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# Exponential correlation of IQ and the wealth of nations

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## Abstract

Plots of mean IQ and per capita real Gross Domestic Product for groups of 81 and 185 nations, as collected by Lynn and Vanhanen, are best fitted by an exponential function of the form:  $GDP = a * 10^{b * (IQ)}$ , where  $a$  and  $b$  are empirical constants. Exponential fitting yields markedly higher correlation coefficients than either linear or quadratic. The implication of exponential fitting is that a given increment in IQ, anywhere along the IQ scale, results in a given *percentage* in GDP, rather than a given dollar increase as linear fitting would predict. As a rough rule of thumb, an increase of 10 points in mean IQ results in a doubling of the per capita GDP.

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## 1. Introduction

In their book, “IQ and the Wealth of Nations”, Lynn and Vanhanen (2002) present a table listing for 81 nations the measured mean IQ and the per capita real Gross Domestic Product as of 1998 (their Table 7.7). They subsequently extend this to all 185 nations, using estimated IQs for the 104 new entries based chiefly on IQ values for immediate neighbors (their Table 8.9). In both cases they observe a significant correlation between IQ and GDP, with linear correlation factors  $R^2 = 0.537$  for the 81-nation group and 0.389 for 185 nations. McDaniel and Whetzel have extended the examination of correlations to quadratic fitting in a paper that demonstrates the robustness of these correlations to minor variations in individual IQ values (McDaniel & Whetzel, *in press*). But an even stronger correlation is found if the fitting is exponen-

tial rather than linear or quadratic. Even more significantly, exponential fitting suggests a real and logical connection between IQ and the acquisition of national wealth. This exponential fitting is the subject of the present paper.

## 2. Experimental fitting to the IQ/GDP data

Several functions have been tried in order to correlate GDP ( $Y$ ) with IQ ( $X$ ), but the most useful ones have been (a) linear as in Lynn and Vanhanen:  $Y = a + b * X$ , (b) quadratic as with McDaniel and Whetzel:  $Y = a + b * X + c * X^2$ , and (c) exponential:  $Y = a * 10^{b * X}$  (this paper, Figs. 1 and 2). The correlation factors  $R^2$  which result are shown in Table 1 for both the 81-nation and the 185-nation data set, and Table 2 gives the empirical constants  $a$  and  $b$  for linear and exponential fitting. Linear correlations are as reported in Lynn and Vanhanen (2002), quadratic correlations are somewhat better (McDaniel & Whetzel, *in press*), and exponential correlations are the best of all. Equivalent correlation factors are smaller for the

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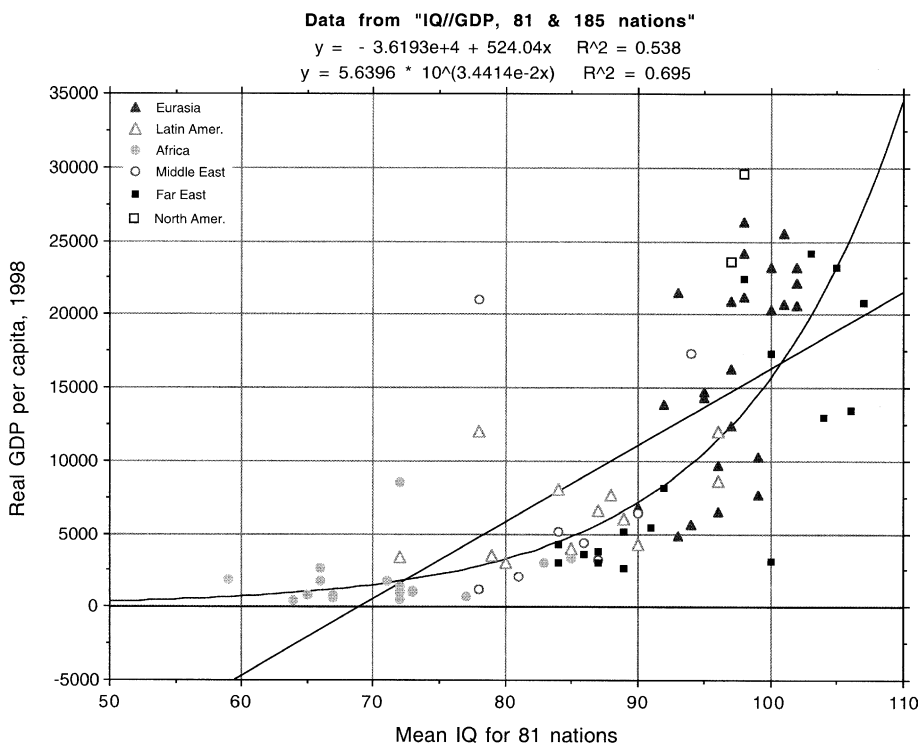


Fig. 1. Plot of mean IQ ( $X$ ) vs. per capita GDP ( $Y$ ) for 81 nations. Linear and exponential curves have been fitted to the data with  $R^2=0.538$  and  $0.695$ , respectively. The linear fit has the form:  $Y = -36,193 + 524.04 * X$ , and the exponential fitting follows:  $Y = 5.6396 * 10^{0.034414 * X}$ . Different symbols are used here to identify approximate geographic locations of the various nations. For a detailed discussion of the implications of this plot, see [Lynn and Vanhanen \(2002\)](#).

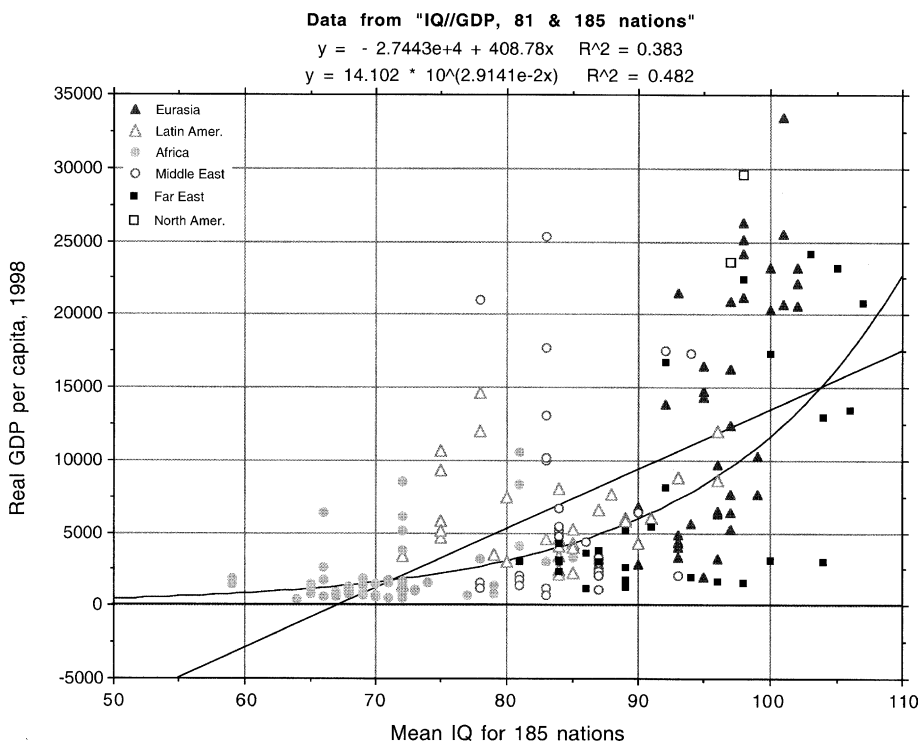


Fig. 2. Similar plot using data from 185 nations, again with both linear and exponential fitting.

**Table 1**  
Correlation factors  $R^2$  for the fitting of linear, quadratic, and exponential curves to data for 81 nations and for 185 nations

Data set	Linear	Quadratic	Exponential
81 nations	0.538	0.608	0.695
185 nations	0.383	0.451	0.482

**Table 2**  
Experimental coefficients for linear fitting with  $Y=a+b*X$ , and for exponential fitting with  $Y=a*10^{b*X}$  ( $X=IQ$ ,  $Y=GDP$ )

Data set	Linear		Exponential	
	$a$	$b$	$a$	$b$
81 nations	-36,193	524.04	5.6396	0.034414
185 nations	-27,443	408.78	14.102	0.029141

185-nation group than for the original 81-nation group, probably a reflection of uncertainties in extrapolation of national mean IQs for the added 104. Quadratic fitting will not be discussed further because

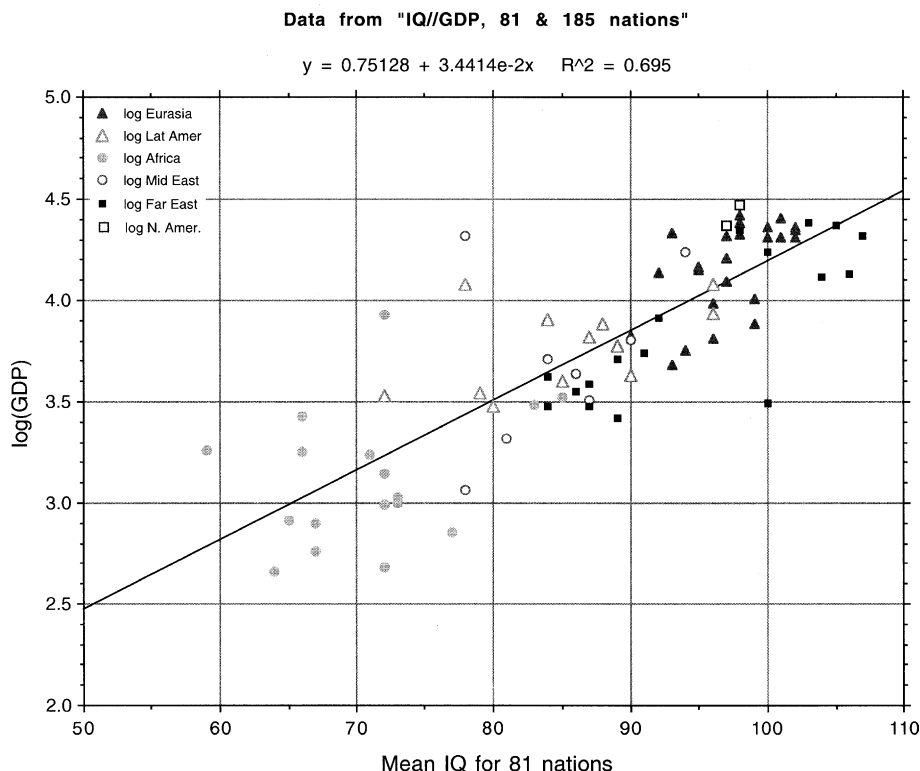
it lacks the theoretical significance that we show below for exponential fitting.

If a correlation follows the exponential expression:  $Y=a*10^{b*X}$ , a linear graph can be obtained by plotting  $X$  against  $\log_{10}Y$ . This has been done for the 81 and 185 nation data sets in Figs. 3 and 4. The correlations and their  $R^2$  coefficients are unchanged, of course; all that has been done is to plot the data in a more informative manner. But these  $\log_{10}Y$  vs.  $X$  graphs do demonstrate what an improvement exponential fitting is over simple linear.

### 3. Functional interpretation of exponential fitting

The foregoing is more than just an exercise in curve fitting and applied mathematics. The fact that per capita GDP depends exponentially on mean IQ helps us understand how they are interconnected. Let  $(X_1, Y_1)$  and  $(X_2, Y_2)$  represent two points along the exponential curve. Then:

$$Y_2/Y_1 = 10^{[b*(X_2 - X_1)]}$$



**Fig. 3.** Conversion of Fig. 1 with exponential fit into a linear plot of  $\log_{10}(GDP)$  vs. IQ. The scatter of points is symmetrically distributed in an oval centered around the exponential correlation line. Nations in North America, Eurasia and the Far East cluster at the high end of the line, Mid East and Latin American nations occupy a belt in the middle, and Sub-Saharan African nations appear at lower left. The Lynn/Vanhanen data have been criticized on the grounds that correlations between GDP and IQ are weak below  $IQ=80$ . But it was decided not to alter the full Lynn/Vanhanen data set. As this figure and the following one indicate, deletion of these low-IQ data would not affect the conclusion of linearity of a  $\log(GDP)$  vs. IQ plot.

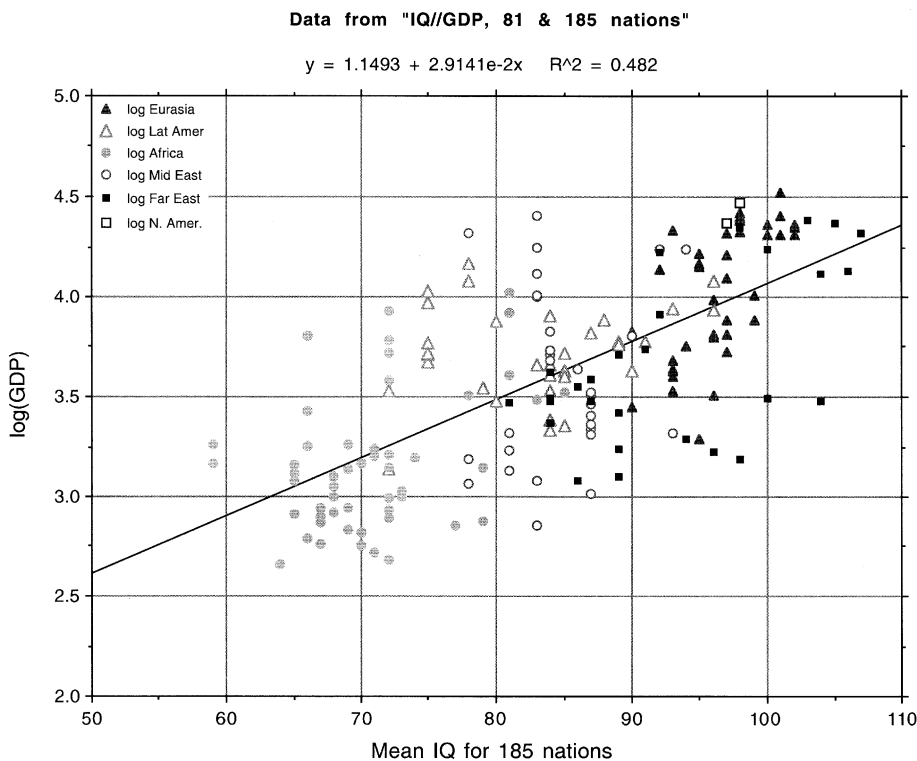


Fig. 4. Similar plot of  $\log_{10}(\text{GDP})$  vs. IQ using data from 185 nations. The scatter now is somewhat more pronounced, probably attributable in part to uncertainties of estimation of mean IQ for the added 105 nations. But the quality of the fit remains high.

The 81-nation data set indicates that a 5 point increase in mean IQ should increase GDP by the ratio:

$$Y_2/Y_1 = 10^{[0.03441*5]} = 10^{[0.1721]} = 1.49$$

and the 185-nation set predicts:

$$Y_2/Y_1 = 10^{[0.02914*5]} = 10^{[0.1457]} = 1.40$$

That is, a 5-point increase in mean IQ anywhere along the IQ scale will be expected to produce a GDP increase of 40% to 50%. Note that this is a *constant percentage change* in GDP, not a constant dollar change as predicted by a linear fitting.

An easily remembered relationship is obtained by considering the effect of a 10 point increase in IQ:

81-nation :  $Y_2/Y_1 = 10^{[0.3441]} = 2.21$

185-nation :  $Y_2/Y_1 = 10^{[0.2914]} = 1.96$

To a good approximation one can predict that a rise in mean IQ of 10 points will produce roughly a doubling of the per capita GDP, anywhere along the IQ scale.

Exponential fitting of GDP to IQ is logically meaningful as well as mathematically valid. It is inherently reasonable that a given increment of IQ should improve the GDP by the same proportional ratio, not the same number of dollars. An increase of GDP from \$500 to \$600 is a much more significant change than is a linear increase from \$20,000 to \$20,100. The same *proportional* change would increase \$20,000 to \$24,000. To select a few examples of points that fall close to the curve in Fig. 2, Cameroon has a mean IQ of 70 and a mean GDP of \$1474, Ecuador has a mean IQ of 80 and a GDP of \$3003, while Turkey has a mean IQ of 90 and a GDP of \$6422. Both the step from Cameroon to Ecuador and that from Ecuador to Turkey involve a factor of two in GDP. At the high end of the data set, Hong Kong with mean IQ 107 is slightly less than 20 IQ points ahead of Turkey, and has a mean GDP of \$20,763, which is slightly less than  $2 \times 2 = 4$  times that of Turkey.

These data tell us that the influence of increasing IQ is a proportional effect, not an absolute one. For the most secure data set, that of 81 nations, the correlation of exponential fitting with experimental data rises to 70%, and no other experimental function tried has approached

this figure. Exponential growth of the wealth of nations with their mean IQ seems to be the norm.

### Acknowledgements

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### References

- Lynn, Richard, & Vanhanen, Tatu (2002). *IQ and the wealth of nations*. Westport CT: Praeger.
- McDaniel, Michael A. & Whetzel, Deborah L. (in press). "IQ and the wealth of nations: prediction of GDP not dependent on precise *g* estimates". Fifth Annual Conference of International Society for Intelligence Research, New Orleans.