b, 2012; Rindermann et al. 2011; Rindermann and Thompson 2011) that countries with higher levels of cognitive skill tend to be characterized by institutions that promote greater levels of economic freedom and democratic development. Finally, note that the economic freedom variables and the GEDI are positively correlated.

3.2 Regression results

Table 3 reports the outcome of estimating Eq. (1). Because it is sometimes argued that our cognitive skill measure and the institutional measures may both capture the same "good" aspects of a society, we first report estimates of Eq. (1) without the freedom measures, then include them separately in the set of controls. In addition to the estimated coefficients and absolute values of the *t* statistics, we also report (in brackets) standardized beta regression coefficients. The standardized beta coefficients permit a direct comparison of the variables' relative importance in explaining variation in the GEDI across countries.

The results reported in the first column of Table 3 indicate that each of our right-hand-side variables is statistically significant. The negative and significant coefficient on the "Postcom" variable indicates that countries that converted from Communist rule are characterized by a lower level of entrepreneurship (using the GEDI) compared with the other countries in our sample. This contrasts with the result reported by Bjornskov and Foss (2008), though it should be noted that they used the GEM, and that they found that its statistical importance was not robust across specifications.

Our regression estimates show that greater income inequality (a higher Gini coefficient) is associated with a lower level of entrepreneurship. The fact that the estimated coefficient on the Gini variable is negative suggests that those in lower echelons of the income spectrum are not incented to engage in activities that allow them to migrate economically upward. Though it may seem counter-intuitive, this finding accords with recent evidence that income mobility may be negatively related to income inequality (Andrews and Leigh 2009).

The fact that the estimated coefficient on real per capita GDP is positive and significant suggests that conditions in lower-income countries are less supportive of entrepreneurial activity. Nystrom (2008) also found that self-employment rates (a proxy for entrepreneurship) and per capita GDP to be negatively related: Self-employment per se is relatively more common in lower-income countries. van Stel et al. (2005) reported that entrepreneurship and economic *growth* are positively related in relatively prosperous countries. For poor countries, however, they did not find such a relationship. One possible explanation is that in low-income, low-growth countries small-scale entrepreneurship, such as selling consumer goods or services, is woefully inefficient and that such the small-scale entrepreneurship itself suggests barriers to efficient scale (Lewis 2004). We believe that our result is consistent with this latter explanation: If the GEDI is capturing the "good" factors that allow

Table 3 Regression results

Variable	Specification		
	1	2	3
CS	0.009***	0.008***	0.005***
	(3.99)	(2.86)	(2.71)
	[0.418]	[0.349]	[0.122]
Postcom	−0.102***	−0.100***	−0.087***
	(3.19)	(3.00)	(2.67)
	[−0.217]	[−0.211]	[−0.184]
Gini	−0.004**	−0.004***	−0.005***
	(2.38)	(2.56)	(2.91)
	[−0.198]	[−0.225]	[−0.249]
RGDP/cap	0.118***	0.093***	0.074***
	(6.31)	(3.98)	(3.47)
	[0.561]	[0.441]	[0.350]
%Manufacture	−0.002*	−0.001	−0.0001
	(1.85)	(0.85)	(0.08)
	[−0.113]	[−0.056]	[−0.006]
Fraser EF		0.042**	
		(2.32)	
		[0.195]	
Heritage EF			0.006***
			(4.25)
			[0.352]
$\overline{R}^2$	0.795	0.805	0.828
F/(pr)	29.73	27.67	32.12
	(0.00)	(0.00)	(0.00)

Absolute values of *t* statistics appear in parentheses. Estimated standardized beta coefficients appear in brackets

Dependent variable: GEDI

Variable definitions: *GEDI* Global Entrepreneurship Development Index, *CS* Cognitive Skill (IQ), *Postcom* (0, 1) for post-communist countries, *Gini* country Gini index, *RGDP/cap* log(Real GDP per capita), %Manufacture = percent of labor force in manufacturing; *Fraser EF* Fraser Economic Freedom of the World Index and Heritage *EF* Heritage Index of Economic Freedom

*** Significance at 1 % level, ** significance at 5 % and * at 10 %. All regressions are estimated using White heteroskedasticity correction. All regressions include regional dummies and a constant term

entrepreneurship to flourish, then the positive coefficient on real GDP per capita reflects the fact that individuals in higher income countries may take advantage of those "good institutions" to a relatively greater extent than those in lower income countries.

Labor market characteristics also impact the level of entrepreneurship. The estimated coefficient on the labor market variable (percent of labor employed in manufacturing) is negative and statistically significant, though only at the 10 % level. Countries that rely (in terms of employment) more heavily on manufacturing (as opposed to, say, services) are more likely to offer fewer opportunities for entrepreneurship and thus a lower GEDI, all else the same.

What is the estimated effect of cognitive skill on entrepreneurship in the presence of these control variables? Even after including our control variables—all of which are statistically significant—the estimated effect of the cognitive skills variable (CS) is positive and statistically significant at greater than the 1 % level.[14] This finding identifies cognitive skill as an important, independent factor that helps explain differences in entrepreneurship across countries. In fact, comparing the standardized regression coefficients in Table 3 to gauge the relative degree of importance indicates that cognitive skill has one of the highest values, second only to real GDP per capita. This indicates that cognitive skill is statistically and economically important.

The regression results found in columns 2 and 3 of Table 3 extend the list of control variables by including the Fraser and Heritage measures of economic freedom to Eq. (1). The estimated coefficients on the freedom variables are positive and significant. Including each freedom measure has some impact on other estimated coefficients. For example, adding the freedom measures reduces the labor market variable (percent manufacturing) to insignificance and diminishes the role that real GDP per capita plays. This is not too surprising, however, given the manner in which these indexes are constructed. More importantly, even though adding these two

[14] This result is not affected by including a measure of education. When the Barro-Lee measure of "years of schooling" is included in the regression, the estimated coefficient on the cognitive skills variable is positive and statistically significant at better than a 1 % level of significance. This finding is similar to previous work where cognitive skills tend to dominate education, especially if the latter is measure as a "years in school" type of measure. This suggests that the cognitive skills variable is capturing something different than education alone. Indeed, the gist of Lynn and Meisenberg (2010) is that their measure is more related to educational *attainment*, in terms of cognitive skills, than cruder measures such as degree attained or average years in school.

institutional measures reduces the effect of CS (the standardized regression coefficient declines in the presence of the Heritage measure) the estimated coefficient on cognitive skill (CS) continues to be positive and statistically significant.

As a test of robustness, we estimated versions of Eq. (1) that account for two issues involving the measurement of cognitive skills. Wicherts et al. (2009, 2010) argued that the Lynn-Vanhanen measurement of IQ in African nations understates their true value. In light of their criticism some previous work (among others, Hunt and Wittmann 2008; Jones and Schneider 2010) "winsorize" low-level scores to a minimum of 80. In our sample, that means increasing the cognitive skill score for South Africa to 80 from 72, and raising the score for Uganda from 73 to 80. In addition, Lynn and Vanhanen sometimes interpolated the cognitive skill data using observations from surrounding countries when country-specific data were not available. Although Lynn and Meisenberg (2010) demonstrated that this procedure does not invalidate the accuracy of the final measure, it might raise a concern about comparative accuracy.

To see if these two alterations affect our results, we re-estimated the regressions in Table 3 after increasing the two African countries' cognitive skill values to 80 and omitting those countries for which only predicted values of cognitive skill are available—Algeria, Latvia and Macedonia. The results from this estimation (which are available on request) show that the estimated values and significance of the coefficients and the overall explanatory power of the equations are little changed relative to those found in Table 3. Of special import is the fact that the size and statistical significance of the estimated cognitive skill coefficient is unaffected by these alterations.[15]

As an additional robustness test we estimated Eq. (1) using the sub-components of the Fraser and Heritage freedom measures.[16] The components to each index include specific measures of, among others, size of government, legal structure and property rights, sound money policies and specific measures of regulatory activity. The results (available upon request) again indicate that cognitive skill is robust to including these more specific institutional measures. Out of 11 possible regressions, cognitive skill is statistically and economically significant in 10. The only instance in which the estimated CS coefficient fails to achieve significance is when the "corruption" component of the IEF is used as a control variable.

The bottom line is that even in the presence of an extended set of economic and institutional control variables, cognitive skill is a statistically and economically important variable that helps predict entrepreneurship across a large sample of countries.

4 A look at the components of GEDI

Acs and Szerb (2010) construct three sub-indexes that are used to capture different aspects of the entrepreneurial process, both in terms of activity and aspiration. In this section we briefly describe these components and then use them in place of the overall GEDI measure to estimate Eq. (1).

4.1 GEDI components

The GEDI is comprised of three major components.[17] These include the entrepreneurial attitude (ATT), the entrepreneurial activity (ACT) and the entrepreneurial aspiration (ASP) sub-indices. The ATT component "aims to identify entrepreneurial attitudes associated with the entrepreneurship-related behavior of a country's population."(p. 7) In essence, these attitudes are influenced by factors such as market size, educational attainment and the overall riskiness of doing business in the country. The ACT sub-index is related to growth potential. It is influenced by education, ease of doing business and the level of development, the latter of which would include population health and well-being. Finally, the ASP sub-index is included to capture the "qualitative, strategy-related" aspects of new business ventures. Some of the institutional measures affecting this sub-index include globalization and the

[15] For example, the estimated coefficient on CS in the regression comparable to column 1 in Table 3 is 0.007 ($t = 3.30$). The coefficient/t-statistic comparable to column 2 is 0.007 ($t = 3.23$); to column 3 it is 0.004 ($t = 3.32$).

[16] Heckelman and Stroup (2000) suggested that potential problems of specification bias from using the broad index may be mollified by using the subcomponent measures along with the overall measure of freedom. This is the approach is used in Garrett and Rhine (2011) and Belasen and Hafer (2012).

[17] This discussion draws on Acs and Szerb (2010), p. 7.

availability of venture capital. Orderly and relatively low-cost (especially in the sense of less-burdensome government regulations) access to funding, through venture capital, through the direct financing via equity and bond markets, or through indirect financing through banks and other financial institutions is often viewed as a key feature in economies that have higher levels of entrepreneurial activity.

To measure these sub-indices and to construct the overall GEDI from them, it is necessary to make decisions about which individual and institutional measures to use in the actual estimation. The 18 individual measures (see Table 3 of the Acs–Szerb paper) are based on GEM-like information pertaining to characteristics, such as the percent of the working-age population (18–64), that recognized good conditions to start a business, the amount of informal investment available and the percentage of start-up business that offer a new product to their customers. Acs and Szerb (2010) added to this 16 institutional measures taken from a variety of other indexes (see Table 4 of their paper). This includes UNESCO's measure of expenditure on research and development as a percent of GDP, and corruption measured using Transparency International's assessment of public corruption; these institutional variables help capture the potential productivity of entrepreneurs. Thus the index captures both the entrepreneurial potential of the population and the entrepreneurial potential of the surrounding economic environment.

4.2 Regression results

The results from re-estimating Eq. (1) for each of the GEDI components are reported in Tables 4 and 5. Table 4 reports the results when the Fraser economic freedom measure is used; Table 5 the estimates when the Heritage freedom measure is the institutional measure included in the regression. There a few differences in the results compared to those found using the overall GEDI. For example, the "percent manufacturing" variable never achieves statistical significance, regardless of the component. This also is true of the Postcom and Gini variables for the ASP component. We also find that the Fraser freedom measure, though always positive, is statistically significant only for the ATT component. In contrast, the Heritage measure of freedom is significant and positive across each component.

Table 4 Regression results

Variable	GEDI component		
	ACT	ASP	ATT
CS	0.010*	0.008***	0.005
	(1.87)	(2.60)	(1.27)
	[0.465]	[0.391]	[0.218]
Postcom	−0.150***	−0.032	−0.120***
	(2.57)	(0.71)	(2.83)
	[−0.318]	[−0.071]	[−0.239]
Gini	−0.004***	−0.003	−0.006***
	(1.80)	(1.22)	(2.41)
	[−0.205]	[−0.162]	[−0.289]
RGDP/cap	0.107***	0.094***	0.077***
	(2.60)	(3.61)	(2.54)
	[0.509]	[0.469]	[0.344]
%Manufacture	−0.001	−0.002	−0.0001
	(0.38)	(1.09)	(0.05)
	[0.045]	[0.044]	[0.004]
Fraser EF	0.041	0.024	0.060**
	(1.39)	(0.91)	(2.13)
	[0.191]	[0.117]	[0.262]
$\overline{R}^2$	0.697	0.667	0.694
F/(pr)	15.81	13.86	15.68
	(0.00)	(0.00)	(0.00)

Absolute values of *t* statistics appear in parentheses. Estimated standardized beta coefficients appear in brackets.

Dependent variable: Components of GEDI; Institutional measure: Fraser Economic Freedom

Variable definitions: *GEDI* Global Entrepreneurship Development Index, *CS* Cognitive Skill (IQ), *Postcom* = (0, 1) for post- communist countries, *Gini* = country Gini index, *RGDP/cap* = log(Real GDP per capita), %Manufacture = percent of labor force in manufacturing; *Fraser EF* = Fraser Economic Freedom of the World Index

*** Significance at 1 % level, ** significance at 5 % and * at 10 %. All regressions are estimated using White heteroskedasticity correction. All regressions include regional dummies and a constant term

More importantly, the results in Tables 4 and 5 show that our CS variable is positive and statistically significant for both the ACT and ASP components, regardless of which freedom measure is included in the regression. In addition, the standardized regression coefficient for CS indicates that it is one of the most important variables explaining the variation in these two measures. We note, however, that CS does not achieve significance (though it is positive) when the dependent variable is the ATT component of the

Table 5 Regression results

Variable	GEDI component		
	ACT	ASP	ATT
CS	0.007**	0.004*	0.004
	(2.01)	(1.67)	(1.14)
	[0.293]	[0.204]	[0.182]
Postcom	−0.136**	−0.018	−0.109***
	(2.34)	(0.38)	(2.87)
	[−0.231]	[−0.040]	[−0.217]
Gini	−0.004**	−0.003	−0.006***
	(1.98)	(1.62)	(2.50)
	[−0.172]	[−0.162]	[−0.311]
RGDP/cap	0.087**	0.074***	0.062**
	(2.22)	(2.87)	(2.15)
	[0.326]	[0.372]	[0.277]
%Manufacture	0.0003	−0.001	−0.0002
	(0.11)	(0.32)	(0.10)
	[0.012]	[0.038]	[0.011]
Heritage EF	0.006**	0.005**	0.007**
	(2.34)	(2.49)	(2.61)
	[0.284]	[0.319]	[0.385]
$\overline{R}^2$	0.707	0.682	0.720
F/(pr)	16.56	14.84	17.55
	(0.00)	(0.00)	(0.00)

Absolute values of *t* statistics appear in parentheses. Estimated standardized beta coefficients appear in brackets

Dependent variable: Components of GEDI, Institutional Measure: Heritage Economic Freedom

Variable definitions: *GEDI* Global Entrepreneurship Development Index, *CS* Cognitive Skill (IQ), *Postcom* = (0, 1) for post- communist countries, *Gini* country Gini index, *RGDP/cap* = log(Real GDP per capita), %Manufacture = percent of labor force in manufacturing; Heritage *EF* = Heritage Index of Economic Freedom

*** Significance at 1 % level, ** significance at 5 % and * at 10 %. All regressions are estimated using White heteroskedasticity correction. All regressions include regional dummies and a constant term

GEDI. Interestingly, for this component the Postcom, Gini and Fraser variables all are significant.

5 Alternative measures of entrepreneurship

As a final part of our investigation, we turn to the question of whether our finding that higher levels of entrepreneurial activity are positively associated with higher levels of CS at the country level holds for an alternative measure of entrepreneurship. How to measure entrepreneurship is an ongoing debate, one that we will not dive into nor even remotely attempt to solve. So which other measure of entrepreneurship to use?

We answer that question by considering a measure that closely represents the kind of entrepreneurship that has significant economic effects. One oft-used measure is the Global Entrepreneurship Monitor (GEM).[18] Country-level GEM measures are based on a survey of adult-age individuals to identify nascent new businesses, or total early-stage entrepreneurial activity (TEA). A major drawback of the GEM measure, however, is that it does not differentiate between formal and informal entrepreneurship (Nystrom 2008).[19] It also is true that the GEM measure, as Hoffman (2007) notes, overstates the rate of entrepreneurship in a country. This occurs because the GEM is based on survey responses, not actual outcomes: Many who claim to be starting a firm seldom carry through.

We use an output-based measure of entrepreneurship, one that monitors new firm entry, where the new firms are private companies with limited liability. This series on new incorporations (NI) is part of the World Bank's Entrepreneurship Survey (2014).[20] What makes this measure preferable to survey–based measures, such as the GEM or the Gallup measure is that it is based on the actual registry of new firms.[21] There are, however, caveats to using this measure. One is that registry requirements may not be strictly comparable across countries. Another is that it fails to capture those new firms that do not register. It may, therefore, underestimate the level of entrepreneurship in a country, a problem that may be greater in low-income countries compared with high-income countries (Acs et al. 2008). Even with these caveats, Acs et al. (2014)

[18] See Reynolds et al. (2005) for a more complete description of the GEM collection and measurement methods.

[19] We would argue that this criticism also applies to other survey-based measures, such as the Flash Eurobarometer survey conducted by the Gallup organization. (Gallup 2009). The Gallup series also is available for only a limited number of countries (27).

[20] We use the "entry density" figure to adjust for scale.

[21] Acs et al. (2014) argue that "attitude surveys provide an insight into the opinion climate that prevails in a given country, [but] tend to suffer from the obvious disassociation from actual activity… and tell us little about how opinions and attitudes translate into action within a given country…"(480).

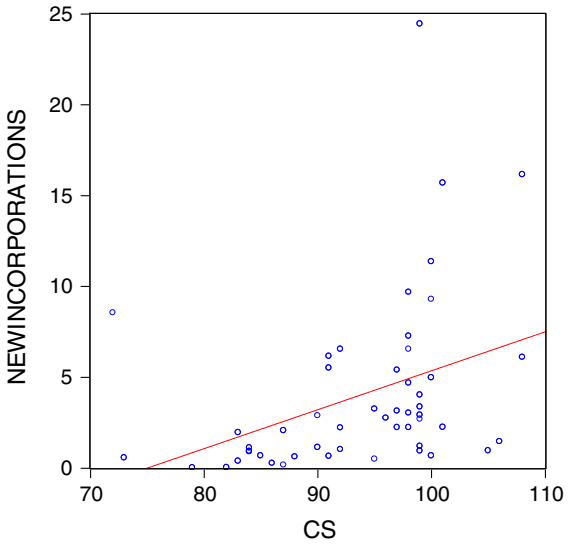

Fig. 2 Scatter plot of new incorporations and cognitive skills

note that "[T]he advantage of registry data is that it tracks formal, and therefore, presumably more consequential new entries." (p. 480). Data for this new incorporations measure of entrepreneurship were collected from the World Bank database for 2006 to make it comparable with the GEDI.[22]

As a first glimpse, Fig. 2 shows the scatter plot of NI and our CS variable. The superimposed regression line indicates that the relationship is positive, just as was found between GEDI and CS in Fig. 1. The correlation between NI and CS is 0.37, which is statistically significant at better than the 1 % level ($t = 2.80$). Though significant, it is somewhat lower than the correlation between GEDI and CS (0.65) reported earlier.

To see how this bivariate relation between NI and CS stands up to the inclusion of control variables, the first column in Table 6 replicates the estimation of Eq. (1) with GEDI replaced by the NI measure, and where the Fraser measure of economic freedom is used.[23] Overall, the results are disappointing. The explanatory power of the equation is notably lower compared to that found when GEDI is the dependent variable. More bothersome is the fact that none of the explanatory variables, including CS, achieve statistical significance. This suggests that multicollinearity between the right-hand-side variables, as suggested by the correlations in Table 2, is more problematic here than when GEDI is used.

Table 6 Regression results

Variable	Specification	
	1	2
CS	0.103	0.228**
	(0.83)	(2.14)
	[0.179]	[0.396]
Postcom	1.505	
	(0.89)	
	[0.117]	
Gini	0.138	0.158*
	(1.55)	(1.66)
	[0.280]	[0.321]
RGDP/cap	1.031	1.79***
	(0.73)	(3.24)
	[0.186]	[0.325]
%Manufacture	−0.028	
	(0.255)	
	[−0.046]	
Fraser EF	2.39	
	(1.23)	
	[0.379]	
$\overline{R}^2$	0.193	0.181
F/(pr)	2.33	2.84
	(0.03)	(0.02)

Absolute values of *t* statistics appear in parentheses. Estimated standardized beta coefficients appear in brackets

Dependent variable: New incorporations

Variable definitions: New incorporations = World Bank New Incorporations, *CS* Cognitive Skill (IQ), *Postcom* (0, 1) for post- communist countries, *Gini* country Gini index, *RGDP/cap* = log(Real GDP per capita), %Manufacture = percent of labor force in manufacturing; and *Fraser EF* = Fraser Economic Freedom of the World Index

*** Significance at 1 % level, ** significance at 5 % and * at 10 %. All regressions are estimated using White heteroskedasticity correction. All regressions include regional dummies and a constant term

[22] The sample of countries is slightly smaller than that for which the GEDI is available. Countries for which the World Bank measure is not available includes Bosnia, China, Egypt, Iran, Portugal, Saudi Arabia, Serbia, the United States and Venezuela.

[23] The results are not different qualitatively if the Heritage measure of economic freedom is used.

To see how sensitive these results are to altering the specification, column 2 in Table 5 reports the outcome of estimating a version of Eq. (1) in which the only variables included are those that are statistically significant at the 10 % level or higher.[24] This parsimonious specification suggests that, for the NI measure of entrepreneurship, countries with higher levels of real GDP per capita tend to have higher levels of entrepreneurial activity. And while the inequality variable is statistically significant, note that the estimated sign on the Gini coefficient switches signs from that found using the GEDI. The explanatory power of the equation remains lower than that found using GEDI. Still, the overall regression is significant (p value $= 0.02$).

What we find most reassuring is the fact that the CS variable has a positive and statistically significant effect on the NI measure of entrepreneurship. Comparing standardized coefficients, the impact of the CS variable is, in fact, the largest of the three. Based on this version of Eq. (1), the outcome validates the results found when GEDI is used to capture the level of entrepreneurial activity at the country level.

6 Implications and further research

This study is, we believe, the first to document a positive relationship between national estimates of cognitive skill and entrepreneurship, here measured as the Acs and Szerb (2010) Global Entrepreneurship Development Index. This finding holds after controlling for a number of economic control variables and indexes of economic freedom. We also find that cognitive skill has a positive and statistically significant effect on an alternative measure of entrepreneurship, the World Bank's measure of new incorporations.

Our results extend and strengthen previous research which found that cognitive skills play an important role in explaining a variety of macroeconomic phenomena. As summarized in Lynn and Vanhanen (2012), CS have been found to be positively and significantly correlated with large number of "agreeable" economic outcomes, including higher levels of real income, faster rates of economic growth, higher investment, and increased savings. Higher cognitive skills also are positively associated with preferable political institutions, such as democracy, property rights and rule of law, improved health conditions, including lower infant mortality and lower rates of HIV, and negatively correlated with income inequality and poverty. Given the broad list of economic and social outcomes with which CS are related, we would be surprised to find that, on average, countries with higher levels of CS do not have higher levels of entrepreneurship.

Previous research has documented micro-level relationships between cognitive skill and various positive economic and social outcomes, including individual rates of successful entrepreneurship. In a global economy, the same set of skills that enable an individual entrepreneur to successfully innovate *within* her country may well help a nation's entrepreneurs to compete globally. In addition, since the GEDI captures both individual entrepreneurial attitudes and pro-entrepreneurship institutions at the country level, higher levels of cognitive skills may contribute to higher-quality institutions, which in turn promote successful, productive entrepreneurship. Taken together, this suggests possible causal mechanisms that may explain the robust cross-country empirical results reported in this paper.

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Appendix

See Tables 7 and 8.

[24] Admittedly ad hoc, we began with a regression of New Incorporations on real GDP per capita and regionals. We then added each of the control variables individually. If the control variable was not significant at the 10 % level or better, it was excluded and the next variable was added. This process produced a "baseline" regression that included the Gini and real GDP per capita variables (plus regionals). What appears in column two of Table 6 is the outcome of adding CS to that baseline regression.

Table 7 Countries used in analysis, with individual GEDI and CS

Country	GEDI	CS (IQ)
Algeria	0.189	83
Australia	0.598	98
Austria	0.454	100
Belgium	0.576	99
Bosnia	0.177	94
Brazil	0.225	87
Canada	0.737	99
Chile	0.414	90
China	0.281	105
Colombia	0.279	84
Croatia	0.284	99
Czech	0.415	98
Denmark	0.763	98
Egypt	0.237	83
Finland	0.564	99
France	0.498	98
Germany	0.544	99
Greece	0.318	92
Hong Kong	0.446	108
Hungary	0.253	97
Iceland	0.617	101
India	0.227	82
Indonesia	0.256	87
Iran	0.145	84
Ireland	0.631	92
Israel	0.472	95
Italy	0.407	97
Japan	0.397	105
Jordan	0.234	85
Korea	0.488	106
Latvia	0.361	98
Macedonia	0.242	91
Malaysia	0.364	92
Mexico	0.270	88
Morocco	0.235	84
Netherlands	0.616	100
New Zealand	0.679	99
Norway	0.623	100
Philippines	0.125	86
Poland	0.286	95
Portugal	0.350	95
Romania	0.246	91
Russia	0.218	97
S. Africa	0.277	72
Saudi Arabia	0.381	80
Serbia	0.183	89
Singapore	0.558	108
Slovenia	0.489	96
Spain	0.401	98
Sweden	0.685	99
Switzerland	0.630	101
Syria	0.163	79
Thailand	0.221	91
Tunisia	0.218	84
Turkey	0.272	90
UAE	0.417	83
Uganda	0.100	73
United Kingdom	0.561	100
United States	0.717	98
Venezuela	0.224	84

Table 8 Data sources

Variable	Source
GEDI	Acs and Szerb (2010)
CS	Lynn and Meisenberg (2010)
Gini	CIA *World Factbook*
RGDP/cap	Penn World Tables
%Manufacturing	CIA *World Factbook*
Education	Barro and Lee (2011)
Fraser	Gwartney et al. (2011)
Heritage	Miller et al. (2012)
New incorporations	World Bank (2014)

References

Acs, Z. J. (2006). How is entrepreneurship good for economic growth? *Innovations, 1*, 97–107.

Acs, Z. J., & Armington, C. (2006). *Entrepreneurship, geography, and American economic growth*. New York: Cambridge University Press.

Acs, Z. J., & Audretsch, D. (Eds.). (2003). *International handbook of entrepreneurial research*. The Netherlands: Kluwer.

Acs, Z. J., Autio, E., & Szerb, L. (2014). National systems of entrepreneurship: Measurement issues and policy implications. *Research Policy, 43*, 476–494.

Acs, Z., Desai, S., & Klapper, L. (2008). What does entrepreneurship data really show? A comparison of the global

entrepreneurship monitor and World Bank Group data sets. *Small Business Economics, 31*, 219–239.

Acs, A. J., & Szerb, L. (2010). The Global Entrepreneurship and Development Index (GEDI). In *Paper presented at "Opening up Innovation: Strategy, Organization and Technology"*. London: Imperial College.

Ahmetoglu, G., Leutner, F., & Chamorro-Premuzic, T. (2011). EQ-nomics: Understanding the relationship between individual differences in trait emotional intelligence and entrepreneurship. *Personality and Individual Differences, 51*, 1028–1033.

Andrews, D., & Leigh, A. (2009). More inequality, less social mobility. *Applied Economics Letters, 16*, 1489–1492.

Audretsch, D. B., Keilbach, D. B., & Lehmann, E. E. (2006). *Entrepreneurship and economic growth*. Oxford: Oxford University Press.

Barro, R., & Lee, J. (2011). Barro-Lee Educational Attainment Dataset. Accessed at BarroLee.com.

Belasen, A., & Hafer, R. W. (2012). Well-being and economic freedom: Evidence from the states. *Intelligence, 40*, 306–316.

Bjornskov, C., & Foss, N. J. (2008). Economic freedom and entrepreneurial activity: Some cross-country evidence. *Public Choice, 134*, 307–328.

Boettke, P., & Coyne, C. J. (2009). *Context matters: Institutions and entrepreneurship*. Hanover, MA: Now Publishers.

Bowles, S., Gintis, H., & Osborne, M. (2001). The determinants of earnings: Skills, preferences, and schooling. *Journal of Economic Literature, 39*, 1137–1176.

Burks, S., Carpenter, J., Goette, L., & Rustichini, A. (2009). Cognitive skills affect economic preferences, strategic behavior, and job attachment. *Proceedings of the National Academy of Sciences, 106*, 7745–7750.

Caree, M. A., & Thurik, A. R. (2003). The impact of entrepreneurship on economic growth. In Acs, Z. J & Audretsch, D. (Eds.), *International handbook of entrepreneurial research*.

Deary, I. (2001). *Intelligence: A very short introduction*. New York: Oxford University Press.

Gallup. (2009). Entrepreneurship in the EU and beyond. In: Flash Eurobarometer Series, European Commission, Brussels.

Garrett, T. A., & Rhine, R. M. (2011). Economic freedom and employment growth in the U.S. states. Federal Reserve Bank of St. Louis. *Review, 93*, 1–18.

Gennaioli, N., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2013). Human capital and regional development. *Quarterly Journal of Economics, 128*, 105–164.

Gwartney, J., Lawson, R., & Hall, J. (2011). *Economic freedom of the World 2011 annual report*. Vancouver: The Fraser Institute.

Hansen, K. J., Heckman, J., & Muller, K. (2004). The effect of schooling and ability on achievement test scores. *Journal of Econometrics, 121*, 39–49.

Hartog, J., Van Praag, M., & Van Der Sluis, J. (2010). If you are so smart, why aren't you an entrepreneur? Returns to cognitive and social ability: Entrepreneurs versus employees. *Journal of Economics & Management Strategy, 19*, 947–989.

Heckelman, J. C. (2005). Proxies for economic freedom: A critique of the Hanson critique. *Southern Economic Journal, 72*, 492–501.

Heckelman, J. C., & Stroup, M. D. (2000). Which economic freedoms contribute to growth? *Kyklos, 53*, 527–544.

Heckman, J. J. (2008). Schools, skills, and synapses. *Economic Inquiry, 46*, 289–324.

Henrekson, M. (2005). Entrepreneurship: a weak link in the welfare state? *Industrial and Corporate Change, 14*, 437–467.

Hoffman, A. (2007). A rough guide to entrepreneurship policy. In R. A. Thurik, D. B. Audretsch, & I. Grilo (Eds.), *Handbook of research on entrepreneurship policy* (pp. 140–161). Cheltenham: Edward Elgar.

Holcombe, R. G. (1998). Entrepreneurship and economic growth. *The Quarterly Journal of Austrian Economics, 1*, 45–62.

Hunt, E., & Wittmann, W. (2008). National intelligence and national prosperity. *Intelligence, 36*, 1–9.

Jones, G. (2011a). National IQ and national productivity: The hive mind across Asia. *Asian Development Review, 28*, 58–71.

Jones, G. (2011b). IQ and national productivity. *New Palgrave dictionary of economics*. New York: Palgrave Macmillan.

Jones, G., & Schneider, W. J. (2006). Intelligence, human capital, and economic growth: A Bayesian averaging of classical estimates (BACE) approach. *Journal of Economic Growth, 11*, 71–93.

Jones, G., & Schneider, W. J. (2010). IQ in the production function: Evidence from immigrant earnings. *Economic Inquiry, 48*, 743–755.

Kirzner, I. (1973). *Competition and entrepreneurship*. Chicago: University of Chicago Press.

Kirzner, I. (1997). Entrepreneurial discovery and the competitive market process: An Austrian approach. *Journal of Economic Literature, 35*, 60–85.

Knight, F. (1921). *Risk, uncertainty, and profit*. Boston: Hart, Schaffner & Marx; Houghton Mifflin Co.

Lazear, E. P. (2004). Balanced skills and entrepreneurship. *American Economic Review, 94*, 208–211.

Lazear, E. P. (2005). Entrepreneurship. *Journal of Labor Economics, 23*, 649–680.

Lewis, W. W. (2004). *The power of productivity*. Chicago: University of Chicago Press.

Lucas, R. E. (1978). On the size distribution of business firms. *Bell Journal of Economics, 9*, 508–523.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*, 3–42.

Lynn, R., & Meisenberg, G. (2010). National IQs calculated and validated for 108 nations. *Intelligence, 38*, 353–360.

Lynn, R., & Vanhanen, T. (2002). *IQ and the wealth of nations*. Westport: Praeger.

Lynn, R., & Vanhanen, T. (2006). *IQ and global inequality*. Athens: Washington Summit.

Lynn, R., & Vanhanen, T. (2012). *Intelligence: A unifying construct for the social sciences*. London: Ulster Institute for Social Sciences.

Meisenberg, G. (2012). National IQ and economic outcomes. *Personality and Individual Differences, 53*, 103–107.

Miller, T., Holmes, K. R., & Feulner, E. J. (2012). *2012 Index of Economic Freedom*. Washington, D.C.: The Heritage Foundation and Dow Jones & Company.

Nystrom, K. (2008). The institutions of economic freedom and entrepreneurship: Evidence from panel data. *Public Choice, 136*, 262–282.

Oesterdiekoff, G. W., & Rindermann, H. (2007). The spread of AIDS in developing countries: A psycho-cultural approach. *Journal of Social, Political and Economic Studies, 32*, 201–222.

Parker, S. C., & van Praag, C. M. (2006). Schooling, capital constraints, and entrepreneurial performance: The endogenous triangle. *Journal of Business & Economic Statistics, 24*, 416–431.

Potrafke, N. (2012). Intelligence and corruption. *Economics Letters, 114*, 109–112.

Powell, B., & Rodet, C. (2012). Praises and profits: Cultural and institutional determinants of entrepreneurship. *Journal of Private Enterprise, 27*, 19–42.

Ram, R. (2007). IQ and economic growth: Further augmentation of the Mankiw-Romer-Weil model. *Economics Letters, 94*, 7–11.

Reynolds, P. D., Bosma, N., & Autio, E. (2005). Global entrepreneurship monitor: data, collection design and implementation 1998–2003. *Small Business Economics, 24*, 205–231.

Rindermann, H. (2007). The g-factor of international cognitive ability comparisons: The homogeneity of results with PISA, TIMSS, PIRLS and IQ-tests across nations. *European Journal of Personality, 21*, 667–706.

Rindermann, H. (2008a). Relevance of education and intelligence at the national level for the economic welfare of people. *Intelligence, 36*, 127–142.

Rindermann, H. (2008b). Relevance of education and intelligence for the political development of nations: Democracy, rule of law and political liberty. *Intelligence, 36*, 306–322.

Rindermann, H. (2012). Intellectual classes, technological progress and economic development: The rise of cognitive capitalism. *Personality and Individual Differences, 53*, 108–113.

Rindermann, H., & Meisenberg, G. (2009). Relevance of education and intelligence at the national level for health: The case of HIV and AIDS. *Intelligence, 37*, 383–395.

Rindermann, H., Sailer, M., & Thompson, J. (2009). The impact of smart fractions, cognitive ability of politicians and average competence of peoples on social development. *Talent Development & Excellence, 1*, 3–25.

Rindermann, H., & Thompson, J. (2011). Cognitive capitalism: The effect of cognitive ability on wealth, as mediated through scientific achievement and economic freedom. *Psychological Science, 22*, 754–763.

Sala-i-Martin, X. (1997). I just ran two million regressions. *American Economic Review, 87*, 178–183.

Smith, A. (1776)[1937] *An inquiry into the nature and causes of the wealth of nations*. New York: The Modern Library.

Strenze, T. (2007). Intelligence and socioeconomic success: A meta-analytic review of longitudinal research. *Intelligence, 35*, 401–426.

van Praag, C. M., & Cramer, J. S. (2011). The roots of entrepreneurship and labour demand: Individual ability and low risk aversion. *Economica, 68*, 45–62.

Van Praag, M., van Witteloostuijn, A., & van der Sluis, J. (2013). The higher returns to formal education for entrepreneurs versus employees. *Small Business Economics, 40*, 375–396.

van Stel, A., Caree, A. M., & Thurik, A. R. (2005). *The effect of entrepreneurial activity on national economic growth*. Working Paper, Max Planck Institute of Economics.

Vinogradov, E., & Kolvereid, L. (2010). Home country national intelligence and self-employment rates among immigrants in Norway. *Intelligence, 38*, 151–159.

Weede, E., & Kämpf, S. (2002). The impact of intelligence and institutional improvements on economic growth. *Kyklos, 55*, 361–380.

Wicherts, J. M., Dolan, C. V., Carlson, J. S., & van der Maas, H. L. J. (2009). Raven's test performance of sub-Saharan Africans: Average performance, psychometric properties, and the Flynn effect. *Learning and Individual Differences, 20*, 135–151.

Wicherts, J. M., Dolan, C. V., Carlson, J. S., & van der Maas, H. L. J. (2010). A systematic literature review of the average IQ of sub-Saharan Africans. *Intelligence, 38*, 1–20.

World Bank. (2014). *New business registration database*. Washington, D.C.: World Bank.