

# Quantitative Methods II

## Assignment 3

September 11, 2011

Solutions

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**Problem 1: Summary Statistics.** A table summarizing the appropriate variables is as follows:

Variable	Mean	Std Dev	Maximum	Minimum
Honesty in Government	4.041	2.098	9.4	1.1
GDP per capita	13,871	16,542	121,700	300

OPEC membership, since it is not numeric, does not have a mean, standard deviation, maximum, or minimum. The same with the world region. However, we can indicate that there were 12 OPEC members in this sample, and 167 non-members.

The States were spread around the world, with the regions having the following representation:

Region	Africa	Eastern	Islamic	Latin America	Western	Other
Number	46	16	33	23	49	12

**Problem 2: Linear Correlation.** As linear correlations require meaningful numbers, the region variable cannot have a correlation. OPEC membership can have a correlation, but only if we treat membership as a ‘1’ and non-membership as a ‘0’. With that in mind, the correlation table is

	Democracy	Honesty in Government	GDP per capita
Democracy	1.00	NA	NA
Honesty in Government	NA	1.00	0.74
GDP per capita	NA	0.74	1.00

Unfortunately, there are missing values in the democracy variable. Options to deal with them include removing those records or filling in your best estimate.

As there are few missing democracy scores (as compared to the number of States in the data set), let us just remove them. Doing this, we have the following

	Democracy	Honesty in Government	GDP per capita
Democracy	1.00	0.45	0.15
Honesty in Government	0.45	1.00	0.74
GDP per capita	0.15	0.74	1.00

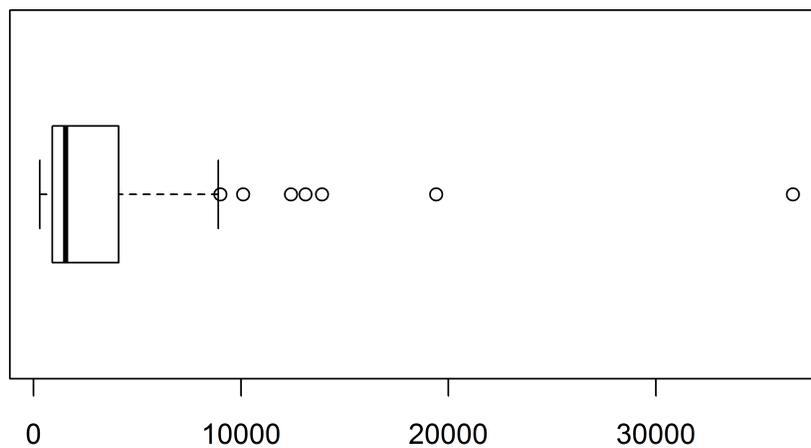
Using Pearson’s product-moment correlation, we find that GDP per capita, Honesty in Government, and Democracy level are all statistically correlated with each other, although the correlation between Democracy and GDP per capita is barely significant ( $\rho = 0.151; t = 1.992; df = 169; p = 0.048$ ).

**Problem 3.** Let us test the null hypothesis:

$$H_0 : \text{The average GDP per capita in Africa is \$5000.}$$

This is a simple one-sample test. To determine which of the two we should use, we need to determine if the GDP per capita in Africa is approximately Normally distributed. The boxplot (Figure 1) strongly suggests a lack of Normality. The Shapiro test concurs, indicating severe deviance from Normality ( $W = 0.566, p \ll 0.0001$ ). As such, we cannot use the t-test.

The Wilcoxon test does not support the null hypothesis. Thus, we conclude that the average GDP per capita in Africa is not \$5000 ( $V = 315.5, p = 0.0141$ ).



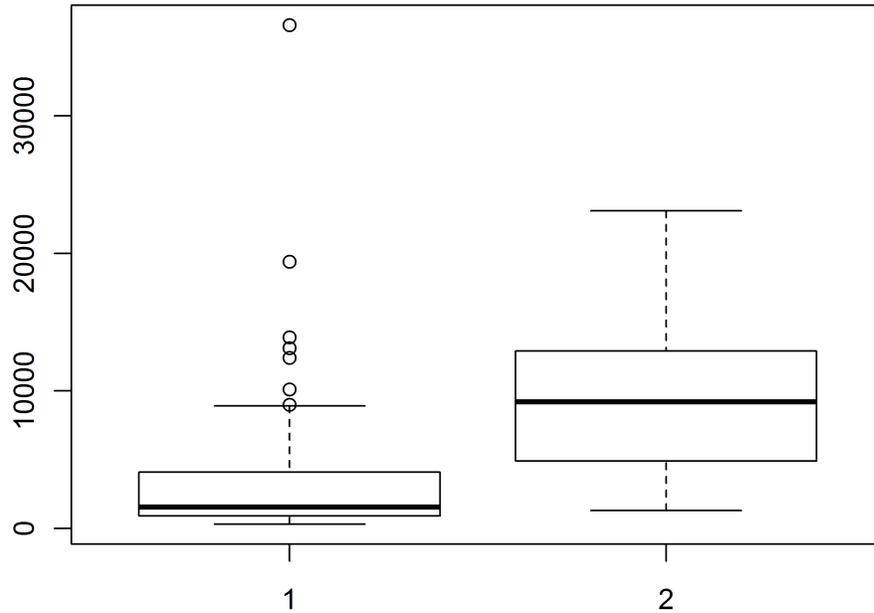
**Figure 1.** *Boxplot of the GDP per capita in African states.*

**Problems 4 and 5.** Let us test the null hypothesis:

$H_0$  : The average GDP per capita in Africa is equal to that of Latin America.

This is a simple two-sample test. As the GDPs per capita in Africa are not Normally distributed (previous problem), we cannot use the t-test. Thus, we will use the Mann-Whitney test.

The Mann-Whitney test indicates that we should reject the null hypothesis. Thus, we conclude that the average GDP per capita in Africa is not the same as in Latin America ( $W = 171.5, p \ll 0.0001$ ).



**Figure 2.** *Boxplot of the GDP per capita in African states (left) and in Latin American states (right).*

**Problem 6.** Let us simultaneously estimate the effects of the level of honesty in government and the region on the GDP per capita of the State. To do this, let us perform linear regression.

The results of this regression are provided in the following table:

	Estimate	Std. Error	t-statistic	p-value
Constant term	-12,454	2086	-5.97	$\ll 0.0001$
Honesty in Government	5631	471	11.95	$\ll 0.0001$
Regions:				
Eastern	2852	3113	0.92	0.3610
Islamic	10,010	2418	4.14	0.0001
Latin America	2001	2719	0.74	0.4627
Western	5011	2612	1.92	0.0567
Other	-2416	3450	-0.70	0.4847

Regarding our hypothesis on the level of honesty in the government, we conclude at the  $\alpha = 0.05$  level that there is a statistically significant difference ( $\beta = 5631, t = 11.95, p \ll 0.0001$ ). Thus, higher GDPs per capita are associated with higher levels of honesty in government.

Regarding the second hypothesis, we reject the null hypothesis and conclude that the six regions of the world differ in terms of GDP per capita, even when taking the level of honesty in government into consideration ( $F = 4.4776, df1 = 5, df2 = 172, p = 0.0007$ ). For instance, the Islamic region has a significantly higher GDP per capita than does the African region ( $\beta = 10,010, t = 4.14, p = 0.0001$ ).