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Structured Rankings of Internet Service Providers on Data and Price in Ghana

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Abstract

The purpose is to compare internet prices of the nation's Internet Service Providers (ISPs) with the aim of ranking them to find out the low cost leaders in the industry. Generally the local ISPs employ the strategy of volume-tiered pricing. Volume-tiered strategies exhibit greater complexity in pricing, more opaque prices and sometimes, even higher prices. The advantage of volume-based pricing for operators is that the uncertainty and risk of consumption remains with the customer, rather than the operator. In addition the ISPs offer disparate data volumes and price points with many of them unique so as to perhaps discourage direct comparisons with one another. This paper overcame the issue of complexity, opacity and the dissimilarities in data offerings by fitting regression functions to the data of the competing ISPs and examining the behaviors of the generated graphs across a broad range. The study clearly identified the low cost leaders in the local ISP industry. Currently there is no national ranking system to find out the relative placements of the ISPs in their various service offerings. The contribution represents one of the first times internet service prices in the country have been analytically studied to identify the ISPs with the best prices.

Keywords: telecom industry, internet service provider, wireless internet, volume-based pricing

1. Introduction

Internet service has proliferated across the length and breadth of Sub-Saharan Africa (SSA) within the past few years. The main source of internet service in SSA comes from the cellular towers scattered across the region. The two popular devices that can pick up internet signals from these towers are internet-ready phones and USB modems plugged into desktop computers, laptops or tablets. Modems are the preferred media through which carriers offer wireless internet services to their customers. An actual modem device is approximately the same size and shape as a typical USB flash pen drive. A SIM card–exactly the same type used in mobile phones – is inserted into a USB modem to give it its unique identification–similar to how a SIM card gives a unique identification to a mobile phone. The modem comes supplied with software that must be installed on a computer. So this portable gadget is mainly a software program encapsulated in a hardware shell. The software allows the modem to make a network connection to a nearby cellular tower so the computer can then be connected to the internet (Reiffel, 2011). There are six telecoms in the SSA country of Ghana who deal in phone and other services in addition to offering internet data. These telecommunication companies (with their respective market shares on data in parentheses) are Mobile Telephone Network aka MTN (50.5%), Vodafone (18.2%), Bharti Airtel (14.4%), TIGO (13.8%), Globacom aka GLO (2.7%) and Espresso (0.3%) (National Communication Authority [NCA], 2014). Out of this 6 only Vodafone offers fixed line access. The rest send their internet data through USB modems and internet-ready mobile phones aka smartphones. The internet data business is very competitive and considerable resources are expended by the telecom companies to convince consumers that they have the lowest prices. In Ghana the National Communication Authority (NCA) is the regulatory body charged with supervising over the ISPs in the rendition of their services. The following information in quotes is lifted from the website of the NCA. "The object of the Agency is to regulate the provision of information communications technology, ensure the provision of quality information communications technology, promote standards of efficiency and ensure quality of service. In discharging its functions, the agency shall take into account the following: (a) the protection of the interest of consumers under the Electronic Transactions Act (Act

772) as regards the choice, *price*, quality of service and value for money, (b) the opinions of consumers and of members of the public generally. Consumers are entitled to the following rights when entering into telecom service contracts: i) The right to have access to basic telecommunications services at *affordable and reasonable prices*; ii) The right to *choose* from a variety of telecom services provided; iii) The right to have a variety of information to choose from services advertised; iv) The right to select preferred services; v) The right to be informed about products and services in complete, accurate, simple and clear language (NCA, 2014)."

Considerable resources are expended by the ISPs to market their internet services especially with regard to their low prices. However both the NCA and the consumer who are major stakeholders in the industry have no clear knowledge of which provider actually delivers on this message. This knowledge gap is what this work intends to fill. The purpose of this paper is to equip the consumer with information to be able to determine from whom he gets the best prices. The paper proposes a model to exhaustively analyze the prices of the internet service delivered by the nation's internet service providers with the view to finding the cost leaders, and "*informing the stakeholders about products and services in complete, accurate, simple and clear language*"(NCA, 2014). The main objective is to analyze the price structures of the 6 network ISPs and then rank them; so the research question is which of the 6 ISPs have the lowest price offers; in other words which network gives the consumer the most 'bang for the buck' price wise, so to speak. Table 1 shows the data volumes and associated prices of the ISPs of Ghana.

Table 1. Data and price (cedis) grids of the ISPs of Ghana

Airtel Data	Airtel Prices	Espresso Data	Espresso Prices	Glo Data	Glo Prices	Mtn Data	Mtn Prices	Tigo Data	Tigo Prices	Voda Data	Voda Prices
30	1	100	2	50	1	60	2	50	1.5	30	1
50	1.5	250	5	250	4	150	5	100	2.99	200	5
100	3	550	10	300	5	300	10	500	8.99	400	10
200	5	1000	15	750	10	750	15	1000	15	750	15
750	15	2000	20	1200	15	1000	20	1500	19.99	2500	30
2000	30	3500	30	3000	25	2500	40	2500	30	3500	45
5000	60	6000	50	3200	40	4000	60	4500	55	6000	80
6000	75	10000	80	6000	55						
12000	150	14000	110	10000	80						

Source: websites of ISPs spanning the years 2013 – 2014.

Quality wireless internet service should be measured by more than one criterion, but research has shown that internet cost is of an overarching concern to consumers in SSA (Schumann, 2013; Sanou, 2013; Ampah et al., 2009). Thus there is the need to inform the SSA public about the players in the industry that have the ability to give them the lowest cost possible, all things being equal.

The six telecom networks selected for the study previously offered phone services nationwide long before the advent of the internet into the country. Thus entry into the internet data industry was a natural extension of business reach.

Below is the outline of the paper.

1) Section 2 provides literature review of the cost of internet connectivity, and it includes cost connectivity challenges in Sub-Saharan Africa with emphasis on the case country Ghana.
2) Section 3 explains the methodology, which is fitting appropriate functions to participant ISP input data to generate curves so as to enable comparisons of the outputs of these functions.
3) Section 4 presents the results that accentuate the differences between ISP price behaviors, their segmentation into low and high cost providers as well as rankings on who are the best in terms of the price criterion.

4) Section 5 presents a summary of the main findings, conclusions, and limitations, new knowledge derived from the research and recommendations.

2. Cost of Internet Access

Cost is a major barrier to Internet penetration in Africa. Recent statistics show that connectivity remains out of reach for many in Africa because monthly access fees in Africa require 291.3% of the average monthly income, compared to only 1.4% of the average monthly income in Europe (International Telecommunication Union [ITU], 2011; Pejovic et al., 2012). Information and Communications Technologies (ICTs) can only serve as effective tools of broad-based development and opportunity for all if all people in developing countries can afford access to them (Bornman, 2012; Khalil, 2003). In general, a mobile Internet subscription costs up to seven times more than a mobile telephone subscription. The average prices for a computer-based mobile-broadband service with 1GB monthly data allowance and a handset-based plan with 500MB monthly allowance are more than 22% and 15% of GNI per capita in Africa, respectively. In the rest of world, average prices for mobile-broadband are less than 10% of GNI per capita (Guerrero, 2016: ITU, 2014b; Akue-Kpakpo, 2013). High cost seriously demotivates use. It is posited that an internet application such as e-learning cuts down on learning time and cost and thus encourages more organizations to support e-learning education. Barriers to deployment of eLearning include cost and time. It is posited that an internet application such as e-learning cuts down on learning time and cost. Mat (2000) and Hara et al. (1999) cited costs as barriers to eLearning in the era where eLearning was primarily distance learning and thus the costs postulated could not have included internet costs (Frimpon, 2012; Mat, 2000; Hara & Kling, 1999). Universally bandwidth accessed via fiber optic cable should be far cheaper than that accessed via satellite. In 2004, a 2Mg (E1) bandwidth cost between US$4,000 and US$6,000 over satellite while the same bandwidth cost US$12,000 over the SAT3 undersea cable which passes through Accra. Osiakwan suggested the existence of a cartel among various satellite operators since, despite liberalization and competition in some African countries, internet connectivity is still expensive. Internet service cost seven times that of the United States largely due to the monopolistic structure of internet service in Africa (Osiakwan, 2007; Oyeyikan and Adeya, 2002; Speight, 1999). Yet in other regions of the world where cut-throat competition is taking place, there has been an explosive penetration of mobile telephony and broadband services, thus driving prices down (Frost and Sullivan Report, 2008). According to CIPESA (2005), Hesselmark (2003), issues related to Internet Governance are not the main hindrance to usage of internet in Africa, but rather due to (i) the technology currently deployed being expensive (ii) cumbersome and expensive licensing procedures (iii) Internet Service Providers (ISPs) profiteering from high charges for their services. In East Africa, Kenya has amongst the lowest prices of any of the countries across the regions. This goes some way to explaining its higher internet penetration in spite of lower incomes than many of the countries in the other regions studied in this report (Schumann et al., 2013).

In Nigeria and other African countries, the cost of getting connected to the internet is so high that private individuals find it extremely difficult to get connected to the net. In a survey of cybercafés' in Delta State, Nigeria, it was found that 72.2 per cent of the sample indicated the high cost of internet connectivity and 44.4 per cent indicated the frequent/occasional loss of contact/signals with the ISP as problems militating against the cybercafé´ internet services business (Adomi, 2005; Hussain et al., 2012). Affordability relates to service pricing, as well as the cost of smart-phones, tablets, laptop computers or other devices which permit Internet access. 45.3% of the respondents to a survey in Ghana, Kenya, Tanzania and Zambia think that Internet access is expensive (Guerrero, 2016; Audience Scapes, 2010). A major problem is the exorbitant prices of internet connectivity, in particular broadband connectivity, in Africa and Sub-Saharan Africa. The costs of internet connectivity are in some cases literally a thousand times higher than for broadband users in the developed world (Bornman, 2012; ITU, 2011; Cherlin, 2009).

The cost of accessing ICT is prohibitively large for most people; for example 30 hours of internet use costs an average $50 in sub-Saharan African countries representing 207 per cent of the average pre-capital income per month (UNIDO, 2004; Adomi, 2005). According to (Pospischil, 1998), costs were the binding constraint; income therefore is a strong determinant on Internet access (Oyeyikan & Adeya, 2002). In 1997 average cost of using a dial-up internet account for 20 hours per month was about $68 (including usage fee and local call time). In the US, the average cost was $29 for 20 hours/month including telephone charges. This comes to $1.45 per hour compared to $3.4 per hour for Africa, with less than one-tenth per capita income, and relatively poor internet services (Oyeyikan & Adeya, 2002). People have more access and use ICTs more in countries where prices are more affordable and cost a relatively small portion of their income. Thus prices and affordability represent major factors determining access to and use of ICTs and thus in bringing people into the information age. Research by the ITU (2011) furthermore indicates that countries with relatively high ICT prices have relatively low levels of

ICT access, uptake and use. The opposite is also true (Bornman, 2012; ITU, 2011).

In 2000, the average cost for a local dial-up Internet account for 20 hours a month in SSA was about USD 60.00 (including usage fees and local call telephone time, but not telephone line rental). In comparison, 20 hours of Internet access costs around USD 22.00 a month (including telephone charges) in the United States, USD 33.00 in Germany and USD 39.00 on average for other European Union (EU) countries. All these countries have per capita incomes at least ten times greater than the SSA average. Internet access and cost access are significantly correlated (Gyamfi, 2005; Oyeyikan & Adeya, 2002).

It is noteworthy that Africa follows the global trends, including US experience, with its universities used as locomotives of technological progress. Regrettably, due to the high costs of access, the range of users is limited to professors, staff and some postgraduates. The majority of students cannot enjoy free access to the Internet even in the educational centers (Polikanov & Abramova, 2003). In SSA, the cost of a computer and Internet connection, and the lack of supporting communication infrastructure, constitutes major impediments to digital technology inclusion. The high costs of computers and Internet connections act as barriers to information access for many people in SSA (Anyimadu & Falch, 2003; Quay, 2001; Gyamfi, 2005). The many write-ups above clearly show that internet usage in SSA is an expensive activity.

3. Design and Methodology

The ISPs in Ghana employ volume-based pricing scheme for their internet data offerings. In this strategy, consumers buy internet packages or bundles, use them and may choose to reload on depletion. There are no bills to pay and nobody owes anybody. An alternative strategy which is common in advanced countries is flat-rate or unmetered pricing. The main advantages of flat-rate or unmetered pricing are that it is easy to understand and enables direct comparisons between providers. The Organization for Economic Co-operation and Development [OECD] notes that direct comparisons are difficult for data-limited or capped offers. Volume-based pricing charge customers on the basis of the data downloaded and have typically been adopted in regions with high costs of international Internet connectivity such as SSA. The drawbacks of volume-tiered strategies are many and include greater complexity in pricing, more opaque prices and sometimes, even higher prices. The greatest advantage of volume-based pricing for operators is that the uncertainty and risk of consumption remains with the customer, rather than the operator (Biggs & Kelly, 2006; OECD, 2004). The local ISPs add another level of complexity by offering data volumes and the associated price points that are intentionally different from the competition. In addition some offer data and prices that are mere multiples of their other offers. As a result there are hardly any price points or data where the ISPs can be compared across board. Thus a straightforward comparison of prices and data volumes is difficult. This opacity calls for structured and rigorous analyses to compare prices so as to identify the true low cost providers.

Table 1 shows the Data volumes in megabytes and Price Points in cedis (PP) of the ISPs of Ghana. The steps below summarize what the methodology does.

3.1 Steps of Methodology

- Collect internet data and their associated prices from the official websites of the ISPs
- Cleanse data to eliminate duplicates, triplicates and promotions.
- Fit regression functions to cleansed data.
- Generate output graphs and examine the behaviors of these functions over all ranges (Low end, Mid-section and Upper end).
- Identify the overall best low-cost ISP or set of best low-cost ISPs over each and all ranges.

3.2 Data Collection

The input data was obtained from the websites of the ISPs over the approximate a 2-year period between 2013 and 2014. Because the data observed during the monitoring period were not subject to change there was not the need to calculate statistics such as measures of central tendency and variation. The changes if any were the addition or removal of new data volumes as a result of promotions.

3.3 Aggregation of Price Points and Data Volumes

Table 2 is a contingency table that shows how much a data value is worth across the ISPs. The intersection of a data value and an ISP is the price of the data value of the ISP.

Table 2. Contingency table of Ghana internet service data (MB) and price points (Cedis)

#	DATA	AIRTEL	ESPRESSO	GLO	MTN	TIGO	VODA	Count
1	30	1					1	2
2	50	1.5		1		1.5		3
3	60				2			1
4	100	3	2			2.99		3
5	150				5			1
6	200	5					5	2
7	250		5	4				2
8	300			5	10			2
9	400						10	1
10	500					8.99		1
11	550		10					1
12	750	15		10	15		15	4
13	1000		15		20	15		3
14	1200			15				1
15	1500					19.99		1
16	2000	30	20					2
17	2500				40	30	30	3
18	3000			25				1
19	3200			40				1
20	3500		30				45	2
21	4000				60			1
22	4500					55		1
23	5000	60						1
24	6000	75	50	55			80	4
25	10000		80	80				2
26	12000	150						1
27	14000		110					1
	COUNT ➔	9	9	9	7	7	7	48

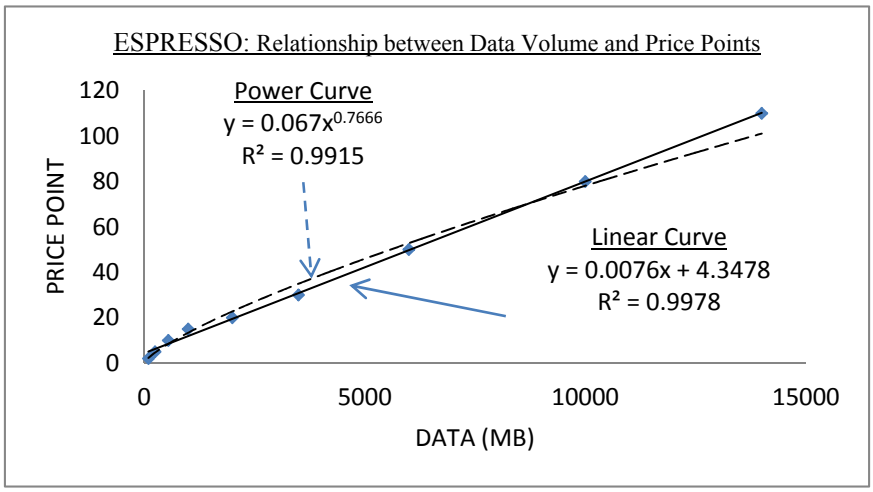
Given a data value, a blank cell under an ISP means that data is not offered by the ISP. A glance at the interior of the table shows many blank cells. In fact there are 162 cells of which only 48 (29.6%) are filled. The occurrence of over 70% blank cells indicates that there is not much commonality in the data offerings by the ISPs. A fill rate of around 100% would make a straightforward comparison possible without the resort to functions. With such paucity in common data values and common price points it becomes difficult to compare prices to find the ISP with the lowest prices.

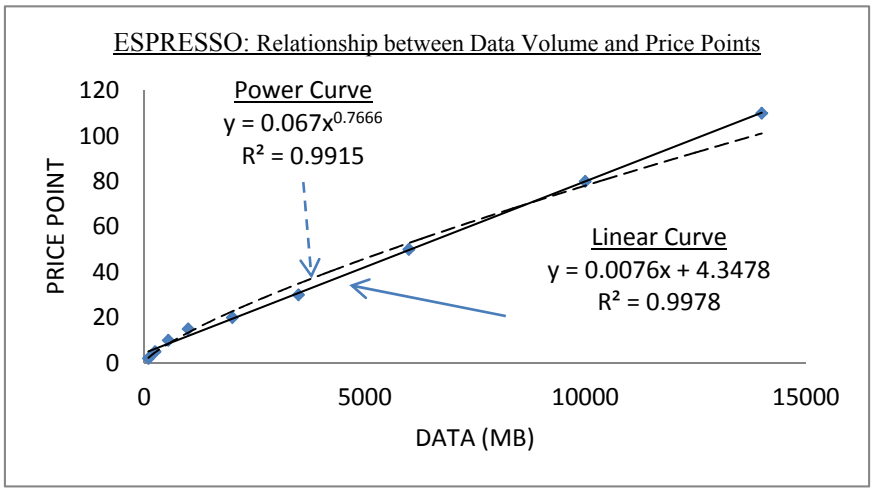
Table 3. Offered data distribution

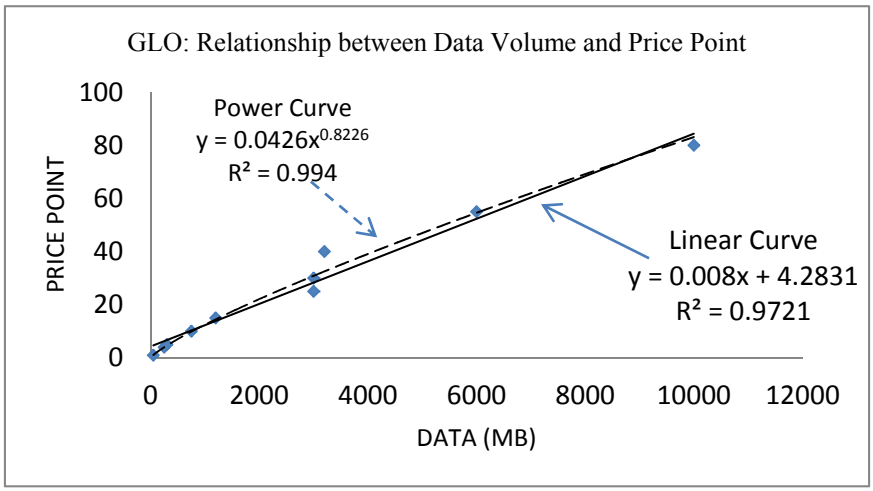
Competing Isps	Data Points	Cumulative Datapoints	% Datapoints	% Cumulative Datapoints
ONE	14	14	51.85%	51.9%
TWO	7	21	25.93%	77.8%
THREE	4	25	14.81%	92.6%
FOUR	2	27	7.41%	100.0%
TOTAL	27		100%	

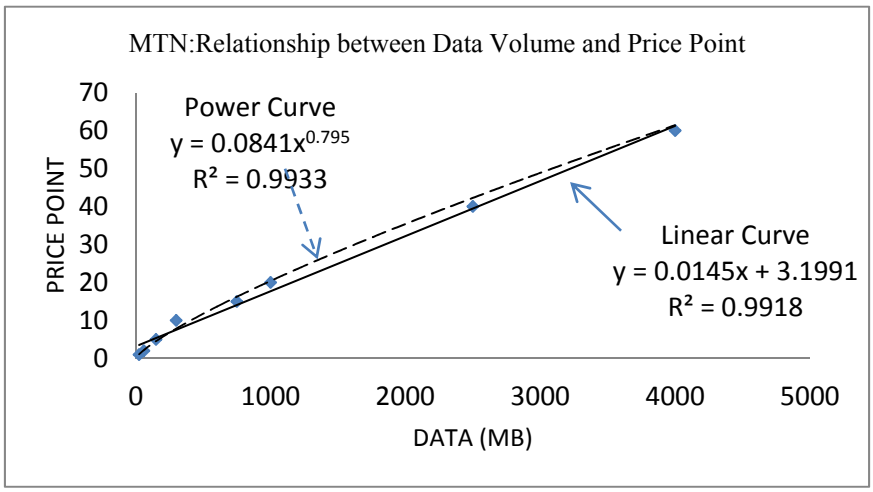
Table 3 shows the distribution of data points and the number of ISPs that compete on them. From this table 52% of the data values (14 out of the 27) are standalones where there will be no pressure to match a competitor; 78% of the data values are chosen so that only one other competitor has to be contended with; 93% have only two other ISPs to contend with and all data values are chosen so that at most only four ISPs compete; there are no data values where there are more than four competitors. In other words there is no data value that is offered by five or all six ISPs. This buttresses the point that a straight forward comparison of data values is practically impossible; an ISP can always create additional and different ‘data value, price point combinations’ in order to

avoid a direct comparison with a competitor. The challenge now is how best to compare the ISPs given this lack of commonality in data offerings.









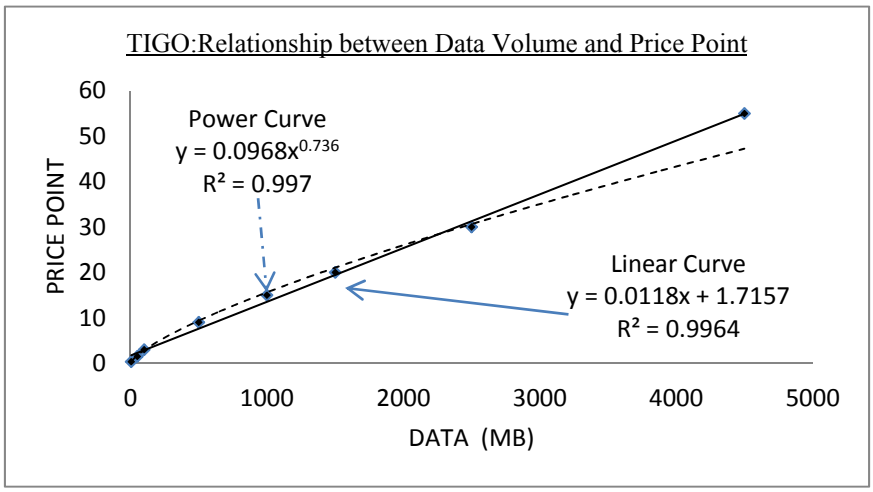


Figure 1. Graphs showing functional relationships between data and price

3.4 Best-Fit Cost Functions and Graph Generation

Best fit equations, which are basically regression functions, were determined from the 'data volume and price' combinations of the ISPs in Table 1. The resultants of fitting these equations are captured in Figure 1. These graphs completely described the data offerings, and could be used for interpolation or extrapolation purposes. Information such as gradients and exponents could then be compared across the whole spectrum of values to determine individual ISP performance. Again from Figure 1, there are two curves, a power function and a linear one. The use of both was meant to give even more credence to the accuracy of the fits. The relationship between data and price point should not be perfectly linear ($R^2 = 1$) due to the usual volume discounting since the more data bought the lesser should be the unit cost. Power functions best show this.

Table 4. Functional relationships between Data (X) and PP (f(X))

ISP	POWER FUNCTIONS	LINEAR FUNCTIONS
ESPRESSO	$0.067X^{0.7666}$	0.0076X+4.3478
GLO	$0.0426X^{0.8226}$	0.008X+4.2831
VODA	$0.0728X^{0.7946}$	0.0126X+2.5403
AIRTEL	$0.046X^{0.8571}$	0.0123x+1.8175
TIGO	$0.0968X^{0.736}$	0.0118X+1.7157
MTN	$0.0841X^{0.795}$	0.0145X+3.1991

4. Results and Discussions

The power functions in Table 5 were used to generate graphs as a means of examining the behaviors of the data offerings over a finite but broad range.

4.1 Behavior and Categorization of Functions

Table 6 is a collection of the graphs of the ISPs generated from Table 4 using the power functions. Displayed on the full-range graph in Figure 2 is the Arithmetic mean. The placement of a graph above this measure of central tendency shows it is in a high cost category; the converse is true.

Figure 2 clearly shows that the ISPs are of two distinct groupings. GLO, ESPRESSO and TIGO mostly lie underneath the mean (broken lines) and are thus the low cost carriers. MTN, VODAFONE and AIRTEL lie above these lines and are thus the high cost ISPs. The data range was further segmented to enable a more thorough examination of the behaviors. Figure 3, which is a graph of the low end of the range shows that GLO is dominant in this domain with Espresso and TIGO in some pursuit. Figure 4, the graph of the mid-section shows that GLO and Espresso are together the best in this range. However Espresso is the better one in the upper end of this range. Figure 5 is a graph of the upper ranges. It shows that Espresso is the better one with GLO a respectably close second with TIGO also in good contention. All the charts show that GLO and Espresso are the low cost leaders. GLO is dominant over most ranges. However Espresso begins to take over in the upper ranges. Mathematically the point is 1647 megabytes of data.

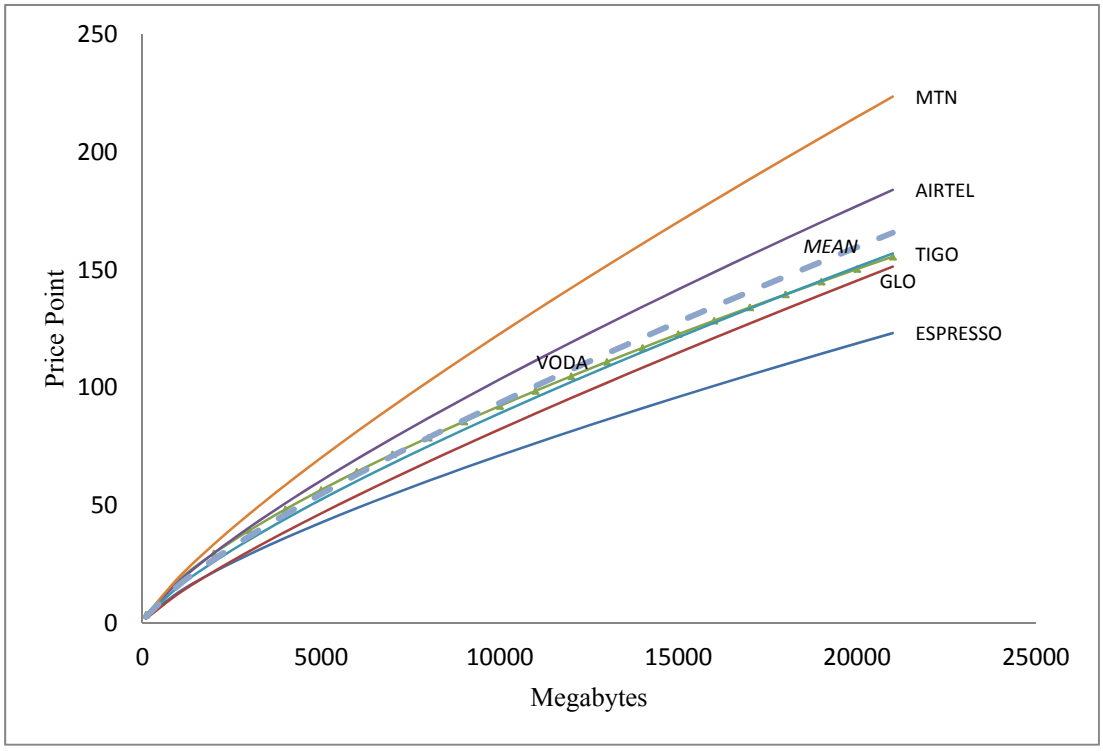


Figure 2. Placement of ISPs and the mean across full range **[0 – 25,000]**

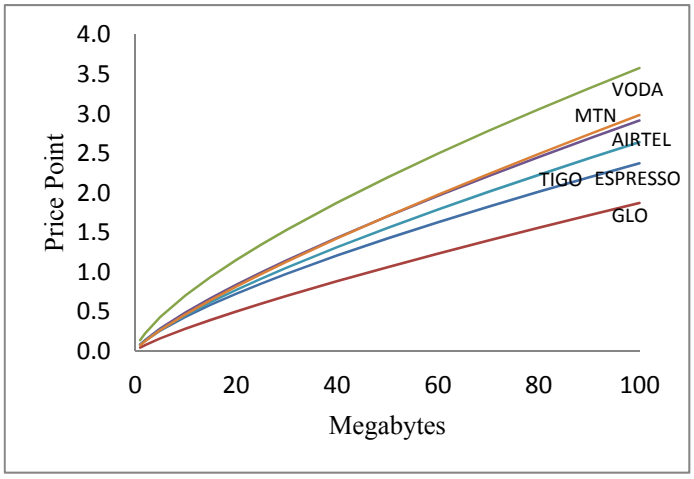


Figure 3. Placements of ISPs at the low end **[0 – 100]**

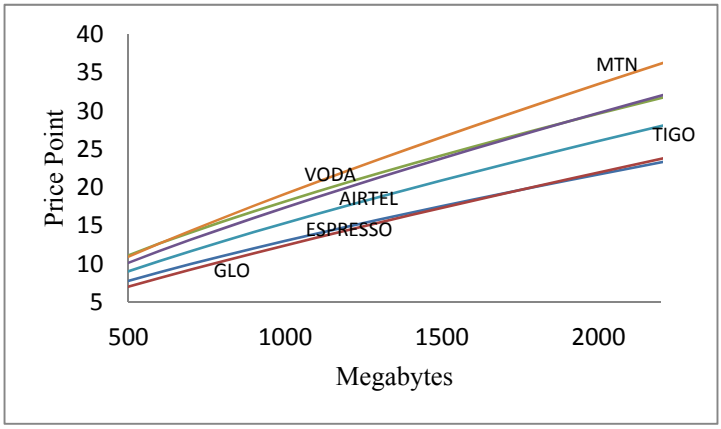


Figure 4. Placements of ISPs at the mid-section **[500 – 2000]**

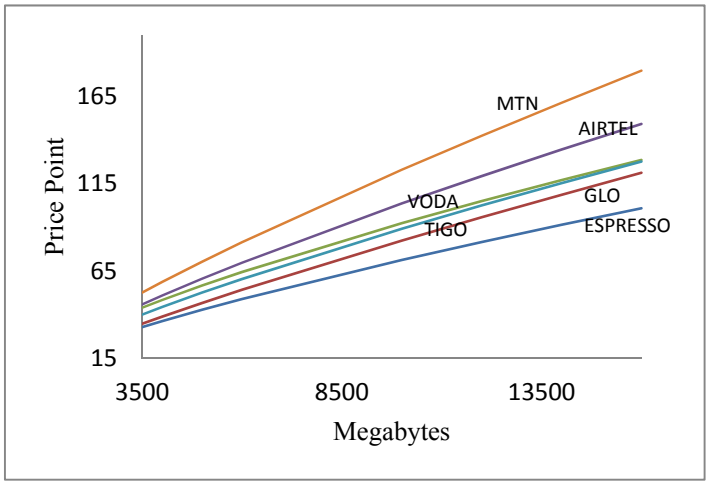


Figure 5. Placements of ISPs at the upper end **[3500 – 15500]**

5. Conclusion

An objective of this paper was to provide a structured process to measure ISPs on their internet data price offerings. A major challenge was that ISPs dispense their service offerings in an infinite 'price points and data

volumes' space that avoid head to head comparisons. Thus for the average consumer finding the lowest cost provider(s) is difficult. Table 3 shows the number of providers that compete on selected data volumes. Conspicuously absent are #5 and #6. That means there is no data value where 5 or all six ISPs offer the same data volume. In other words there is no data volume that would form the basis of a head-to-head price comparison. The paper reveals the true costs of internet service of the local ISPs, and builds a simple model that can be used to continuously monitor price performance. For 'pay as you go plans' where the customer buys and immediately pays for data without recourse to a contract, aggregated costs can get very high as usage hours increases. Competition drives down prices so the ISPs by trying to avoid competing on similar price points are deliberately keeping prices artificially high. The rankings show the low cost leaders. These are the two smallest ISPs by market volume as stated in the introduction. For these two ISPs, economies of scale should result in their having higher prices, so if the smaller ISPs give the lowest prices then there is probable cause for concern.

5.1 Recommendations

The Sub-Saharan African has the least disposable income, so cost beyond a certain threshold will stunt the growth of the internet in this region. The inclination is to recommend that SSA make do with minimum speeds because of its weak financial state. However it is impoverished regions rather which need to figure out ways to use the richer internet because the internet is basically a 'catch-up tool'. According to the Global Internet Phenomena Report (Sandvine Report 2013; MIT 2001), video and audio streaming applications will account for over 60% of mobile usage by 2018. This is what drives the internet. If the internet loses its capacity to entertain via YouTube, Gaming and Social Networking, its growth will slow and more serious applications such as online Education, Filesharing, Storage, Communications, and e-commerce will suffer, but no region needs these applications more than SSA. Any efforts to lower prices would have a tremendous impact on affordability and hence access. Some of the ways to attack the cost concern are (i) reducing taxes and tariffs. If this is done government can recoup its shortfall in tax revenue through lower cash investments into traditional education (ii) Use appropriate technologies with the ability to approximate what the developed world has done. (iii) Lower termination fees and where competition is limited, through regulatory action. Governments should apply their legislative authorities to enforce low price/ high connectivity business models and encourage competitiveness, so as to prevent monopolistic telecommunication markets (Ampah et al., 2009; Bon, 2007). Also since the service is relatively new in the region, benchmarks which are in alignment with global standards to support and regulate the industry must be created.

5.2 Limitations

There is a dearth of information on contemporary academic literature on the internet in SSA. That was a hindrance on the writing of this paper, and the hope is that more research will be done to close the information gap between this region and the others. In assessing the findings of this study, it is important to make the supposition that internet service experience is not about cost only. Therefore the rankings here are not for the best service providers. They are simply about low cost leadership. Also there isn't much fluidity in the prices of data as advertised or published on the websites of the ISPs but for the promotions. Promotions which were not considered in this study are a big part of marketing strategy and should be factored in in order to arrive at definitive ranking conclusions. The research focused only on the years specified on the data collection window i.e. 2013-2014. The rankings can and will change in subsequent periods.

5.3 Future Research

Promotions should be incorporated into attempts to quantitatively rank Ghana ISPs on their service renditions. Beyond that the criteria field should be expanded to include the other dimensions of Speed, Usability, Reliability, and Support (Elwany, 2007; ISO/IEC 9126, 1991; Ossadnik & Lange, 1999; Lai et al., 1999; Ngai & Chan, 2005). A local metric 'Ubiquity /Availability' should be included to capture internet service to the rural areas because providers that extend their reach beyond the urban centers need to be recognized.

References

Abramova, I., & Polikanov, D. (2003). Africa and ICT: A Chance for Breakthrough? *Information, Communication & Society, 6*(1), 42-56. http://dx.doi.org/10.1080/1369118032000068778

Adomi. E.E (2005). Internet development and connectivity in Nigeria. *Program, 39*(3), 257-268. http://dx.doi.org/10.1108/00330330510610591

Akue-Kpakpo. (2013). *Study on International Internet Connectivity in Sub-Saharan Africa*. Telecommunication Development Bureau (BDT).

Ampah, A., Camos, D., Briceño-Garmendia, C., Minges, M., Shkratan, M., & Williams, M. (2009). Information

and Communications Technology in Sub-Saharan Africa: A Sector Review. Retrieved from http://www.infrastructureafrica.org

Audience Scapes. (2010). Audience Scapes Online Data Analysis Tool. Retrieved from http://www.audiencescapesdata.org/adscap/ASQuestions.jsp

Biggs, P., & Kelly, T. (2006). Broadband pricing strategies. *Info, 8*(6), 3-14.

Bon. A. (2007). Can the Internet in tertiary education in Africa contribute to social and economic development? *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 3*(3), 122-131.

Bornman, E. (2012). The Mobile Phone in Africa: Has It Become A Highway To The Information Society Or Not?" *International Conference on Communication, Media, Technology and Design* (ICCMTD), 09-11, May 2012, Istanbul, Turkey.

Cherlin, E. (2009). *An Internet bandwidth bonanza coming to Africa*. Retrieved September 29, 2010 from http://www.olpcnews.com/internet/access/internet_bandwidth_bonanza_africa.html

CIPESA. (2005). *ICANN, Internet governance and Africa.* CIPESA ICT policy briefing series. Retrieved from http://www.wougnet.org/WSIS/docs/ICANN_Final_Brief4dissemination.pdf

Elwany, A. (2007). Proceedings of the 37th International Conference on Computers and Industrial Engineering, Alexandria, Egypt.

Frimpon, M. (2012). A Re-Structuring of the Critical Success Factors for E-Learning Deployment. *American International Journal of Contemporary Research, 2*(3).

Frost and Sullivan Report. (2008). *Mobile Telephony and Broadband Services Drive Market Growth for the Colombian Telecommunication.* Retrieved from http://www.reuters.com/article/pressRelease/idUS147001+14-Jan-2008+BW20080114.

Guerrero, M. (2015). The impact of Internet connectivity on economic development in Sub-Saharan Africa. Retrieved from http://partnerplatform.org/eps-peaks

Gyamfi, Y. (2005). Closing the Digital Divide in Sub-Saharan Africa: Meeting the challenges of the information age. *Information Development*, *21*(1). http://dx.doi.org/10.1177/0266666905051910

Hara, N., & Kling, R. (1999). Students' frustrations with a web-based distance education course. *First Monday*, *4*(12), 5. Retrieved March 13, 2007, from http://wotan.liu.edu/dois/data/Articles/doifirmony:1999:v:4:i:12:p:5.html

Hesselmark, O. (2003). *Internet prices in Africa: A comparative study.* Retrieved from http://topics.developmentgateway.org/ict/rc/filedownload.do~itemId=358672

Hussain, H., Kehl, D., Lennett, B., Li, C., & Lucey, P. (2012). The Cost of Connectivity: A comparison of high-speed Internet prices in 22 cities worldwide. Open Technology Institute. Retrieved from http://www.newamerica.net

ISO/IEC 9126. (1991). *Information Technology- Software product evaluation-quality characteristics and guidelines for their use*. Geneve.

ITU. (2011). Measuring the Information Society Report 2011. Geneva: International Telecommunication.

ITU. (2014b). *Measuring the Information Society Report 2014.* Geneva: International Telecommunication Union.

Khalil, M. (2003). *The wireless Internet opportunity for developing countries.* Retrieved 27 February, 2008 from, http://www.infodev.org/files/1061_file_The_Wireless_Internet_Opportunity.pdf

Lai, V. S., Trueblood, R. P., & Wong, B. K. (1999). Software selection: A case study of the application of the AHP to the selection of a multimedia authoring system. *Information & Management, 36*(1999), 221-232.

Massachusetts Institute of Technology (2001). *MIT to make nearly all course materials available free on the World Wide Web*. Massachusetts: MIT. Retrieved from http://web.mit.edu/newsoffice/2001/ocw.html

Mat, J. (2000). Technology in the Malaysian education system, Paper presented at the *International Conference and Exhibition on Electronic Learning*. Kuala Lumpur, Malaysia.

NCA. (2014). Retrieved from http://www.nca.org.gh/downloads/regdocs/Ghana_National_Information_Technology_Agency_Act_771.pd

f

Ngai, E. W. T., & Chan, E. W. C. (2005). Evaluation of knowledge management tools using AHP. *Expert Systems with Applications, 29*, 889-899.

OECD. (2005). OECD Communications Outlook 2005. Retrieved from http://www.oecd.org/document/15/0,2340,en_2649_201185_35269391_1_1_1_1,00.html

Osiakwan, E. M. K. (2007). Is Africa in a digital quagmire? Retrieved 26 March, 2008. From http://www.satsig.net/gispa-afrispa.htm

Ossadnik, W., & Lange, O. (1999). AHP-based evaluation of AHP software. *European Journal of Operational Research, 118*(3), 578-588.

Oyeyikan, B., & Adeya, C. (2002). *Internet Service in Africa: An Empirical Exploration*. United Nations University.

Pejovic, V., Belding, E., Johnson, L., Parks, L., & Zheleva, M. (2012). The Bandwidth Divide: Obstacles to Efficient Broadband Adoption in Rural Sub-Saharan Africa. *International Journal of Communication, 6*.

Reiffel. A. (2011). USB Modems in Ghana. Retrieved from http://www.docstoc.com/docs/124694490/USB-Modems-In-Ghana

Sanou B. (2013). *ICT Fact and Figures: The World in 2013*. Retrieved from http://www.itu.int/ict

Schumann, R., & Kende, M. (2013). *Lifting Barriers to Internet Development in Africa. Suggestions for improving Connectivity.* Retrieved from http://www.analysysmason.com