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Internet Penetration Rates of Countries by Geographical Regions Some Examples of Regional Digital Divides

Chaiho Kim
Santa Clara University

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ABSTRACT

There have been many studies of impact of per capita GDP and other income\wealth related variables on Internet penetration rates (IPP) of countries. However, these studies tend to treat the countries in their samples as one group - be it a group selected from the entire world or a group selected from a region such as Sub Sahara Africa, Asia or Europe. This study will examine 193 countries as one group and then divide them into six regional groups and in some cases sub regions. The study finds that while correlation between per capita GDP and IPPP is very significant for 193 countries as a group they are less significant for the regions and not significant for some sub regions. The study also finds that belonging to one region as oppose to anther is often a more statistically significant predictor of IPP which has implications of regional digital divides attributable to social, cultural, and other factors.

KEYWORDS

Internet Penetration Percent, Global Digital Divides, Digital Divides, Internet Uses, Internet Access

CASE FOR THIS STUDY

There have been a large number studies to explain the variations in the computer and Internet uses in different countries in the world. However, the countries selected were designed to meet the need for the given study, for example, OECD countries, developed and developing countries where undeveloped countries have been left out, or some other criterion. Also, the set of explanatory variables used to explain the variations were different from one study to another. They include variables relating to national income such as per capita GDP, education, trade policy, urbanity, telecommunication infrastructure and investment, number of telephones, religion, political freedom, conditions for entrepreneurship, English speaking, and the list goes on. It is not clear whether one set of explanatory variables selected for one group of countries, for example OECD, would be applicable to a different group of countries such as Sub Sahara Africa or South America.

The objective of this study is somewhat limited. Instead of tying to find a set of variables that would explain most of the variations in Internet Penetration rates of all countries, we will try to evaluate (1) if the per capita GNP, found to be the most significant explanatory variable by almost all studies, is statistically significant for all geographic regions of the world and (2) if data suggest that some other variables besides per capital GNP may account for the variations between two geographically connected regions.

This study will first examine the data for the entire 193 countries as one global group and then divide them into six groups based on the whole on geographic regions. The resulting groups are: (1) Middle East of 13 countries, (2) Eastern Europe of 21 countries, (3) Africa of 52 countries, (4) North America, Western Europe, Australia and New Zealand of 24 countries, (5) Asian countries of 46 countries, and (6) Latin America and the Caribbean of 37 countries. The above grouping has taken into account two grouping frameworks available: that of UNESCO and that of Internet World Stats (http://www.internetworldstats.com/). We followed the UNESCO grouping framework with an exception. We substituted the UNESCO's Arab States group with that of the Middle East Group of Internet World States.

We believe that there has not been any study that attempts to examine the variations of Internet Penetration Rates of countries in the different geographic regions of the world.

RECENT STUDIES

A large number of literatures exist on topics relating to this study. We have selected a small subset of them and only those studies that included Internet Penetration Rate or Internet Use Rate (IUR).

Hargittai (1999), one of the earliest social scientists to study the differences among the countries, concludes that among OECD countries that he studied the economic wealth and telecommunication policy are two factors that matter in predicting their Internet connectivity.

Guillen and Suarez (2001) found in their study of 141 countries and paired studies of four countries Ireland, Singapore, Argentina and Spain found that, after controlling per capita and installed telephone lines, cross national differences in the number of Internet users and hosts depends on favorable conditions for entrepreneurs and investment.

Beilock and Dimitrova (2003) made study of 105 developed and developing countries and found that the per capital income (GNPP) is the most important determinant of Interne usage rate (IUR) and that the relationship appear to be nonlinear with income differences having greater impact on IUR at lower than higher levels. They also found that the openness of society, as measured by the breadth and qualities of civil liberties enjoyed by its people is an important determinant of IUR and found at the same time that other non-economic factors such as religion, customs, arts, ethics are not significant.

Oyelaran-Oyeyinka and Kaushalesh (2003) studying 49 countries in Sub Sahara Africa, of which 33 of them are Least Developed Countries (LDC) by United Nations, found that GDP is an important determinant of diffusion of the Internet and that R-square between Per Capita GDP and Internet User is .62 which confirms the findings of the earlier studies.

Chinn and Fairlie (2004) of 161 countries over 1999-2001 observed the importance of per capital income in explaining the gap in computer and Internet use while other factors such as disparity in telecommunication infrastructure may account for the gap. They argue that the US-Middle East/North Africa Internet gap is associated with differences in regulatory gap and that nearly one third of the Internet penetration rates would be closed if countries in Middle East and North Africa have similar regulatory quality as the United States.

Dewan, Gangly, and Kramer (2005) of 40 countries of developed and developing countries in North America, Europe, Asia, South America observed that IT penetration (main frames, PC, and the Internet) is positively associated with national income and association between penetration and income is stronger for countries with higher levels of penetration. They point out that while IT penetration levels are increasing in both rich and poor countries they increase at a substantially higher rate in poor countries, the poor countries being those developing countries such as South Korea, Malaysia, China, Poland, Brazil, and South Africa. They observe that the differential effect of the socio-economic factors across developed and developing countries may be the primary causal force for the digital divide to date.

DATA

Two critical data used in this study consist of IPP and Per Capita GDP. IPP is based on time series data provided as Internet Statistics, Usage and Population. It provides three time series data: Population (Estimated 2008 population), Internet Users (Number of internet users), and Penetration (Internet Users divided by Population) reported on http://www.internetworldstats.com. Footnotes of the reports indicate that Population numbers are from the US Census Bureau and the Internet usage numbers are mainly from data published by Nielsen//NetRatings, ITU, local NICs and other sources. Wikepedia provides three lists of Per Capital GDP-PPP (Purchasing Power Parity) and Per Capita Nominal. Lists are based on International Monetary Fund (IMF), World Bank (WB), and the CIA. Among the information provided by Wikepedia for most countries are GDP and Per Capita GDP, both nominal and PPP, are based on the data provided by IMF. Our study was carried out with per capital GDP-PPP reported in Wikepedia. This study was carried out with GDP-PPP
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ALL REGIONS AS ONE GROUP

An OLS linear regression model was with IPP as dependent variable and GDP-PPA as independent variable for all 193 countries. Outputs are shown below. Note that per capita GNP-PPP is statistically significant with F value of 275 and p-value of 6.01E-36.

Regression Statistics	
Multiple R	0.767612
R Square	0.589228
Adjusted R Square	0.587088
Observations	193

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.296959	7.296958663	275.412	6.00846E-39
Residual	191	5.086982	0.026494697		
Total	192	12.38394			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.081077	0.015438	5.251838	3.98E-07

Per Capita GDP-PPP	1.27E-05	7.68E-07	16.59554	6.01E-39

Table 1: Regression Model Output for World

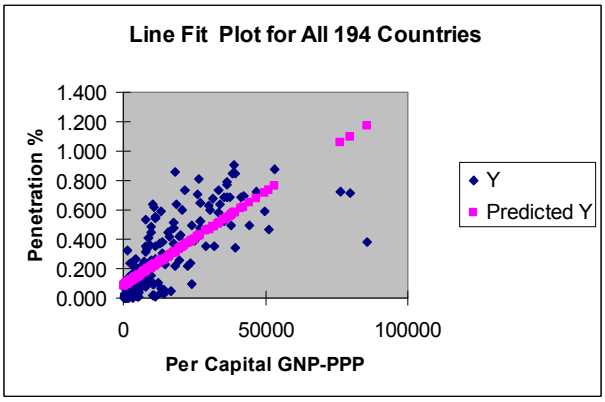

Figure 1 Regression Line Fit Plot for World

A regression line fit plot is also shown above. Three countries with extremely high GDP are Qatar, Luxemburg, and Bermuda with Per Capita GDP-PPP of $85,638, $79,645, and $76,403 respectively whereas the next highest Per Capita GDP-PPP is $53,000 belonging to Norway, Removing these three observations with high leverages, the regression outputs are shown below.

Regression Statistics	
Multiple R	0.824309
R Square	0.679485
Adjusted R Square	0.677789
Observations	190

ANOVA	*df*	*SS*	*MS*	*F*	*Significance F*
Regression	1	8.10284	8.102839598	400.6755	1.40826E-48
Residual	188	3.822137	0.020222947		
Total	189	11.92498			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.047775	0.014175	3.370489	0.00091
Per Capita GDP-PPP	1.62E-05	8.07E-07	20.01688	1.41E-48

Table 2 Regression Model Output for World Excluding Qatar, Luxemburg, and Bermuda

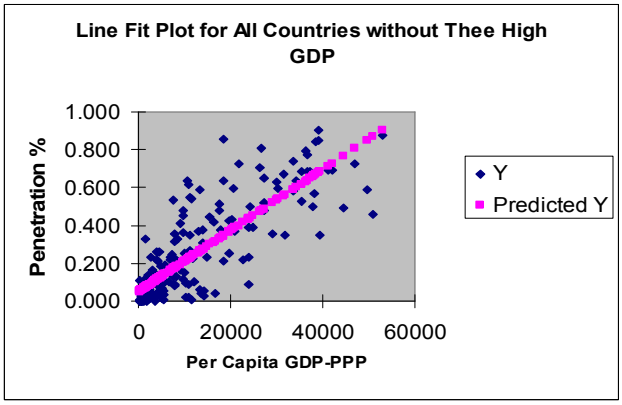

Figure 2 Regression Line Fit Plot for World Excluding Qatar, Luxemburg, and Bermuda

Note that the F value increase to 400.7 and the p-value decreased to 1.41E-48, suggesting a stronger relation between Per Capita GDP-PPP and IPP. It should be noted that the data consists of countries of with extremely low GDP-PPP and low IPP such as those in Sub Saharan Africa as well as very high GDP-PPP with high IPP in Western Europe and North America. Samples which include very low and high per capita GDPs are likely produce very significant correlations between the IPP

and per capita GDP because, after all, per capita GDP is a proxy variable for other digital divide related variables such as the number of PCs, number of telephones, investment in telecommunication infrastructure, all of which would have bearings on the IPP. What is surprising however is a large F value that leads to such a low p-value.

STUDY OF SIX REGIONS AND SOME SUB REGIONS

Mid East Region

The Middle East region includes Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen. A regression model outputs are shown below.

Regression Statistics	
Multiple R	0.592437
R Square	0.350982
Adjusted R Square	0.29198
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.122047	0.122047	5.948672	0.032881548
Residual	11	0.225683	0.020517		
Total	12	0.347729			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.149341	0.058338	2.559933	0.026522
Per Capita GDP-PPP	4.42E-06	1.81E-06	2.43899	0.032882

Table 3 Regression Model Output for Middle East Region

We note that Per Capita GDP-PPP is statistically significant at the .05 level but not at the .01 level. A scatter diagram is shown below.

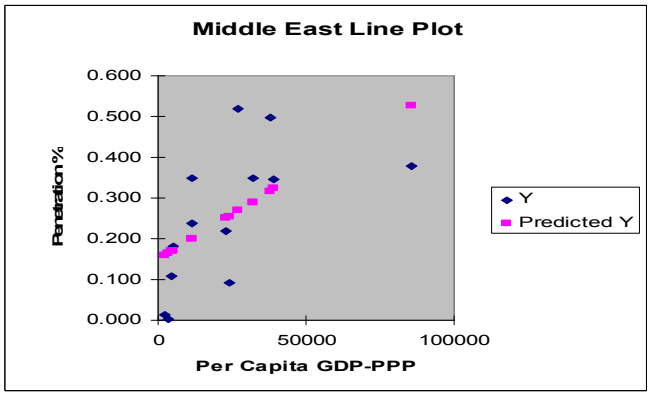

Figure 3 Regression Line Fit for Middle East

Our observations reveal that UAR, Israel, Bahrain, and Iran are significantly above the regression line and that of Qatar, Oman, Yemen and Iraq are significantly below the regression line. Other countries such as Jordan, Syria, Lebanon, Saudi Arabia, and Kuwait are close to the regression line.

Central and Eastern Europe Region

The UNESCO grouping of Central and Easter Europe consist of Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Montenegro, Poland, Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovakia, Slovenia, Macedonia, Turkey, and Ukraine. Regression outputs are shown below.

Regression Statistics	
Multiple R	0.640258079
R Square	0.409930408
Adjusted R Square	0.378874114
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.204490427	0.20449	13.19959	0.001769857
Residual	19	0.294351383	0.015492		
Total	20	0.49884181			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.166609261	0.067951	2.451897	0.024053029

Per Capita GNP-PPA	1.6204E-05	4.46E-06	3.633124	0.001769857

Table 4 Regression Model Output for Central and Easter Europe Region

We note that Per Capita GDP-PPP is statistically significant at the .01 level. A scatter diagram is shown below.

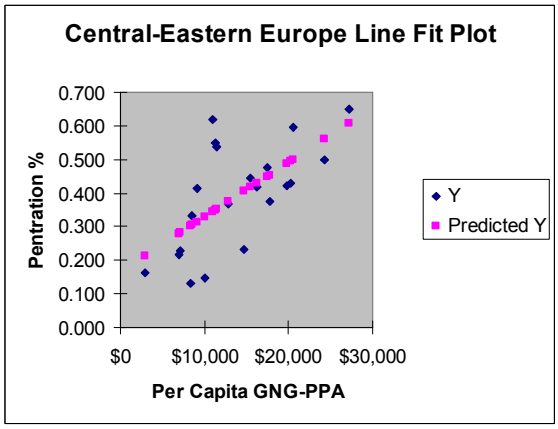

Figure 4 Regression Line Fit Plot for Central and Easter Europe Region

Those countries above the regression line include Estonia, Latvia, Romania, Belarus, Bulgaria, and those significantly below the regression line are Russia, Serbia, and Albania.

Africa Region

Countries include Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tom & Principe, Sierra Leon, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe, 52 countries. Regression outputs are provided below.

Regression Statistics		ANOVA					
Multiple R	0.445763		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.198705	Regression	1	0.030453	0.030453	12.39897	0.000927
Adjusted R Square	0.182679	Residual	50	0.122804	0.002456		
Observations	52	Total	51	0.153257			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.025812	0.008798	2.933841	0.005043			
Per Capita GDP-PPP	6.47E-06	1.84E-06	3.521217	0.000927			

Table 5 Regression Model Output for Africa Region

Note that per capita GDP-PPP is statistically significant at the .01 level. A scatter diagram is shown below.

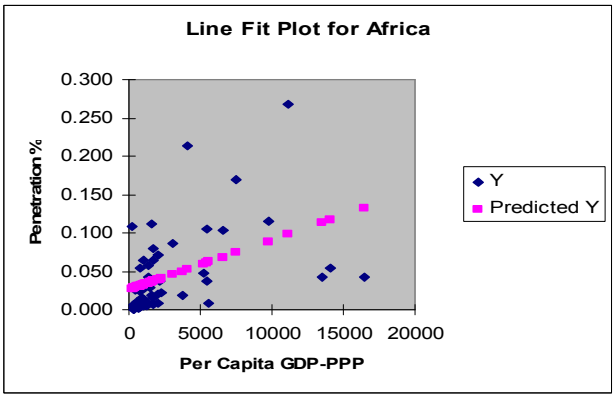

Figure 5 Regression Line Fit Plot for Africa Region

As shown in the scatter diagram above, a high F value is influenced by a few extreme observations from countries in North Africa and the island country of Mauritius. A revised model was constructed by leaving out five countries in North Africa; Egypt, Morocco, Libya, Tunisia, Algeria and the island country of Mauritius. Outputs are shown below.

Regression Statistics	
Multiple R	0.301974
R Square	0.091188
Adjusted R Square	0.070533
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.004067	0.004066757	4.414864	0.041389281
Residual	44	0.040531	0.000921151		
Total	45	0.044597			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.024743	0.005499	4.499832	4.93E-05
Per Capita GDP-PPP	2.88E-06	1.37E-06	2.101158	0.041389

Table 6 Regression Model Output for Africa Excluding North Africa and Mauritius

Note that Per Capita GDP-PPP is not statistically significant at the .01 level. A scatter diagram is shown below.

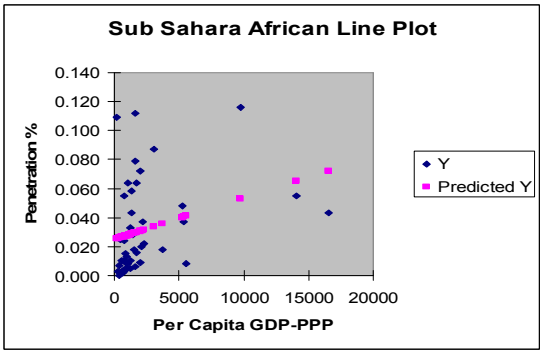

Figure 6 Regression Line Fit Plot for Africa Excluding North Africa and Mauritius

In view of the fact that only 3 of 46 countries have per capita GDP-PPP of about $10,000 or higher and other 43 countries have less than $6,000, we have eliminated the top 3 countries – Botswana, Gabon, and South Africa and ran the regression model again. Outputs are shown below. Note that F value is 1.03 with p-value of .315.

Regression Statistics	
Multiple R	0.157006
R Square	0.024651
Adjusted R Square	0.000862
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000898	0.000898017	1.036229	0.314669665
Residual	41	0.035531	0.00086662		
Total	42	0.036429			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.023087	0.007091	3.255636	0.002273
Per Capita GDP-PPA	3.59E-06	3.53E-06	1.017953	0.31467

Table 7 Regression Model Output for Sub Sahara Africa

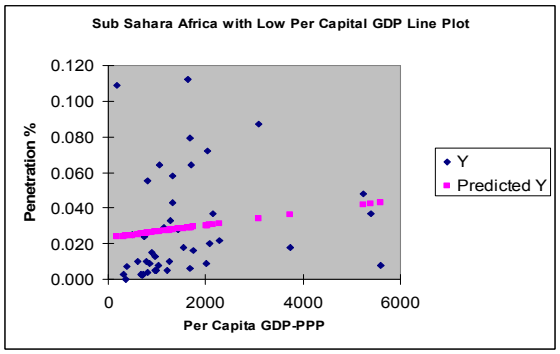

Figure 7 Regression Line Fit Plot for Sub Sahara Africa

The scatter diagram shows that for those 43 countries with per capita GNP-PPP of $6,000 in Sub Saharan Africa, there appears to be no strong correlation between GDP-PPP and IPP.

Western Europe, North America, and Australia-New Zealand Region

UNESCO groups North America and Western Europe as one group and places Australia and New Zealand as a part of East Asia and the Pacific. We included all these countries in one group. Countries included are Andorra, Austria, Australia, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxemburg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. Regression outputs are shown below.

		ANOVA				
Multiple R	0.314743		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.099063	Regression	1	0.049759	0.049759	2.419029	0.134138444
Adjusted R Square	0.058112	Residual	22	0.45254	0.02057		
Observations	24	Total	23	0.5023			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.516877	0.10112	5.111498	4.02E-05
Per Capita GDP-PPP	4.04E-06	2.6E-06	1.555323	0.134138

Table 8 Regression Model Output for Western Europe, North America, Australia and New Zealand

Line fit plot is shown below indicating that not strong correlation between GDP-PPP and IPP. Note that per capita GDP-PPP is not statistically significant at the .05 level.

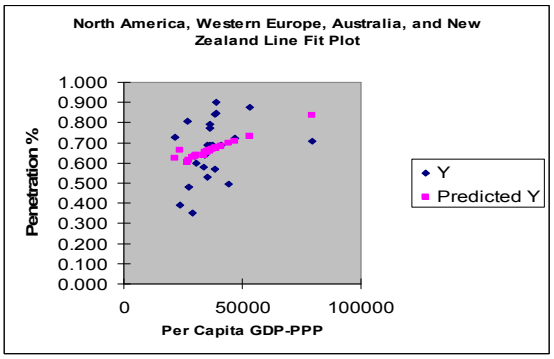

Figure 8 Regression Line Fit Plot for Western Europe, North America, Australia and New Zealand

Per Capita GDP of Luxemburg is $80,000 which is $27,000 higher than the next highest per capita GDP-PPP of $53,000 for Norway and yet its IPP is significantly below the regression line. A significant portion of Luxemburg's GDP may have been contributed by foreign corporations, particularly banking and insurance companies, taking advantage of the country's low taxes. This will raise the per capita GDP considerably due to its small population size of half million and yet the benefits might not accrue to its citizens to the extent displayed by its high per capita GDP. Running the model without Luxemburg with such a high leverage will lead to the outputs shown below.

Regression Statistics		ANOVA					
Multiple R	0.4299821		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.1848846	Regression	1	0.092518	0.092518	4.763223	0.040574279
Adjusted R Square	0.14606959	Residual	21	0.40789	0.019423		
Observations	23	Total	22	0.500408			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.35151347	0.146802	2.394478	0.026053			
Per Capita GDP-PPP	8.863E-06	4.06E-06	2.182481	0.040574			

Table 9 Regression Model Output for Western Europe, North America Et All without Luxemburg

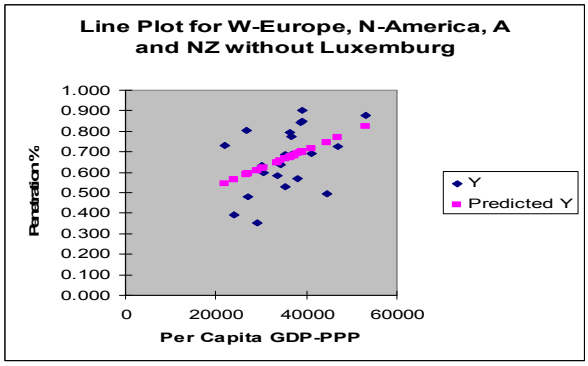

Figure 9 Regression Line Fit Plot for Western Europe, North America et all Excluding Luxemburg

Asia and the Pacific Region

Using the UNESCO grouping, we group the countries in Asia and Pacific regions as: **Central Asia**: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, Uzbekistan; **East Asia**: Brunei Darussalam, Cambodia, China, Hong Kong, Indonesia, Japan, Laos, Macao, Malaysia, Myanmar, Philippines, Singapore, South Korea, Thailand, Taiwan, Vietnam, **South and West Asia**: Afghanistan, Bangladesh, India, Maldives, Nepal, Pakistan, Sri Lanka, Laos, and Myanmar. Iran was included as a part of Middle East even though UNESCO places it as a part of West Asia; **Pacific Islands**: Cooks Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu. Timo-Leste, Nauru, Niue, and Tokelau were excluded because some of the needed data were not available. Furthermore, the population sizes of Nauru and Niue are less than 1,400 each. Regression outputs are shown below.

Regression Statistics		ANOVA					
Multiple R	0.838582		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.703219	Regression	1	1.573232	1.573231697	104.2576	3.49855E-13
Adjusted R Square	0.696474	Residual	44	0.663954	0.015089857		
Observations	46	Total	45	2.237185			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.044643	0.022588	1.976418	0.054397			
Per Capita GDP-PPP	1.47E-05	1.43E-06	10.21066	3.5E-13			

Table 10 Regression Model Output for Asia and the Pacific Region

We note that per capita GDP-PPP is extremely significant. A scatter diagram is provided below.

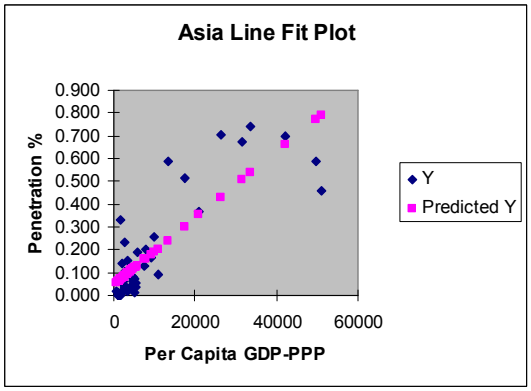

Table 10 Regression Line Fit Plot for Asia and the Pacific Region

Even though Per Capita GDP-PPP and IPP is very significant for the entire Asia and Pacific region, that is not necessarily the case within some of its sub regions. The table below shows the regression model output for 17 countries in Central, South, and West Asia. We note that the p-value is .105.

Regression Statistics		ANOVA					
Multiple R	0.405869		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.16473	Regression	1	0.005003	0.005003	2.958257	0.10599837
Adjusted R Square	0.109045	Residual	15	0.025369	0.001691		
Observations	17	Total	16	0.030372			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.035568	0.018235	1.950565	0.070048
Per Capita GDP-PPP	6.84E-06	3.98E-06	1.719958	0.105998

Table 11 Regression Model Output for Central, South and Western Asia Region

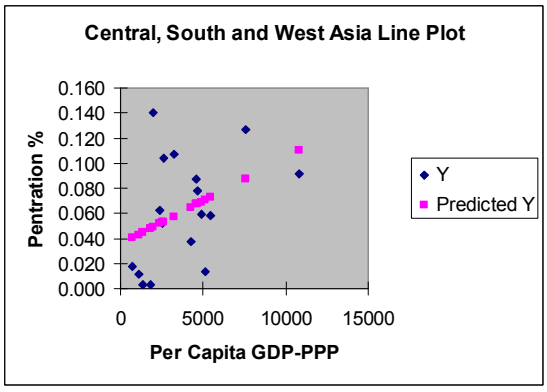

Figure 11 Regression Line Fit Plot for Central, South and Western Asia Region

Latin America and the Caribbean Region

The region has been separated into two groups: **Latin America** and the Caribbean. Latin America group include Argentina, Bolivia, Brazil, Chile, Columbia, Ecuador, Guyana, Honduras, Paraguay, Peru, Suriname, Uruguay, Venezuela, Belize, Costa Rica, El Salvador, Guatemala, Mexico, Nicaragua, Panama; **the Caribbean group** include Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Netherlands Antilles,

Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Vincent, and Trinidad and Grenadines, Trinidad and Tobago. Cayman Islands is excluded because we were not able to identify an appropriate per capita GDP-PPP. Regression model output and line plot for all 38 countries in the region are presented below.

Regression Statistics	
Multiple R	0.468496
R Square	0.219489
Adjusted R Square	0.197808
Observations	38

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.359585	0.359585	10.12361	0.003011408
Residual	36	1.278699	0.035519		
Total	37	1.638283			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.160072	0.043949	3.642217	0.000844
Per Capita GDP-PPP	8.19E-06	2.57E-06	3.181763	0.003011

Table 12 Regression Model Output for Latin America and the Caribbean Region

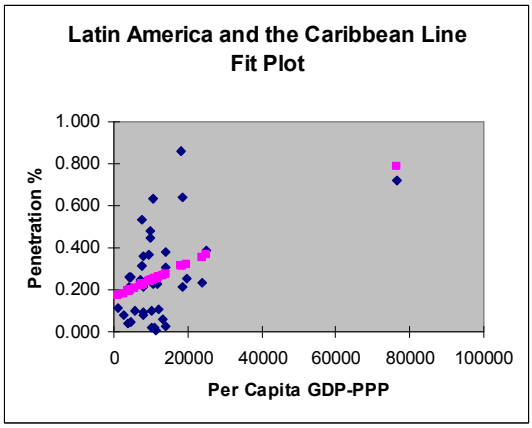

Figure 12 Regression Line Fit Plot for Latin America and the Caribbean Region

Note that there is an extreme observation with per capita GDP-PPP of $76,400 with IPP of 72.1 percent that belongs to Bermuda. It is a city nation that houses main offices of many international insurance companies. Its per capita income is influenced by huge incomes generated from these companies divided by its population size of 66,000. This is an extremely influential observation with a high leverage. The output of the regression model without Bermuda is presented below.

Regression Statistics	
Multiple R	0.3381
R Square	0.114312
Adjusted R Square	0.089007
Observations	37

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.162382	0.162381992	4.517298	0.040686528
Residual	35	1.258135	0.035946708		
Total	36	1.420517			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.121973	0.067023	1.819874	0.07734
Per Capita GDP-PPP	1.2E-05	5.64E-06	2.125394	0.040687

Table 13 Regression Model Output for Latin America Region without Bermuda

We note that the p value changed from .003 to .040. The line fit plot is presented below.

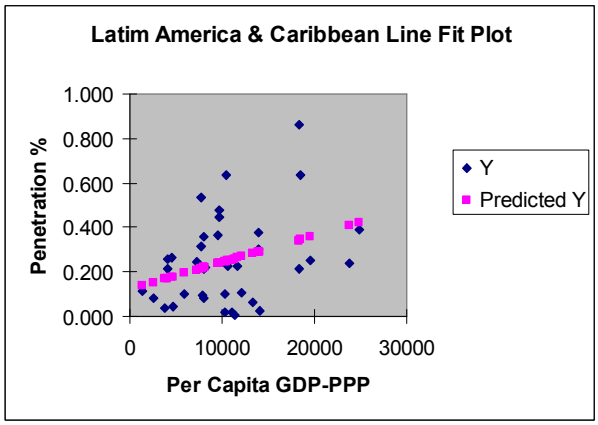

Figure 13 Regression Line Fit Plot for Latin America Region without Bermuda

Latin America Region

The regression outputs and a line fit plot for the Latin America group are presented below. Note that there is not a strong relation between the per capita GDP-PPP and the IPP. In fact the slope is negative.

Regression Statistics	
Multiple R	0.011458
R Square	0.000131
Adjusted R Square	-0.05542
Observations	20

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.98E-05	3.97695E-05	0.002364	0.96176006
Residual	18	0.302865	0.016825843		
Total	19	0.302905			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.172819	0.073222	2.360203	0.029755
Per Capita GDP-PPP	-4E-07	8.2E-06	-0.04862	0.96176

Table 14 Regression Model Output for Latin America Region

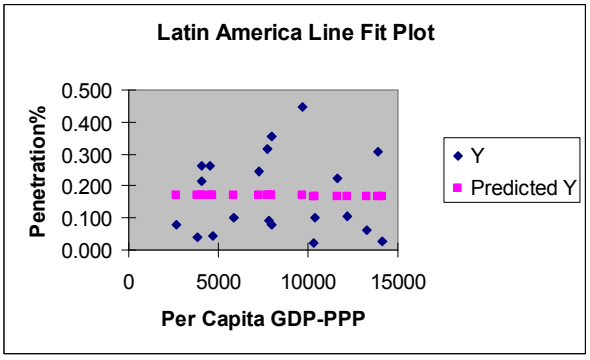

Figure 14 Regression Line Fit Plot for Latin America Region

Caribbean Region with Bermuda

Regression model outputs and the line plot for the Caribbean with Bermuda are presented below. Note that p-value is .074. However, this p-value is likely to be heavily influence by Bermuda

Regression Statistics	
Multiple R	0.430566
R Square	0.185387
Adjusted R Square	0.134474
Observations	18

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.182776	0.182776322	3.641226	0.074474179
Residual	16	0.803142	0.050196372		
Total	17	0.985918			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.253639	0.077397	3.277094	0.004743
Per Capita GDP-PPP	6.44E-06	3.37E-06	1.9082	0.074474

Table 15 Regression Model Output for the Caribbean Region with Bermuda

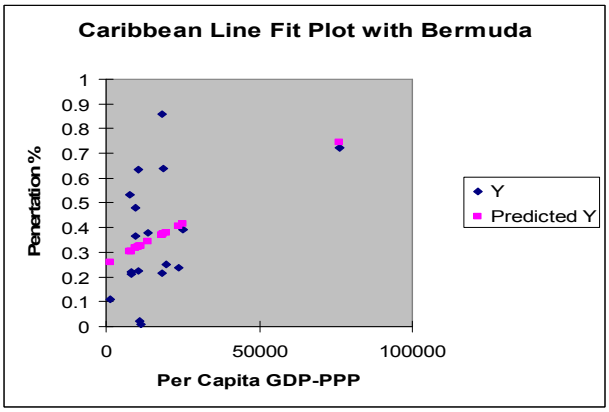

Figure 15 Regression Line Fit Plot for the Caribbean Region with Bermuda

We ran the regression model without Bermuda and outputs are shown below. It shows that removing Bermuda reduces F value significantly and the p-value is now .346.

Regression Statistics		ANOVA				
Multiple R	0.243508		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.059296	Regression	1	0.050352	0.05035192	0.945507	0.346285921
Adjusted R Square	-0.00342	Residual	15	0.798808	0.053253888		
Observations	17	Total	16	0.84916			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.223327	0.132839	1.681184	0.113425
Per Capita GDP-PPP	8.83E-06	9.08E-06	0.972372	0.346286

Table 16 Regression Model Output for the Caribbean without Bermuda

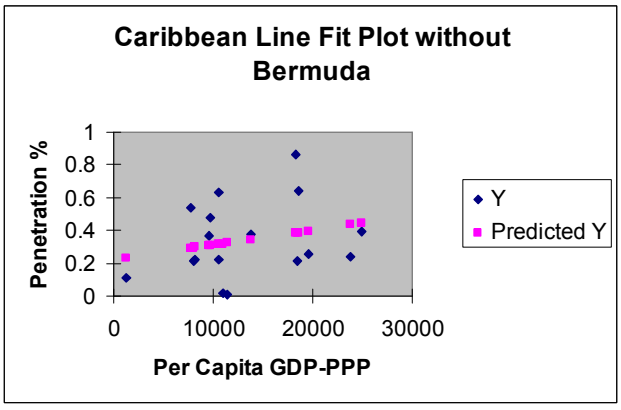

Figure 16 Regression Line Fit Plot for the Caribbean without Bermuda

DIGITAL DIVIDES BETWEEN TWO REGIONS

Middle East and Central-Eastern Europe are close to each other and they have approximately the same range of Per Capita GDP. When we ran a regression model with the countries in both regions, countries from Central-Eastern Europe tend to be above the regression line with exception of Israel and UAR. This observation led us to investigate whether belonging into

one region as opposed to the other have an effect on the IPP. If that were the case, we might attribute that to social-cultural-other factors not directly related to income and wealth and call it a regional digital divide, lacking a more suitable term. We will examine a number of such cases below.

Between Middle East and Central-Eastern Europe Regions

To see whether there is any regional effect on the penetration percent between the Middle East and Central-Eastern Europe, we combined countries in the two regions and ran a simple regression model with all countries in the two regions. The regression model outputs are provided in the table below. Note that it is not significant at the .05 levels.

Regression Statistics		ANOVA					
Multiple R	0.33385301		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.11145783	Regression	1	0.111739	0.111739	4.014048	0.05365164
Adjusted R Square	0.08369089	Residual	32	0.890787	0.027837		
Observations	34	Total	33	1.002526			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.27273735	0.043967	6.203275	6.03E-07			
Per Capita GDP-PPP	3.7903E-06	1.89E-06	2.003509	0.053652			

Table 17 Regression Model Output for Middle East and Central-Easter Europe Combined

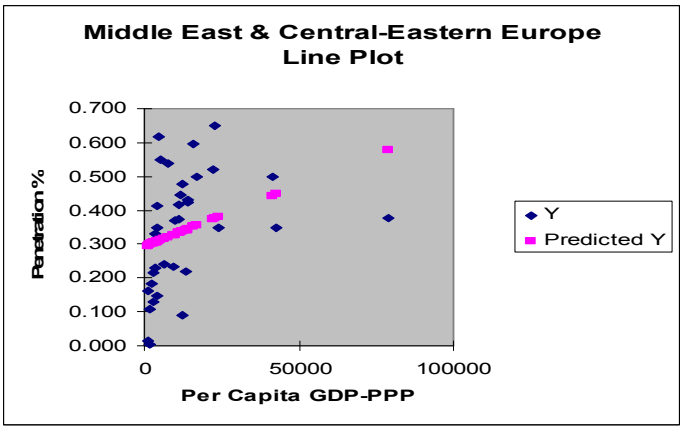

Figure 17 Regression Line Fit Plot for Middle East and Central-Eastern Europe Combined

The line fit plot above leads only UAR and Israel above the regression line and other Middle East countries are either on or below the regression line. This suggests that a variable explaining the IPP for the Middle East and Central-Eastern European countries may be whether a country belongs to the Middle East region or the Central-Eastern Europe region. We added zero-one variable Region where 1 stands for the Central-Eastern Europe region and 0 stands for the Middle East region and ran a multiple regression model along with per capital GDP-PPP. Outputs are shown below.

Regression Statistics		ANOVA					
Multiple R	.621[a]		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.385	Regression	2	0.386	0.193	9.715	.001[a]
Adjusted R Square	0.346	Residual	31	0.616	0.02		
Observations	34	Total	33	1.003			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.199	0.056	2.129	0.041			
Per Capita GDP-PPP	5.72E-06	0	3.404	0.002			
Region	0.194	0.052	3.716	0.001			

Table 18 Multiple Regression Model Output for Middle East and Central-Eastern Europe Combined

We note that R-square increased from .111 to .385, that F=9.715 is significant at the .001 level and each of the two variables Per Capita GNP-PPA and Region are both significant at .01 level. The outputs suggest that, given a level of per capita GDP-PPP, a country belonging to the Central-Eastern European group will increase the Internet penetration rate by 19.4 percent.

Between Africa and Middle East Regions

Regression model outputs and a line fit plot for 52 African countries including those in North Africa and 13 Middle East countries are presented below.

Regression Statistics		ANOVA					
Multiple R	0.738829		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.545868	Regression	1	0.51999205	0.519992	75.72611	2.13E-12
Adjusted R Square	0.538659	Residual	63	0.432605088	0.006867		
Observations	65	Total	64	0.952597138			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.038796	0.011667	3.325378	0.001475754			
Per Capita GDP-PPP	6.75E-06	7.76E-07	8.702075	2.12741E-12			

Table 19 Regression Model Output for Africa Region and Middle East Combined

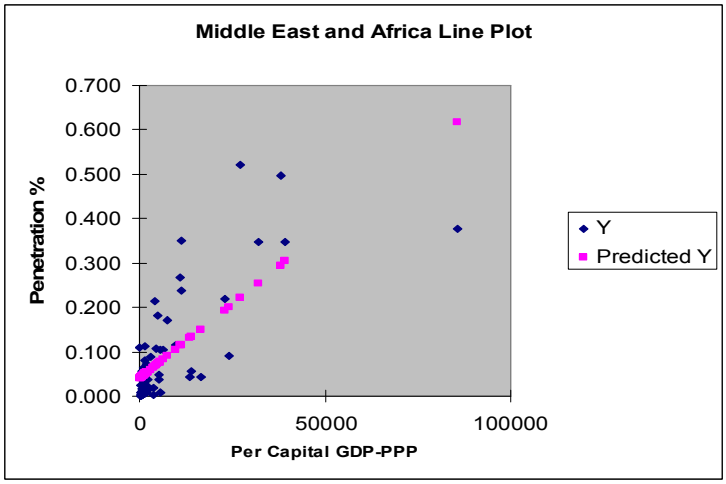

Figure 19 Regression Line Fit Plot for Africa and Middle East Combined

With exception of Qatar, Oman, Yemen, and Iraq other nine Middle West countries are above the regression line. They include Kuwait, UAE, Bahrain, Saudi Arabia, Lebanon, Israel, Iran, Jordan, and Jordan. This suggests that the variable Region that assigns 1 for Middle East and 0 for Africa might be statistically significant.

Regression Statistics		ANOVA					
Multiple R	0.795		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.631	Regression	2	,601	0.301	53.079	0.000
Adjusted R Square	0.619	Residual	62	0.351	0.006		
Observations	64	Total	64	0.953			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.199	0.011	2.904	0.005			
Per Capita GDP-PPP	4.36E-03	0.000	5.142	0.000			
Region	0.113	0.030	3.790	0.000			

Table 20 Multiple Regression Model Output for Africa and Middle East Combined

Note that both Per Capita GDP-PPP and Region are statistically significant at the .01 level. This suggests again that there is the region factor between Middle East and Africa. Those countries in the Middle East and Africa, belonging to Middle East would raise the predicted IPP by 11.3 percent.

Central-Eastern and Western Europe, North America, Australia and New Zealand Regions

Outputs for a regression model with 44 countries in Europe, North America, Australia, and New Zealand are shown below

Regression Statistics		ANOVA					
Multiple R	0.773689		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.598595	Regression	1	1.086653	1.086653	62.63236	7.37935E-10
Adjusted R Square	0.589037	Residual	42	0.728688	0.01735		
Observations	44	Total	43	1.815341			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.221968	0.044307	5.009724	1.03E-05			
Per Capita GDP-PPP	1.24E-05	1.57E-06	7.914061	7.38E-10			

Table 21 Regression Model Output for Europe, North America and Australia and New Zealand Combined

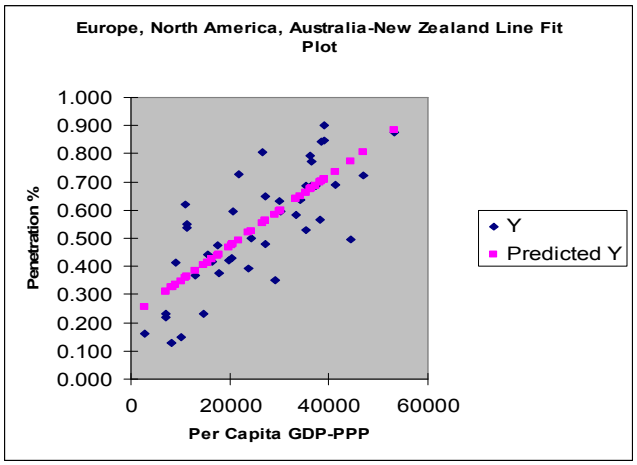

Figure 20 Regression Line Fit Plot for Europe, North America, Australia and New Zealand Combined

Points are equally above and below the regression line for Central-Eastern Europe and the region that include Western Europe, North America and Australia/New Zealand. To confirm this, we ran regression model where Western Europe group =1 and Central-Eastern Europe Group=0. Outputs are shown below.

Regression Statistics		ANOVA					
Multiple R	0.739		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.545	Regression	2	1.006	0.503	25.199	0
Adjusted R Square	0.524	Residual	42	0.839	0.02		
Observations	45	Total	44	1.845			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.302	0.044	6.807	0			
Per Capita GDP-PPA	0.00E+00	0	2.852	0.007			
Region	0.123	0.068	1.806	0.078			

Table 22 Multiple Regression Model Output for Europe, North America, Australia and New Zealand

We note that while Per Capita GDP-PPP is statistically significant at the .01 level the Region is not statistically significant at the .05 level. This suggests that while there is some evidence that belonging to Western European Group may have some effect of raising IPP by an average of 12 percent, that evidence is not that strong.

East Asia from the Rest of East Asia and the Pacific Regions

In view of the fact that IPP of the countries in East Asia are significantly higher than those in other regions of Asia and Pacific islands, a multiple regression model was constructed where East Asia =1 and Others = 0.

Multiple R	0.859		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.739	Regression	2	1.652	0.826	60.740	0.000
Adjusted R Square	0.726	Residual	43	0.585	0.014		
Observations	46	Total	45	2.237			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.026	0.023	1.117	0.270			
Per Capita GNP-PPP	1.282E-5	0.000	8.216	0.000			
Regions	0.098	0.041	2.411	0.020			

Table 23 Multiple Regression Model Output for East Asia and Rest of Asia

The outputs show that F value of 60.74 is significant at the .01 level and Per Capita GNP-PPP at the .01 levels and Region at the .05 level with p-value of .02. This suggests that while Per Capita GDP exerts strong impact on IPP, that a country is in East Asia has an additional impact on IPP.

Latin America and the Caribbean Sub Regions

The observations suggest that at least five of the Caribbean countries – Antigua & Barbuda, Barbados, St Lucia, St Kitts and Nevis, St Vincent, Dominica are significantly above the regression line and Bahamas, Aruba, Puerto Rico, Trinidad are below. Regression was run with Caribbean = 1 and Latin America = 0. Outputs are shown below.

Multiple R	0.462		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.214	Regression	2	0.303	0.152	4.619	0.017
Adjusted R Square	0.167	Residual	34	1.117	0.033		
Observations	37	Total	36	1.421			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.118	0.064	1.845	0.074			
Per Capita GDP-PPP	0.00E+00	0.000	1.033	0.309			
Region	0.139	0.067	2.072	0.046			

Table 24 Multiple Regression Model Output for Latin America and the Caribbean

The fact that p-value for Per Capita GDP-PPP is .309 and that for Region is .046 seems to suggest that belonging to which region a has more predictive power of Internet penetration percent that the country's Per Capita GDP-PPP.

The Caribbean and the Pacific Islands Regions

Both regions consisting island nations, we wanted to evaluate if there exists regional digital divide between them. Regression model outputs and line fit plot for the combined group are presented below.

Regression Statistics		ANOVA					
Multiple R	0.517348		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.267649	Regression	1	0.368149	0.36814886	9.867562	0.004052532
Adjusted R Square	0.240525	Residual	27	1.007343	0.037309		

Observations	29	Total	28	1.375492
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.080367	0.064581	1.244425	0.224038
Per Capita GDP-PPP	1.65E-05	5.25E-06	3.141268	0.004053

Table 25 Regression Model for the Caribbean and the Pacific Islands

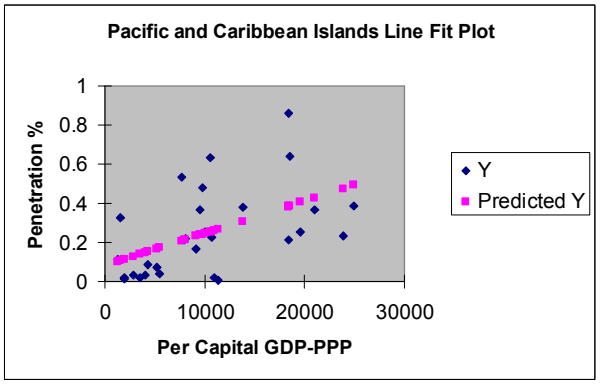

Figure 21 Regression Line Fit Plot for the Caribbean and the Pacific Islands

We note that all observations above the regression line belong to the Caribbean region, namely Antigua and Barbuda, Barbados, St. Lucia, St Vincent and Grenadines, Jamaica, St Kitts and Nevis, Dominica. This suggests that belonging to the Caribbean region is likely to have the effect of raising its IPP to those in the Pacific islands region

Regression model was run where Region=1 for Caribbean islands and Region = 0 for Pacific islands. Outputs are shown below.

Regression Statistics		ANOVA					
Multiple R	0.744		*df*	*SS*	*MS*	*F*	*Significance F*
R Square	0.553	Regression	2	0.779	0.390	17.928	0.000
Adjusted R Square	0.522	Residual	29	0.630	0.022		
Observations	31	Total	31	1.409			
	Coefficients	*Standard Error*	*t Stat*	*P-value*			
Intercept	0.080	0.041	1.955	0.060			
Per Capita GNP-PPP	7.34E-06	0.000	4.065	0.000			
Region	0.171	0.054	3.153	0.004			

Table 26 Multiple Regression Model Output for the Caribbean and the Pacific Islands

CONCLUDING OBSERVATIONS

Geographic Regions and Sub Regions

A summary table of important outputs of the regression models of six regions and some sub regions is presented below.

		Number of Countries	F	P	Comments
A	All Countries - 1	193	275.4	6.00E-39	
B	All Countries - 2	190	400.7	1.41E-41	A less Qatar, Luxemburg, Bermuda
C	Middle East	13	5.94	0.032	
D	Central-Eastern Europe	21	13.2	0.002	
E	Africa 1	52	12.398	0.00009	All Africa
F	Africa 2	46	4.415	0.0413	E less 6 North African Countries

G	Africa 3	43	1.036	0.3146	Sub Sahara Countries with GDP-PPP<$6,000
H	W Europe, Nam, Australia-New Zealand	24	2.419	0.1348	A-NZ: Australia and New Zealand
I	H minus Luxemburg	23	4.763	0.0405	J minus Luxemburg
J	Asia	46	104.257	3.50E-13	
K	Central, South, West Asia	17	2.958	0.106	
L	Latin America and the Caribbean	38	10.123	.0030	
M	L minus Bermuda	37	4.157	.00406	
N	Latin America	20	0.002	0.962	
O	Caribbean with Bermuda	18	3.641	0.0744	
P	Caribbean without Bermuda	17	0.945	0.346	
Q	Caribbean and the Pacific	29	9.867	0.004	

Table 27 Key Regression Outputs from Regression Models for Regions and Sub Regions

We note that the correlation between Per Capita GDP-PPP and IPP of all 193 countries is statistically significant with p-value of 6.0E-39. Removing Qatar, Luxemburg, and Bermuda with high leverages leads to p-value of 1.4E-41. This finding is not surprising in view of the fact, as we pointed earlier, that the entire group consists of countries with extremely low Per Capita GDP-PPP as well as countries with very high GDP-PPP.

For the six regions, correlations are significant at the 0.1 levels for four regions, at the 0.5 levels for one region. For the Western Europe, North America, Australia and New Zealand region, p-value is 0.1348 but decrease to 0.04013 if Luxemburg is removed from the region. For the sub regions, correlations are more problematic. For the sub Sahara sub region consisting 43 countries, the p-value is .3143, for Latin America sub region consisting 20 countries the p-value is .962 with negative slope, and for the Caribbean sub region consisting 17 countries that exclude Bermuda the p-value is .346. We find that the findings of these three regions are surprising in light of the previous studies that led us to assume that IPP are invariably correlated to per capita GDP.

We are not proposing that Per Capital GDP-PPP is not an important correlate for the IPP. It does suggest however that the correlation to be statistically significant, a region or sub region selected must contain countries with wide range of Per Capita GDP-PPP. The 52 countries in Africa that led to p-value of .00009 consisted of very low Per Capita GDP-PPP countries in Sub Sahara Africa and relatively high Per Capita GDP-PPP countries in North Africa. The 46 countries in Asia that led to p-value of 3.5E-13 consisted of very low Per Capita GDP-PPP countries in Central, South, and West Asia and extremely high Per Capita GDP-PPP countries in East Asia.

Digital Divides between Selected Two Geographic Regions

The table below are the outputs of two variable regression models where the first variable is Per Capita GDP-PPP and the second variable is Region where Region=1 for the First Region and Region=0 for the Second Region.

	First Region	Second Region	R-square	F	P-value for F	P-value for GDP	P-value for Region
A	C & E Europe	Middle East	0.385	9.175	0.001	0.002	0.001
B	Middle East	Africa	0.631	53.079	0.000	0.005	0.000
C	W Europe, North Am, etc.	C & E Europe	0.545	25.199	0.000	0.007	0.075
D	East Asia	Rest of Asia and the Pacific	0.739	60.74	0.000	0.000	0.002
E	Caribbean	Latin America	0.267	9.867	0.004	0.309	0.046
F	Caribbean	Pacific Islands	0.522	17.928	0.000	0.000	0.004

Table 28 Key Outputs from Multiple Regression Models

We note that p-values are .004 or less for four of these regional groupings which suggest that, when it comes to predicting IPP, whether a country belongs to the first region or the second region is a statistically very significant factor. In the case of

the Caribbean and Latin America region where the variable Region is not statistically significant at the .01 levels, nevertheless as we pointed out Region seems to have higher predictive power than that of Per Capita GDP-PPP. Our study suggests then that, with exception of perhaps the pair captured by the line C in the table above, belonging to first region of a pair has a statistically significant positive impact on the IPP of the countries of the first region compared to those in the second region. We call this difference between a selected pair of two regions a regional digital divide lacking better words to depict the phenomenon.

Recommendation for Further Study

Given that we have now some understanding of how GNP-PPP explains portions of variations in IPP for the different regions of the world, a next phase of this study should be to evaluate effect of other variables – economic, political, and cultural - on IPP variations for the different regions. We like to believe that while GNP-PPP impacts almost all regions uniformly that may not be the case for other variables. While education and literacy may not be important factors in the regions where people in general are highly educated and literate that may not be the case in regions where educational levels and literacy rates vary great deal among the countries in the region. While political freedom may not be a factor in many regions of the world, it may be a factor in regions that include countries that have laws governing what people can watch on Internet. We believe that our study provides a framework for making such comparisons.

This study also pointed out that there exist a statistically significant dummy variable that explains a portion of IPP variables between two adjoining regions or sometimes within a region. The next phase of this should attempt to identify those economic, political and cultural variables that lead to such dummy variables.

REFERENCES

Baliamoune-Lutz, Mina (2003), "An Analysis of the Determinant and Effects of ICT Diffusion in Developing Countries", *Information Technology for Development*, 10, 151-160.

Beilock, Richard and Dimitrova, Daniela V (2003), "An Exploratory Model of Inter-Country Internet Diffusion", *Telecommunication and Informatics*, vol. 19, 117-137

Beilock, Richard and Dimitrova, Daniela V (2003), "An Exploratory Model of Inter-Country Internet Diffusion", *Telecommunications Policy*, Vol. 23, 237-252

Chinn, M. D. and Fairlie, R. W (2004), "The Determinants of the Global Digital Divide: A Cross-Country Analysis Computer and Internet Penetration", *Economic Growth Center, Yale University. Center Discussion Paper-881*, March 2004.

Chinn, M. D. and Fairlie, R. W (2007), "The Determinants of the Global Digital Divide: A Cross-Country Analysis Computer and Internet Penetration", *Oxford Economic Papers*, pp. 16-44.

Dewan, Sanjeev and Riggins, Frederick J (2005), "The Digital Divide: Current and Future Research Directions", *Journal of the Association for Information Systems*, Vol. 6, No. 12, pp 298-337, December 2005.

Dewan, Sanjeev; Ganley, Dale and Kraemer, Kenneth L. (2005), "Across the Digital Divide: A Cross-Country Multi-Technology Analysis of Determinants of IT Penetration", *Journal of the Association for Information Systems*, Vol. 6, No. 12, pp 409-432, December 2005.

Guillen, Mauro F and Suarez, Sandra L (2001), "Developing the Internet: entrepreneurship and public policy in Ireland, Singapore, Argentina, and Spain", *Telecommunications Policy*, Vol. 25, 349-371.

Hargittai, Eszter, (1999),"Weaving the Western: explaining differences in Internet connectivity among OECD countries", *Telecommunications Policy*, Vol 23, 701-718.

Kiiski, S. and Pohjola, M. (2002), "Cross-Country diffusion of Internet", *Information Economics and Policy*, 14, 297-310.

Ouelaran-Oyeyinka, Banji and Kaushalesh, Lal (2003), "Internet Diffusion in Sub-Saharan Africa: A Cross-Country Analysis", *United Nations University, Institute for New Technologies, Discussion Paper Series*, 2003-5, July 2003

Ouelaran-Oyeyinka, Banji and Kaushalesh, Lal (2005), "Internet Diffusion in Sub-Saharan Africa: A Cross-Country Analysis", *Telecommunications Policy*, 29, 507-527