IQ and Entrepreneurship: International Evidence

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Abstract

National measures of cognitive skill, including IQ tests, have received attention recently as a possible driver of cross-country productivity differences. In a parallel literature, national measures of entrepreneurial activity and pro-entrepreneurship policies have received similar attention. This paper is the first to demonstrate that higher national average IQ reliably predicts higher ratings for the Acs-Szerb Global Entrepreneurship Development Index (GEDI). Results hold after controlling for GDP, education levels, inequality, broad economic freedom indices, and other factors. Microfounded explanations for these results are considered.

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1. INTRODUCTION

There is a large and expanding literature that examines the links between general cognitive skills and various economic and social developments at the national level. At the individual level, higher IQ is already reliably associated with higher earnings (See Bowles, Gintis, and Osborne, 2001; Strenze, 2007; and Jones and Schneider, 2010 for reviews), but do cognitive skill differences at the national level have a reliable relationships with nation-level outcomes?

On the economic side, there is substantial evidence that nations with higher productivity per worker tend to perform better on conventional IQ tests. Lynn and Vanhannen (2002, 2006) first tested the question at the national level by generating national IQ estimates that were then correlated with per capita real GDP and other measures of economic performance. Finding that the IQ-GDP correlation was positive, Lynn and Vanhanen spurred other researchers to use their IQ data in a series of papers (among others, Weede and Kampf, 2002; Jones and Schneider, 2006, 2010; Ram, 2007; Rindermann, 2008a). These national IQ estimates have since been used across the economics, sociology, psychology, and medical literatures (citations in Jones, 2011a,b). The general finding of these studies is that IQ, or general intelligence, is a robust predictor of economic growth and productivity across a large sample of countries.

Cognitive skill also has been found to be an important factor in predicting differences in a number of related areas. For example, countries with high cognitive skill tend to be healthier, and evidence slower spread of major diseases, such as HIV (e.g., Oesterdiekoff and Rindermann, 2007; Rindermann and Meisenberg, 2009). After controlling for other covariates, national average IQ also predicts political development, in particular the development of the rule of law, democracy and lower corruption (Rindermann, 2008b; Rinderman, et al. 2009; Potrafke, 2012).

The implicit path of causation that runs through much of this work, especially when considering the IQ-economic growth nexus, is that societies inhabited by individuals with higher average cognitive abilities will collectively be more adept at starting and running businesses, innovating in ways that expand products and markets (Meisenberg, 2011). Some economists have approached the question of why some become entrepreneurs by focusing on hypothesized traits, such as risk-taking (van Pragg and Cramer, 2001), a trait *positively* correlated with intelligence in experimental samples (Dohmen, et al., 2010; Frederick, 2005; al-Ubaydli, et al, 2012). Others have looked to measures of general intelligence itself for clues. Sternberg (2004) considers the role of *successful intelligence*—the "ability to succeed in life, according to one's own conception of success" (p. 189)—as a foundation for the entrepreneurial spirit. Nicolaou, et al. (2008) compare the entrepreneurial activity of pairs of monozygotic and same-sex dizygotic twins from the United Kingdom to see if there is a genetic trigger that leads to becoming an entrepreneur. The finding that while heredity matters for entrepreneurship, the empirical relationship is modest. And, in a study that has clear implications for our research, Vinogradov and Kolvereid (2010) find 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—is predicted by the average national IQ score of the immigrant's nation of origin.

This wide-ranging body of evidence suggests that higher levels of general intelligence are associated with greater development across a wide spectrum of measures (economic, health, political) and may be an important part of the story why entrepreneurial activity is higher for some countries than others. In this paper we wish to further examine that question by testing the

basic hypothesis: Does IQ help explain observed differences in entrepreneurial activity across countries?

Understanding the factors that give rise to entrepreneurship is key to understanding what causes some countries to succeed economically and others to not. It has long been recognized (Adam Smith, 1776; Knight, 1921; Kirzner, 1973, 1997) that profit-seeking entrepreneurs play an important role in an economy. Lazear (2004, 2005) has even suggested that the role of the entrepreneur may be second to none in the modern economy. Holcombe (1998) believes 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, suggests Holcombe, 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) That is, entrepreneurship may not affect the inputs *per se* but influences the *process* by which those inputs are combined to produce goods and services. The evidence, though mixed, does suggest that entrepreneurship (in various forms) plays an important role in economic growth models.[1]

We test that hypothesis by employing a new measure of entrepreneurial activity, the Global Entrepreneurship Monitor recently published by Acs and Szerb (2010). Among other aspects, this measure covers a broader set of countries than previous indexes of entrepreneurship. We also use as our measure of general intelligence at the national level the updated Lynn and Vanhanan series recently published in Lynn and Meisenberg (2010). In addition to considering the empirical relationship between these two measures, we test whether measures of economic

[1] Acs and Audretsch (2003); Caree and Thurik (2003); Acs and Armington, 2006; and Audretsch, et al. (2006) provide useful reviews of this literature.

freedom not only affect the role of IQ but also whether they help explain national differences in our measure of entrepreneurship.

The remainder of the paper is as follows. Section 2 provides a brief description of the Acs-Szerb series on entrepreneurship and the IQ measure. Section 3 contains our empirical analysis examining the specific role of IQ. Section 4 extends the analysis by considering the impact of economic freedom on entrepreneurship. This is done not only to further test the robustness of IQ as a predictor of entrepreneurship, but also to widen the reach of our study. Section 5 closes the paper with implications of our findings and suggestions for further research.

2. MEASURES OF ENTREPRENEURSHIP AND IQ

2.a *The Global Entrepreneurship and Development Index*

A significant amount of previous research has relied on the Global Entrepreneurship Monitor (GEM) as the measure of entrepreneurial activity in a country. Thus multi-year data set is based on a 29 country questionnaire survey of individuals ages 16 through 64. It is often considered a valuable look into entrepreneurial actions and aspirations since the survey covers approximately 77,000 individuals. The major drawback of this rich data set is that it covers a relatively small number of countries. While some (e.g., Nystrom 2008) have tried to circumvent this by using panel estimation techniques, it still remains that the entrepreneurial activity of only 29 different economies is being considered.

In this study we use the Global Entrepreneurship and Development Index (GEDI) as constructed by Acs and Szerb (2010). Their measure, like the GEM, is a multi-dimensional index designed to capture the many aspects of why individuals become entrepreneurs and the environments within which this 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.[2] Such measures do not, as Acs and Szerb (2010) note, "capture *quality* differences across entrepreneurial activity, such as opportunity recognition, skills, creativity, or innovation and high growth." (p. 6)

Acs and Szerb (2010) use a multi-layer approach to creating their index. In doing so, they attempt to incorporate into one measure the quality differences that may affect entrepreneurial decisions, and the institutional and environmental factors that affect the social and economic context in which entrepreneurial activity may arise. 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 they argue that any useful index of entrepreneurship must be "complex," reflecting the complexity of the process and the environment within which economic agents engage in entrepreneurial activity.

The GEDI incorporates three sub-indexes.[3] These include the entrepreneurial attitude (ATT), the entrepreneurial activity (ACT) and the entrepreneurial aspiration (AS) 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, the level of education and the overall riskiness of doing business in the country. The ACT sub-index is related to growth potential. It is influenced by measures such as education, ease of doing business and the level of development, the latter of which would include population health and well-being. Finally, the AS sub-index is there to capture the "qualitative, strategy-related" aspects of new business ventures. Some of the

[2] See Acs and Szerb (2010). footnote 17, for references.
[3] This draws on Acs and Szerb (2010), page 7.

institutional measures affecting this sub-index include globalization and the 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 create the GEDI from them, it is necessary to make decisions about which individual and institutional measures are used in the actual estimation. The 18 individual measures (see Table 3 of their paper) are based on GEM-like information pertaining to measures 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. To this Acs and Szerb (2010) add 16 institutional measures taken from a variety of other indexes (see Table 4 of their paper). This set 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. In total there are 71 countries for which the GEDI measure is available, double that for the GEM measure. As noted below, we will use 60 of these countries in our analysis due to lack of common data for the GEDI and IQ measures.

2b. *National measures of IQ*

As noted above, an oft-used measure of general intelligence at the national level has been the IQ series first published by Lynn and Vanhanen (2002, 2006). We use the related series found in Lynn and Meisenberg (2010). Lynn and Meisenberg (2010) test whether the Lynn and Vanhanen IQ data are consistent with educational attainment in the standard areas of math,

science and reading comprehension. The scope of the available measures of educational attainment is quite wide. Two widely cited measures of educational attainment are the Third International Mathematics and Science Study (TIMSS) and the Program 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.[4] The PISA assessment is done at age 15, and there are 3 available (Lynn and Meisenberg, 2010). Lynn and Meisenberg (2010) use the average of the 8th grade TIMSS and the PISA score for countries that participating in no less than one of the assessment studies.[5] Comparing their IQ measure to measures of "educational attainment" (or EA as they term it) where both are available (86 countries), they find that the correlation is very high: 0.917. And for those countries in which they estimated IQ and EA the correlation is 0.907. In addition the Spearman rank correlation for both sets of countries is found to be greater than .90. Lynn and Meisenberg (2010) thus conclude that "The 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)[6]

The Lynn-Meisenberg IQ data set was matched to the countries for which the GEDI measure is available. There are 60 countries for which both variables are available. Appendix Table 1 lists the countries along with their GEDI and IQ values.

[4] 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..

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

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

2c. *Correlations*

At this preliminary stage it is useful to first test for any simple correlation between our measure of IQ and entrepreneurship. Figure 1 is a scatter plot of the raw data. It is readily apparent that the two measures have a positive relationship: Countries with higher levels of IQ also tend to be those countries with a higher GEDI rating. This is verified by the simple correlation between the two series of 0.65, which is significant at greater than the 1% level. Of course, this correlation could be spurious. To better evaluate the relationship, we turn to our regression analysis.

3. ANALYSIS

Our goal is to test for any independent effect that IQ plays in explaining observed differences in entrepreneurship across our sample of countries. Although correlations such as those reported above are useful, they are limited. To better understand the link between IQ and entrepreneurship, we use regression analysis. In this vein, we propose to estimate a regression of the general form:

$$GEDI_i = \alpha + \beta 1\ (IQ_i) + \beta_i\ (Controls) + \varepsilon_i \qquad (1)$$

where GEDI is the Acs-Szerb (2010) measure of entrepreneurship in the ith country, IQ is the ith country's IQ from Lynn and Meisenberg (2010), "Controls" is a set of economic and institutional variables across countries, α and the βs are coefficients to be estimated and ε is the error term.

3.a *Data*

To test spuriousness, we include as controls other plausible drivers of cross-country differences in entrepreneurial activity. We include in our set of control variables measures of income, income distribution, manufacturing employment and education. Although we also

considered other specific measures as controls, the list below represents those that demonstrated at least some statistical relationship with GEDI.[7] One such measure is the variable "Postcom," which is a (0,1) variable assigned to countries that have recently converted from Communist rule. In some previous work (Bjornskov and Foss, 2008) using the GEM measure of entrepreneurship, the estimated coefficient on this variable was found to be positive, though it often does 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.

It is arguable that income inequality, evidenced by the Gini coefficient, may prohibit individuals from taking entrepreneurial risks. Bjornskov and Foss (2008) use such a measure in their explanation of entrepreneurial activity. Meisenberg (2011) finds that IQ is a robust predictor of *lower* income inequality. With the Gini coefficient as the dependent variable, Meisenberg finds that IQ has a significant, positive relationship with income inequality across a large sample of countries. This result holds after controlling for a number of controls, such as income, race diversity and measures of economic and political freedom.

Another control we employ is the level of real GDP per capita. This variable is the work-horse of most such analyses, accounting for variation in economic well-being. In addition to accounting for a country's economic success, we include a labor market variable. Similar to the measure used in Bjornskov and Foss (2008), the percent of labor employed in manufacturing is included to control for any influence that a country's distribution of labor may have on its level of entrepreneurial activity.

[7] Other possible control variables included (all for 2005) the Gender-related Development Index, a measure of government spending to GDP, life expectancy, the percent of labor in agriculture and the percent of adults with a bachelor's degree. In each instance, the estimated coefficient was correctly signed but 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 IQ.

It is important in such a study as this to include some measure of educational attainment as a competing measure of human capital. In previous work, there is evidence that higher levels of education are associated with higher levels of entrepreneurship (Acs, 2006). Education also is a reasonably robust predictor of economic growth (among others, Sala-i-Martin, 1997). And, as noted earlier, there is a positive relation between education and IQ. But what is unresolved is how best to measure education. In this paper we use years in school. Arguably, a preferable measure might be one that captures achievement rather than mere years attended. To this end we experimented with an alternative, the percent of the adult population with at least a bachelor's degree, and found that this variable is not robust in the presence of IQ. This is not too surprising given the high correlation between IQ and the educational achievement measures examined by Lynn and Meisenberg (2010). What is surprising is the fact that, as demonstrated below, years-of-school is a significant factor explaining the variation in the GEDI.

Table 1 provides summary statistics for the variables used. The IQ data were reported in 2010; all other data are for 2005. Sources of the data are provided in Appendix Table 2. Table 2 provides the simple bivariate correlations between these measures. As reported earlier, the correlation between IQ and GEDI is positive and significant. Note also that IQ and the Gini coefficient are negatively correlated, similar to the finding in Meisenberg (2011), and that IQ and education are significantly and positively correlated.

3b. *Regression results*

We now turn to the estimation of equation (1). Our approach is to first estimate equation (1) using only IQ and regional dummies as the only explanatory variables. Then we add the control measures to gauge the robustness of IQ as a predictor of entrepreneurship. Table 3 reports the outcome of this exercise.

The first column of Table 3 reports the result from using IQ and regional dummies as the explanatory variables.[8] The estimated coefficient on IQ is positive and statistically significant at greater than a one percent level. This result corroborates the ocular evidence provided in Figure 1 and the correlation in Table 2, with the caveat that the regression allows for regional idiosyncrasies to be accounted for. The estimated coefficient on IQ indicates that an increase in IQ by one standard deviation is associated with a 0.16 increase in the level of GEDI; that is, about a one standard deviation increase (See Table 1).

How robust is that finding to the inclusion of the other control variables? The second column of Table 3 reports those results. The variable "Postcom" is a (0, 1) variable assigned to countries that have recently converted from Communist rule. Recall that Bjornskov and Foss (2008), using the GEM measure of entrepreneurship, found the estimated coefficient on this variable to be positive, though of questionable statistical importance. We find, in contrast, that for our larger sample and using the GEDI measure, countries that have converted from Communist rule actually are characterized by a lower level of entrepreneurship than the rest of the sample.

Turning to the effect of income distribution, a greater the inequality in income (a higher Gini coefficient) significantly decreases the GEDI measure of entrepreneurship. This result is opposite to that found by Bjornskov and Foss (2008), though they provide no explanation for their estimated positive coefficient. The fact that our estimated coefficient is negative suggests that, at least using this measure of entrepreneurship, income inequality does not spur those in lower echelons of the income spectrum to engage in activities that allows them to migrate upward. Our finding, in contrast, accords with recent evidence that income mobility may be negatively related to income inequality (Andrews and Leigh, 2009).

[8] Only, that is, in the presence of regional variables, which are included in every specification.

Nystrom (2008), in her analysis of self-employment rates finds that the estimated coefficient on per capita GDP is negative: self-employment *per se* is more common in low-productivity countries. But self-employment is only one narrow measure of entrepreneurial potential, and our results indicate that lower-income countries are less supportive of entrepreneurial activity. This finding is similar to that of van Stel, et al. (2005) who report that entrepreneurship increases economic growth, but only in their sample of countries that are prosperous. For poor countries, they find that increased entrepreneurship does not lead to marked increases in economic growth. One possible explanation is that in low-income countries such small-scale entrepreneurship as selling consumer goods is woefully inefficient, and the small-scale entrepreneurship itself suggests barriers to efficient scale (Lewis, 2004).

Our findings are consistent with this latter explanation: the estimated coefficient on real GDP per capita is positive and statistically significant. If the GEDI measure is capturing the "good" factors in the institutions-education-innovation sphere—factors that allow entrepreneurship to flourish—then our estimated coefficient on the level of real GDP per capita simply reflects the fact that higher income countries may enjoy more of those "good institutions" than lower income countries.

Conditions in the labor market also have a significant relationship with entrepreneurship. The estimated coefficient on our "percent of labor employed in manufacturing" variable is negative and statistically significant. The negative and significant estimated coefficient suggests that countries that rely (in terms of employment) more heavily on manufacturing (as opposed to, say service) tend to have lower levels of entrepreneurship, when controlling for other factors.

Finally, we find that greater educational attainment significantly increases the level of entrepreneurship. This finding accords with previous work showing that high-educational

attainment countries also tend to be characterized by higher levels of income and faster economic growth (among others, Sala-i-Martin, 1997). If more education leads to better institutions within which entrepreneurship can grow, then we should not be surprised to find that an increase in schooling is positively (and significantly) related to entrepreneurship.

Adding the control variables results in a marked increase in the explanatory power of the equation. When only IQ (and the regional dummies) is used to explain GEDI, the adjusted-R^2 is about 50 percent. Adding the control variables increases the explanatory power of the equation to over 89 percent.

But the focus of our study is to determine the effects of IQ on entrepreneurship. In the presence of these control variables, how does IQ fare? As found in Table 3, even after the inclusion of our control variables—all of which are statistically significant—the estimated coefficient on IQ continues to exert a statistically significant positive effect on entrepreneurship. Based on the estimated coefficient in column two of Table 3, increasing IQ by one standard deviation increases the GEDI measure of entrepreneurship by 0.06, or about a third of one standard deviation. Although its economic impact is reduced from that found in column 1, it remains an economically and statistically significant predictor of entrepreneurship.

The results in Table 3 support the view that general intelligence, represented by IQ, is an important factor in explaining the variation in the Acs-Szerb measure of entrepreneurship across countries.

4. IQ OR ECONOMIC FREEDOM?

It is logical to infer that at least beyond some point, the larger is the government's presence in the market, the lower the incentives for entrepreneurial activity will be at the margin:

Government activity will eventually crowd 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.

A number of researchers have focused attention on the relationship between entrepreneurship and economic freedom. Theoretical arguments linking entrepreneurship and institutions include Boettke and Coyne (2009). Bjornskov and Foss (2008) provide supporting empirical evidence.[9] They attempt to explain this variation using five component measures of the Fraser Institute's Economic Freedom Index, including government size, legal structure, sound money, international trade and the level of regulatory activity. Across the three entrepreneurship measures derived from the GEM index, Bjornskov and Foss find that only the government size and sound money components are significant in explaining entrepreneurship. In a similar study, Nystrom (2008) uses a panel estimation approach to test for the effect of these economic freedom measures on entrepreneurship. Instead of using an entrepreneurship measure based on the GEM data, she measures of entrepreneurship as the rate of self-employment in a given country. The data set includes 23 OECD countries with data from 1972-2002. She finds

[9] Further empirical evidence is contained in Powell and Rodet (forthcoming).

that three of the freedom components are statistically significant: size of government, legal structure and regulation. The evidence from these two studies indicate 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 all factors that increase the likelihood of entrepreneurship.

We extend this line of research by reconsidering the freedom-entrepreneurship nexus within the context of our model. This accomplishes two goals. First, we can further test the robustness of IQ within the presence of other institutional measures that may influence the economic environment within which entrepreneurship does or does not takes place. Second, it allows us to add to growing literature on the role that economic freedom plays in explaining observed economic outcomes.

Unlike the aforementioned empirical studies we use not one but two measures of economic freedom in our analysis. One measure that is widely used in previous research is the Fraser Institute's Economic Freedom Index (EF). As described in Gwartney, et al. (2011), the freedom index is designed to capture the level of government intervention in an economy. This entails the size of government, in terms of how much it consumes relative to the total economy, how active it is in redistributing income, whether through taxation or social entitlement programs, and in public investment. It also captures the role of property rights in the economy. According to most theories, established and protected property rights, and a rule of law, are positive determinants of entrepreneurship. The overall economic freedom index, which is a composite of specific sub-indices, ranges in value from zero to 10. The higher the score the more economic freedom exists.

In addition to the overall index of economic freedom, just discussed, we use several of the EF measures. Heckelman and Stroup (2000) suggest 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 used in Garrett and Rhine (2011) and Belasen and Hafer (2012). These component indexes include the "size of government"; "legal structure and property rights"; "access to sound money"; "freedom to trade internationally"; and "regulation." Space constraints preclude a detailed description of each series, which can be found in Gwartney, et al. (2011), although the descriptors are reasonably transparent.

The other freedom measure used is the one published by the Heritage Foundation (Miller, et al., 2012). Popularized by its annual appearance in the *Wall Street Journal*, the Heritage Index of Economic Freedom (IEF) is, theoretically, comparable to the Fraser measure: Each is trying to gauge the level of economic freedom in an economy by measuring the level of governmental intervention and assessing a numerical value from 0 to 100. As with the Fraser index, the higher the score the greater is economic freedom deemed to exist. The Heritage measure is available as an overall index, and as 10 different subcomponents. In order to make our comparisons sensible, we use those components from the Heritage measure that match as closely as possible with those of the Fraser measure. We therefore use seven of the subcomponents. As shown in Table 4, sometimes the Heritage measures overlap with more than one Fraser measure since the measurement schemes are not identical.

We believe that incorporating both measures into our analysis provides a valuable and informative robustness check on the claim that general intelligence influences entrepreneurship. It also provides a useful comparison of the relative import of the two freedom measures, and their various components, in explaining entrepreneurship as measure by the GEDI.

Is using the two measures redundant? Table 4 addresses that concern. There we report simple correlations between the two economic freedom measures, based on the aggregative "overall" measures and their components. As one can see, the correlations are all positive and in some instances close to unity. Still, many of the component measures are not so closely related that their independent effects cannot be assessed. In the interest of completeness, we use both measures in our tests.

The estimation results from adding the Fraser and Heritage freedom measures are found in columns 1 and 2, respectively, of Table 5. Both estimated coefficients are positive, as predicted, but only the Heritage measure achieves statistical significance. Since previous researchers have noted that using the overall index may introduce bias in the estimates (Heckelman and Stroup, 2000) we may not wish to place too much weight on these results. More importantly, in the presence of this additional institutional information, the estimated coefficient on IQ remains statistically significant and, relative to the full-results reported in Table 5, maintains its independent economic impact on entrepreneurship.

We now turn to the results of separately adding each freedom measure's components to the estimated model. First, the results using the Fraser measure, reported in Table 6. There we see that only two of the components—legal structure and regulation—are statistically significant.[10] The fact that both coefficients are positive is consistent with previous work and indicates that better legal structures and reduced regulatory burden both improve the conditions in which entrepreneurship can occur. But for present purposes, it also is important to note that IQ continues to have a significant influence on entrepreneurship. Whether or not one includes

[10] Analysis indicates that the significance of the government subcomponent is sensitive to the presence of the education measure. That is, if we delete education the government component of the Fraser index is significant.

these additional institutional measures, the estimated coefficient on IQ remains positive and statistically significant.

Table 7 presents the estimated coefficients on the subcomponents of the Heritage measure of economic freedom. The results are striking. For one, the estimated coefficient on each subcomponent of this measure of economic freedom is positive. This suggests that, like the Fraser measure, improvements in economic freedom, whether by less regulation, lower corruption or improved protection of property rights, all increase the likelihood of higher levels of entrepreneurship. Unlike the Fraser measure, however, the results using the Heritage index are statistically significant at least at the 10% level. Still, as in Table 6, IQ is an important factor that helps explain observed variations in entrepreneurship across our sample of countries.

What is important for our purpose is that the results in Tables 6 and 7 generally corroborate those found in Table 5: IQ is a statistically and economically important variable in explaining the variation in entrepreneurship across our sample of countries. The one exception in Table 7 to this robust result is the finding that when the "corruption" component of the Heritage measure is included in the regression, IQ becomes insignificant though correctly signed. This insignificance is not, however, surprising. On the statistical side, the simple correlation between IQ and corruption is 0.62, significant at greater than a 1 percent level of significance, so collinearity is one possible explanation.

On the economic side, Potrafke (2011) finds that IQ robustly predicts corruption in a large sample of countries when including a large variety of controls. Further, both Potrafke and Jones (2011a,b) argue that there are microstructural reasons why higher cognitive skill should cause lower corruption. Their central claim is that because intelligence is reliably positively correlated with patience (among others, Frederick, 2005; Dohmen, et al., 2010), high IQ

populations will engage in the reputation-building and long-term cooperation that make corruption less appealing. Thus, the specific regression result may partly be explained by cognitive skills mattering heavily through a corruption-reduction channel.[11]

5. IMPLICATIONS AND FURTHER RESEARCH

Our findings can be summarized briefly: We provide the first evidence that national estimates of cognitive skill are reliable predictors of entrepreneurship, measured here by the Acs and Szerb (2010) Global Entrepreneurship Development Index. This outcome holds even after controlling for alternative human capital measures, real GDP per capita, two leading economic freedom indices, geography and other conventional economic variables.

While one might be reluctant to draw causal conclusions from cross-country regressions, the strong micro-level relationship between IQ and various positive economic and social outcomes suggests that policies that raise a nation's average IQ—health and nutrition improvements, immigration policies that favor high-tech, high-skilled workers, and perhaps improvements in formal education—will increase both the entrepreneurial potential of a nation's population and the actual degree of productive economic innovation (Jones 2011a,b).

Future work should investigate the precise channels through which attaining higher levels of cognitive skill can increase a nation's entrepreneurial potential: Do the more-skilled build better institutions? Do they take more business risks? Or, are both channels equally important? Both microeconomic and cross-country approaches will be useful in discovering and documenting the key channels of influence. Experimental research can be used to determine whether high-IQ subjects innovate more—and more effectively—in the laboratory. Finally,

[11] As Sala-i-Martin (1997) emphasizes, even statistically important variables are likely to be statistically insignificant in the occasional specifications: As two simple summaries of IQ's robustness, we note that the median and mean t-statistic for IQ in our reported multivariate regressions are 3.3 and 3.1, respectively.

future work should explore both which portions of the GEDI index hold the most robust relationship with national cognitive skill and which portions of the GEDI have the strongest relationship with long-term economic performance.

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Table 1
Summary statistics

Variable	Mean	Std. Dev.
IQ	93.10	8.39
GEDI	0.39	0.18
Gini	37.12	9.22
RGDP/cap	21748.44	13656.48
%Man	22.95	7.92
YearSchool	9.01	2.46

N = 60

Table 2
Correlations

Variable	IQ	ENT	Gini	RGP/cap	%Man	YearSchool
IQ	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	
YearSchool	0.68***	0.71***	-0.48***	0.68***	-0.57***	1.00

Notes: *** denotes significance at the 1% level; ** the 5% level; and * the 10 percent level.

Table 3
Regression results
Dependent variable: GEDI

	Specification	
Variable	1	2
IQ	0.019***	0.007***
	(7.20)	(3.56)
Postcom		-0.146***
		(4.07)
Gini		-0.003**
		(2.10)
RGDP/cap		0.078***
		(3.34)
% Manufacture		-0.003**
		(2.12)
Year School		0.023***
		(2.76)
$\bar{R}2$	0.478	0.815
F/(pr)	14.41	28.88
	(0.00)	(0.00)

Notes: Absolute values of t-statistics appear in parentheses. ***denotes significance at 1% level, ** significance at 5% and * at 10 percent. All regressions are estimated using White (1980) heteroskedasticity correction. All regressions include regional dummies and a constant term.

Table 4
Correlations between Fraser and Heritage measures of economic freedom

Source/Measure		
Fraser	Heritage	Correlation (/t-statistic)
Overall	Overall	0.93 (19.36)
Legal	Corruption	0.90 (15.01)
Legal	Property Rights	0.88 (13.87)
Regulation	Business	0.70 (7.12)
Trade	Trade	0.51 (4.46)
Money	Monetary	0.68 (7.00)
Government	Fiscal	0.64 (6.30)
Government	Gov Spending	0.63 (6.18)

Table 5
Regression results
Dependent variable: GEDI
Results with IQ, controls and overall measures of economic freedom

	Specification	
Variable	1	2
IQ	0.007***	0.004**
	(3.31)	(2.37)
Postcom	-0.146***	-0.129***
	(4.10)	(3.37)
Gini	-0.004**	-0.004***
	(2.14)	(2.77)
RGDP/cap	0.061**	0.047*
	(2.21)	(1.89)
% Manufacture	-0.002	-0.001
	(1.31)	(0.37)
Year School	0.022**	0.018**
	(2.48)	(2.43)
Fraser	0.027	
	(1.43)	
Heritage		0.005***
		(3.77)
$\bar{R}2$	0.819	0.839
F/(pr)	26.38	30.25
	(0.00)	(0.00)

Notes: Absolute values of t-statistics appear in parentheses. ***denotes significance at 1% level, ** significance at 5% and * at 10 percent. All regressions are estimated using White (1980) heteroskedasticity correction. All regressions include regional dummies and a constant term.

Table 6
Regression results
Dependent variable: GEDI
Results with IQ, controls and subcomponents of Fraser economic freedom index

	Specification				
Variable	1	2	3	4	5
IQ	0.006***	0.006**	0.008***	0.008***	0.008***
	(3.06)	(3.04)	(4.00)	(3.60)	(4.12)
Postcom	-0.117***	-0.149***	-0.156***	-0.155***	-0.159***
	(2.99)	(4.41)	(4.41)	(4.48)	(4.60)
Gini	-0.003*	-0.003**	-0.003*	-0.003**	-0.002*
	(1.88)	(2.36)	(1.92)	(2.02)	(1.64)
RGDP/cap	0.048**	0.057**	0.067***	0.070***	0.070***
	(2.18)	(2.11)	(2.58)	(2.90)	(3.07)
% Manufacture	-0.002	-0.002	-0.003*	-0.003*	-0.002**
	(1.70)*	(1.40)	(1.87)	(1.89)	(2.10)
Year School	0.022***	0.019**	0.023***	0.024***	0.024***
	(2.57)	(2.34)	(2.70)	(2.64)	(2.77)
Legal	0.031**				
	(2.11)				
Regulation		0.035***			
		(2.80)			
Trade			0.005		
			(0.36)		
Money				-0.0004	
				(0.046)	
Government					-0.008
					(0.79)
$\bar{R}2$	0.831	0.837	0.814	0.814	0.816
F/(pr)	28.55	29.88	25.53	25.46	25.91
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

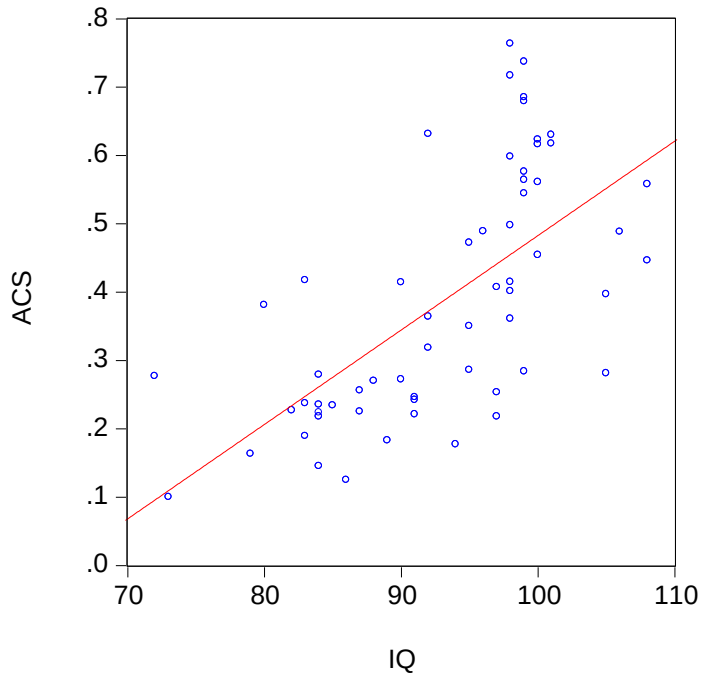
Notes: Absolute values of t-statistics appear in parentheses. ***denotes significance at 1% level, ** significance at 5% and * at 10 percent. All regressions are estimated using White (1980) heteroskedasticity correction. All regressions include regional dummies and a constant term.

Table 7
Regression results
Dependent variable: GEDI
Results with IQ, controls and subcomponents of Heritage economic freedom index

	Specification					
Variable	1	2	3	4	5	6
IQ	0.006***	0.001	0.008***	0.007***	0.006***	0.003*
	(3.02)	(0.79)	(3.88)	(3.46)	(3.35)	(1.64)
Postcom	-0.164***	-0.062	-0.156***	-0.146***	-0.142***	-0.095**
	(5.19)	(1.41)	(4.35)	(4.10)	(4.13)	(2.04)
Gini	-0.004***	-0.002	-0.003**	-0.004**	-0.003**	-0.002
	(3.11)	(1.62)	(2.02)	(2.39)	(2.17)	(1.56)
RGDP/Cap	0.030	0.034*	0.091***	0.072***	0.075***	0.055**
	(1.28)	(1.77)	(4.08)	(3.12)	(3.13)	(2.54)
% Manufacture	-0.001	-0.001	-0.002**	-0.002	-0.003*	-0.002
	(0.25)	(0.87)	(2.10)	(1.15)	(1.84)	(1.20)
Year School	0.024***	0.018**	0.026***	0.020***	0.022***	0.018**
	(3.17)	(2.14)	(3.27)	(2.55)	(2.61)	(2.21)
Business	0.004***					
	(3.88)					
Corruption		0.004***				
		(3.64)				
Trade			-0.002*			
			(1.93)			
Labor				0.002*		
				(1.73)		
Monetary					0.022*	
					(1.92)	
Property						0.003***
						(2.81)
$\bar{R}2$	0.852	0.854	0.817	0.821	0.814	0.833
F/(pr)	33.26	33.81	26.04	26.84	25.46	28.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: Absolute values of t-statistics appear in parentheses. ***denotes significance at 1% level, ** significance at 5% and * at 10 percent. All regressions are estimated using White (1980) heteroskedasticity correction. All regressions include regional dummies and a constant term.

Figure 1



APPENDIX

Table 1

Country	GEDI	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	0.27	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	0.35	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	0.63	101
Syria	0.163	79
Thailand	0.221	91
Tunisia	0.218	84
Turkey	0.272	90
UAE	0.417	83
Uganda	0.1	73
United Kingdom	0.561	100
United States	0.717	98
Venezuela	0.224	84

Table 2
Data sources

Variable	Source
GEDI	Acs and Szerb (2010)
IQ	Lynn and Meisenberg (2010)
Gini	CIA World Factbook
RGDP/cap	Penn World Tables
%Manufacturing	CIA World Factbook
Education	Barro & Lee (2011)
Fraser Freedom	Gwartney, et al. (2011)
Heritage Freedom	Miller, et al. (2012)