IQ in the Utility Function: Cognitive skills, time preference, and cross-country differences in savings rates

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I. Introduction

Why do some countries save more than others? This question has motivated a vast literature spanning the fields of international economics, economic growth, and public finance. In this paper, we propose a new answer to this question: that national savings rates differ across countries in large part because rates of time preference differ across countries. And time preference differs across countries in large part because psychometric intelligence, a key predictor of patient behavior, differs persistently across countries. Our thesis can be summed up quite simply: Smarter groups are more patient, and more patient groups are more frugal.

We merely take a stylized fact from the world of behavioral economics—that smarter individuals are more patient, less impulsive—and use that fact to calibrate a Ramsey growth model. This paper is thus another contribution to the emerging field of behavioral macroeconomics. In a world where the Feldstein-Horioka puzzle holds, and a country’s savings rate is strongly correlated with its investment rate, the fact that smarter groups are more patient allows us to make a further prediction: High-IQ countries will be more capital intensive. And under conventional though restrictive assumptions, we also predict that the marginal product of capital will be lower in high-IQ countries.

We make no claim that IQ differences are permanently intractable, nor that they explain 100% of the difference in savings rates across countries. Such claims are far beyond the scope of this paper; instead, we claim that differences in measured intelligence—whether proxied by IQ tests, or by math and science tests—are one important driver of cross country differences in savings and hence productivity. Even if all other structural differences between countries were eliminated, if today’s IQ differences still remained, then the nations of the world would still have substantial income inequality. In a conventional Cobb-Douglas production function with a broad capital share of 2/3, the high-IQ countries are predicted to be 50% richer than the low-IQ countries in steady state, just through the time preference/capital accumulation channel.

We begin by discussing the microeconomic and psychological literatures showing a link between patience and IQ. This gives us some estimates of the link between IQ and time preference. We largely use the most conservative estimate in our work. Along the way, we note the link between IQ and risk aversion: Though high-IQ individuals tend to be more risk tolerant, and though risk tolerance implies more savings in a typical Ramsey model, this channel turns out to be too small to matter. Perhaps future working using other preference assumptions will overturn this result.

After collecting these parameter estimates, we insert them into a conventional Ramsey growth model with CRRA utility. In a closed economy, this would be the end of the story: Each country’s steady-state capital/output ratio would be pinned down by that country’s
We use two sets of quantitative exercises: First, we calculate the extent to which IQ differences are able to explain the magnitude of real-world differences in savings and investment rates, physical marginal products of capital, and capital output ratios. Second, we run simple (indeed “naïve”) calibrations to see how well an IQ-augmented Ramsey model can match the data.

Finally, we integrate these results with the results of Jones and Schneider (forthcoming), who showed that IQ’s well-documented effect on wages can explain 1/6th of cross-country differences in log productivity. Together, these two neoclassical channels can explain XX% of the log variance in productivity across countries.

2. IQ and Time Preference at the Individual Level.
Psychologists have known for decades that higher IQ is associated with greater patience, which they often refer to as “delay discounting.” (see also Jensen, c. XX). A recent meta-analysis of 24 studies concluded: “[A]cross studies, higher intelligence was associated with lower D[elay] D[iscounting]...” And recent work by economists (inter alia, Frederick, “Cognitive Reflection and Decisionmaking,”; Benjamin Brown Shapiro “Who is Behavioral”) have demonstrated that low-IQ individuals act in a more “behavioral” fashion.

These results establish that IQ and patience are negatively related; but quantitative macroeconomists need more than that. We need a precise number, a coefficient that sums up how much one more IQ point reduces a person’s rate of time preference, ρ. Fortunately, we have two estimates of the quantitative influence of IQ on ρ, or \( \frac{\partial \rho}{\partial \text{IQ}} \). We will focus on two studies, an econometric estimate from Warner and Pleeter (2001), and an experimental measure from Dohmen et al. (2007).

Warner and Pleeter used the results from a unique, high-stakes event to estimate the link between cognitive skill and time preference: The downsizing of the U.S. military at the end of the Cold War. At that time, the military offered over some enlisted personnel a choice between a lump-sum payment and an annuity; the typical lump-sum offer was $25,000, so this was a genuine high-stakes choice. Their sample contained over 200,000 enlisted personnel, they used a wealth of personal characteristics as regressors to estimate the determinants of the personal discount rate.

Among the characteristics were four categories of AFQT (Armed Forces Qualifying Test) score, the score used in the NLSY. The top two “Mental Groups” had statistically significantly lower discount rates: Mental Group I, whose scores were 1.5 to 2.3 standard deviations above the mean, had a discount rate 1.6% lower than Mental Group IV. Mental Group II, 0.5 to 1.5 standard deviations above the mean, had a discount rate 0.6% lower than Mental Group IV. Both were significant at the 5% level, which Mental Group III was indistinguishable from group IV, and since the Group III coefficient was itself negligible (+0.2%), we assume that III and IV combined have identical discount rates.
These estimates almost surely understate the influence of general mental ability on time preference, since many of the other statistically significant control variables included in the regression—a career in electronics or medicine, income, college education, and the like—are in themselves tests of mental ability (Gordon, “Everyday life as an IQ test). Thus, the regression is implicitly including multiple IQ tests, and our AFQT measure is only one among the throng, a point made in a similar context by Zax and Rees (XXXX).

Nonetheless, it is worthwhile to estimate our parameter of interest, $\frac{\partial \rho}{\partial IQ}$, where, as throughout this paper, IQ is measured in standard deviations. We assume normality in order to estimate the midpoint between Mental Group I and the combination of Mental Groups III and IV. Since the military does not accept applicants below the 10th percentile, groups III and IV span a range from the 10th to the 69th percentile, and yielding a midpoint of -0.27σ. Mental Group I has a midpoint of +1.8 σ, so a 2.27σ rise in mental ability appears to cause a 1.6% fall in the discount rate. Thus, we arrive at our econometric estimate: $\frac{\partial \rho}{\partial IQ} = -1.6%/2.27 \sigma = -0.77$.

Our experimental estimate is much simpler to calculate. Dohmen et al. gave subjects two portions of typical IQ test (a symbol-matching test and a vocabulary est) during an economic experiment on impatience and risk-aversion run in Germany; the experiment used cash as well as attitude surveys to elicit measures of patience. They report overwhelming evidence that higher IQ predicts greater patience, even after controlling for income, personality measures, and other demographics.

Then in their appendix, they go one step further: They assume a CRRA utility function in order to separate out risk aversion from impatience, and the estimate they effect of IQ on the rate of time preference. In these estimates, based on strong functional form assumptions, higher IQ is a statistically significant predictor of greater patience in 3 of 6 estimates, with no incorrectly signed significant results. Their coefficients across various specifications, reported in $\frac{\partial \rho}{\partial IQ}$ form, are: -1.5, -1.4, -1.2, -0.6, +0.2, +0.4. If we have uniform prior beliefs about the true value of $\frac{\partial \rho}{\partial IQ}$, then a simple average yields us a posterior estimate: -0.68, remarkably close to the Warner and Pleeter estimate.

In the absence of other precise estimates, we take the average of these two as our baseline estimate of $\frac{\partial \rho}{\partial IQ}$: -0.73.

3. IQ and Time Preference in General Equilibrium.

In our simple calibration exercise, our goal is to be as conventional as possible. Thus, we follow the Ramsey models covered in the second chapters of both Romer (XXXX) and Barro and Sala-i-Martin (XXXX), and use a constant relative risk aversion (CRRA) utility measure. Note that CRRA is routinely used in Dohmen et al. piece, and in much of the choice under
uncertainty literature as well as in the growth and productivity literature; so this modeling choice is the most conservative possible.

We assume that each national economy is closed to capital flows; to the extent that the Feldstein-Horioka stylized fact is true—that national savings is strongly and persistently correlated to national investment—little will be lost with this assumption. Throughout, we suppress time subscripts whenever possible.

As in the standard Ramsey model, we use a Cobb-Douglas production function, \( Y = K^\alpha (AL)^{1-\alpha} \), and a per-period utility function of \( u(c) = c^{1-\theta} \). Then, if \( A \) (technology) grows at annual rate \( g \), and \( L \) (labor supply) grows exogenously at annual rate \( n \), and future utility is subjectively discounted at rate \( \rho \), the following is true in steady state:

The Ramsey savings rate is:

\[
 s^* = \frac{\alpha(g + n + \delta)}{\rho + \theta g + \delta}
\]

And in steady state, the capital/output ratio is

\[
 (K/Y)^* = \frac{\alpha}{\rho + \theta g + \delta}
\]

The values we care about most are \( d(s^*)/d(IQ) \) and \( d(K/Y)^*/d(IQ) \): We want to know how IQ influences a nation’s steady-state savings rate and capital intensity. These values will depend on conventional growth model parameters. Taking the U.S. as a benchmark nation, we take the real return on capital, \( \rho + \theta g \), to be 0.04 or 4%, as in conventional RBC models; as average IQ falls in a country and time preference rises, the real return on capital should rise. We assume capital shares, \( \alpha \), equal to 1/3 or 2/3, depending on whether we are considering narrow physical capital or a broader measure that also includes human capital. We also take \( g = 0.02 \), and \( n = 0.01 \) in these comparisons.

Finally, we assume a depreciation rate of \( \delta = 0.03 \) as in Mankiw, Romer, and Weil; for ease of exposition, we assume population growth of 1% per year in this first exercise, but use actual cross-country population growth data in the calibration below.

3A. IQ’s influence on steady-state values

With these values in hand, we calculate how equilibrium interest rates, savings rates, and capital intensities and capital intensities will differ as IQ differs across the observed range of cross-country variation.

As Lynn and Vanhanen show, going from the 5\textsuperscript{th} percentile to the 95\textsuperscript{th} percentile of the national average IQ distribution takes us across a span of 38 IQ points. This span, from 68 to 106, is equivalent to 2.5\( \sigma \) within a typical national population. Two recent studies (XXXX) raise some questions about the reliability of the national average IQ estimates in sub-Saharan Africa—the authors provide some evidence that the scores are perhaps 10-12 points too low, and argue that average African IQ is closer to 80 or 82—but even these critics conclude that average IQ scores in sub-Saharan Africa are still the lowest in the world. To span both estimates, we will calculate the effect of both a 1.6\( \sigma \) (24 IQ points) and
a 2.5σ (38 IQ points) rise in IQ; we will also provide a 1σ (15 IQ points) estimate for reference.

Since we treat the U.S. as the benchmark nation, the values in the table can be interpreted as the effect of a fall in IQ from the U.S. average of 100; or by simply changing the sign, one can interpret it as the effect of a rise in IQ to the U.S. level.

<table>
<thead>
<tr>
<th>X</th>
<th>1</th>
<th>1.6</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>dr/dIQ</td>
<td>0.007</td>
<td>0.012</td>
<td>0.018</td>
</tr>
<tr>
<td>dKY/dIQ (alpha = .33)</td>
<td>-0.445</td>
<td>-0.674</td>
<td>-0.975</td>
</tr>
<tr>
<td>dlog(K/Y)/dIQ</td>
<td>-0.099</td>
<td>-0.154</td>
<td>-0.232</td>
</tr>
<tr>
<td>dKY/dIQ (alpha = .67)</td>
<td>-0.904</td>
<td>-1.369</td>
<td>-1.979</td>
</tr>
<tr>
<td>dlog(K/Y)/dIQ</td>
<td>-0.099</td>
<td>-0.154</td>
<td>-0.232</td>
</tr>
<tr>
<td>ds/dIQ (alpha = .33)</td>
<td>-0.027</td>
<td>-0.040</td>
<td>-0.058</td>
</tr>
<tr>
<td>dlog(s)/dIQ</td>
<td>-0.110</td>
<td>-0.183</td>
<td>-0.302</td>
</tr>
</tbody>
</table>

The results are stark: In the world’s low-IQ countries, the steady-state interest rate is predicted to be between 1.2 and 1.8% higher; this may sound small, but with 4% as the U.S. benchmark this means 30% to 45% higher real borrowing costs in low-IQ countries. Capital-output ratios will be between 15% and 23% lower in the low-IQ countries, and the savings rates will fall by 4% to 5.8% of GDP, a drop of 18% to 30% from their U.S. benchmark levels.

These results establish that using conventional calibration parameters in a Ramsey model, the effect of IQ differences on steady-state savings rates and capital intensity are too big to ignore. In the next section, we fit our model for goodness of fit against cross-country data.

3B.

We begin by reporting some basic correlations. National average IQ estimates are from Lynn and Vanhanen (IQ and global ineq., 200X); these data have been used widely in the economic and psychology literatures, including in Ram, Weede and Kampf, Jones and Schneider, Jones, and Rindermann. Global average IQ (unweighted by country size) is 90 IQ points (compare against the U.S. mean of 100; the highest score in their sample is Singapore with 107). The standard deviation across countries is 11; compare this against the within-country standard deviation of 15 within the U.S.. Finally, recall that 15 IQ points is the 1σ measure we use throughout this paper.

Data on capital per worker, output per worker, and the marginal product of capital come from Caselli and Berger (XXXXX). Savings data are from Penn World Tables, and reflect average national savings rates [(I+X)/Y] averaged over 19X0-2000. Since Caselli and Berger’s data are somewhat sparse, sometimes overlapping with LV’s IQ data on only 35 observations, we also report results using LV’s interpolations of IQ scores for countries that lack IQ data. LV have good evidence that such interpolations are reliable: Their first data base (2001) only included data from 81 countries, plus interpolations for the rest, while their second contained data on 113
countries. Thus, they could compare their interpolated values against later, actual IQ scores. The correspondence was remarkable, with an absolute deviation of only XXXX and a standard error of only XXXX. Therefore, we use the interpolations with great confidence.

The correlation matrix below shows that IQ always has a correlation greater than 0.6 in absolute value with the variables of interest. Of course, reverse causation and omitted-factor causality could be quantitatively important, but the power of calibration lies in its ability to separate out the influence of one particular causal channel.

Let us begin with a calibration of the capital-output ratio. The raw correlation between IQ and K/Y is 0.64, with an R² of 41%. If we leave that capital share as a free parameter, and if the error term is multiplicative, then taking logs yields the following specification:

$$\log(K/Y) = \log(\alpha) - \log(0.04 + 0.0073*IQ + 0.03) + \varepsilon$$

This specification, with only one free parameter—capital share—fits the data extremely well with an R² is 37%. Thus, over 1/3 of the IQ/capital intensity relationship can be explained by IQ’s direct influence on the steady-state capital output ratio. With only 4% more of the variance explained by other factors, there may be little need to invoke reverse causation and other causal channels.

Turning to savings, unconstrained OLS indicates that a 1σ fall in IQ predicted a 9.6% fall in the savings rate (s.e. 1.4), with an R² of 39%.


data

<table>
<thead>
<tr>
<th></th>
<th>IQ</th>
<th>IQ(interp)</th>
<th>K</th>
<th>Y</th>
<th>KY</th>
<th>s</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ</td>
<td>1.00</td>
<td>1.00</td>
<td>0.80</td>
<td>0.79</td>
<td>0.64</td>
<td>0.64</td>
<td>-0.67</td>
</tr>
<tr>
<td>IQ(interp)</td>
<td>1.00</td>
<td>1.00</td>
<td>0.80</td>
<td>0.79</td>
<td>0.64</td>
<td>0.64</td>
<td>-0.67</td>
</tr>
<tr>
<td>K</td>
<td>0.80</td>
<td>0.80</td>
<td>1.00</td>
<td>0.94</td>
<td>0.85</td>
<td>0.66</td>
<td>-0.83</td>
</tr>
<tr>
<td>Y</td>
<td>0.79</td>
<td>0.79</td>
<td>0.94</td>
<td>1.00</td>
<td>0.66</td>
<td>0.54</td>
<td>-0.75</td>
</tr>
<tr>
<td>KY</td>
<td>0.64</td>
<td>0.64</td>
<td>0.85</td>
<td>0.66</td>
<td>1.00</td>
<td>0.74</td>
<td>-0.88</td>
</tr>
<tr>
<td>s</td>
<td>0.64</td>
<td>0.64</td>
<td>0.66</td>
<td>0.54</td>
<td>0.74</td>
<td>1.00</td>
<td>0.58</td>
</tr>
<tr>
<td>r</td>
<td>-0.67</td>
<td>-0.67</td>
<td>-0.83</td>
<td>-0.75</td>
<td>-0.88</td>
<td>-0.58</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Our model has a stark prediction about future savings rates: As long as East Asian countries have higher average IQ’s than the rest of the world, they will continue to have higher savings rates than the rest of the world. If the Feldstein-Horioka link between savings and investment continues to hold, then we can predict that East Asian economies will continue to grow more capital intensive. But if their puzzle fades, and capital moves toward countries whose citizens have higher rates of time preference, then more and more of the world’s physical and organizational capital will be owned by citizens of the world’s most patient countries. In the limiting case, the theoretical model of Barro and Sala-i-Martin
would become a reality: All the world’s capital would be held by the most patient countries, the countries of East Asia.

[Further results to be included later]

3C. The frugality externality.
[To be included later.]

6. Conclusion
A vast literature in psychology has shown that average IQ scores differ widely across countries. A separate, recent literature has shown that these differences in cognitive skill are robust predictors of national economic performance (Jones and Schneider, Jones, Hindermann, etc.). In a parallel microeconomic literature, higher IQ scores are shown to be strong predictors of individual rates of time preference. Our paper is the first to quantitatively link these two literatures together. When we insert these IQ-driven differences in time preference into a standard Ramsey model, the resulting calibration implies that roughly XXX of the difference in savings rates across countries can be explained by persistent differences in national average IQ.

John Rae (1834) provides a precursor of our approach, and Clark (2006) provides an modern restatement of some of these themes; but ours is the first paper to formally quantify the link running from cognitive skills to patience to savings.

[Incomplete references below]

Cited in Elmendorf and Mankiw:
Frankel (1991), Mussa and Goldstein (1993), and Gordon and Bovenberg (1996) review the evidence regarding international capital mobility and discuss a number of explanations for the observed immobility. For a recent attempt to explain the Feldstein-Horioka puzzle within the context of neoclassical growth theory, see Barro, Mankiw, and Sala-i-Martin (1995).


John Rae 1834, Sociological Theory of Capital.

Becker and Casey Mulligan (QJE, 1997) Endogenous determination of time preference