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ECONOMIC CONDITIONS FOR FULLY INTEGRATING LESS DEVELOPED COUNTRIES' MACROECONOMIC SYSTEMS WITH THE DIGITAL WORLD - THE CASE OF NIGERIA

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Abstract:
Debates on how to fully incorporate the macroeconomics of developing countries into mainstream digital economics and economy is inconclusiveness with mixed outcome especially due to huge power infrastructure constraints. Yet the economic impact of the internet is widely documented. Thus, this called for a mathematical economics research. This is to scientifically distil the relevant factors and variables in a pure logical sequence that also generate variables that will enable further research. The main objective of this paper is to examine practical ways of fully integrate the fragile macroeconomies of developing economies into the digital world using Nigeria as a case in point. Pure economic logic and mathematical economic derivation were used for the argument. The finding of this study shows that infinitesimal expansion of consumable short term and long term resources is possible. In terms of economics, biological species can socially co-exist with humanoids and artificial intelligent enabled bots based on programmes and unconstrained economic resources. Virile virtual infrastructure, digital economics can be sustainable in a developing economy if energy per capita is dropped drastically through innovative schemes. Based on the findings of this study, the following recommendations are suggested: policy formulation and implementation that will monitor and coordinate

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renewal energy research outputs to increase their percentage contribution to GDP. Thereby encourage their mass consumption. More so, since macroeconomics of the digital world is feasible and there is social co-existence is possible anywhere service firms, manufacturing concerns and internet industry should come together to ensure this full integration.

JEL: O11; O14

Keywords: digital economy, electronic money, Internet economy

1. Introduction

The Internet is a potent global force in aiding full global integration of international macroeconomics. It plays a huge part in boosting Gross Domestic Product (GDP), capacity development, business profitability and efficiency, and employment generation (Jha & Kaleja, 2008; Kozma, 2015). The Internet is a gateway to the electronic world/eWorld and in the last twenty years of its founding it has continued to expand its digital footprints and realms where all systems can socially coexist. This digital footprint is increasingly defining, redefining and refining our macroeconomics as it increasingly integrates with the eWorld or virtual world, vWorld. Following the scramble in 2020 for containing the corona virus spread, most activities that define basic human activity is being punched and digitized on the eWorld platform which is also becoming the new reality for mankind. The internet industry is playing an important role in the world's economy in term of contribution to gross domestic production (GDP), reducing unemployment rate through employment generation, providing platform and channels of efficient and effective communication for investors.

More so, we can assume that there is an indirect nexus between the eWorld and economic capacity. According to Kim (1999), economic capacity as the amount a firm or an economy can produce using its current equipment, workers, capital and other resources at full tilt. According to Prior and Nela (2001), it is the financial limit of a firm, economy or person. Changes in economic capacity are used to assess economic efficiency; It is one of the most frequently used statistics for identifying economic prosperity. However, eWorld to an extent plays an important role in saving time and reduces the cost of transportation and distribution thus, influences predetermined prices of a basket of goods and services. Factors such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain will bring about the next phase of quantum industrial and technological progress.

According to the Internet Association (2019), the internet industry's contribution in GDP has risen to 11% as of 2018 compared to 3.4% in 2012. The report observed that the industry also facilitated to flow of about 56% of Foreign Direct Investment in the countries from the fiscal year 2016 to 2019 which stood at $931.2 billion. In the form of taxes, the internet sector contributed about $1.4 Trillion to thirteen governments in the study during the same period of time.

Furthermore, due to continuous innovation and improvement in the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain, ranges of services are expected to directly or indirectly impact on global macroeconomics and create a new jobs. Nevertheless, despite several packages of services offered online the global economy is still witnessing slow economic growth (GDP), slow rate of economic expansion, over reliance on physical money, literacy level and over emphasis of the crippling effect of the much touted digital divide.

However, several pieces of literature review on the impact of the internet industry as related to international macroeconomics in terms of economic growth, economic capacity, the decline in rate of expansion and over reliance on physical money are inconclusive with a mixed outcome. For instances, Chukwu and Uzoma (2014); Clarke and Wallsten, (2006); Broadband Commission (2019) and (2020), ITU (2018), (2019), concludes that Internet industry have a positive and significant impact on GDP via eGDP, economic capacity of nations, its rate of expansion, *and value for and of money*.

On the other hand, Odior and Banuso (2013), Dalberg (2013) and Schuppan (2009) posited that there is not so much significant impact of internet on the international macroeconomics - eGDP, economic capacity, the decline in rate of expansion. Similarly, Nguku (2009) and Mado (2000) posited that internet revenue does not contribute significantly to economic growth. Thus, following inconclusiveness and mixed results in the literatures on impacts internet has on economic growth called for deliberate mathematical derivation in order to ascertain impact of internet on GDP as well as to examine the nexus between internet and GDP, economic capacity and rate of expansion. Therefore, this study proposes to use mathematical derivation based on telecommunication economic theories. The rest of the paper is organized as follows; Section two is the review of selected literature relevant to the subject matter. Section three focuses on telecommunication economics mathematical derivation, analysis and discussion while, section four, deals with conclusion and recommendation.

2. Literature Review

Conceptually, the internet is defined as a global collaborative network of electronic gadgets. Dalberg (2013) argues that it has a vast potential for inclusive growth and socio-economic development. In the same vein, the electronic world/eWorld is a sphere of existence that is a human creation and can also accommodate human feelings, emotions and activities, (Shuai, Ye, and Meng, 2019; Bassi, 2006). McCloskey (2013) explained that the eWorld is an autonomous creation that can support human consciousness.

On the other hand, economic growth (proxied by GDP) is defined as according to Uwakaeme (2015), the term economic growth is described as the positive and sustained increase in aggregate goods and services produced in the inter economy within a given time period. According to Naz, Ahmad, and Naveed, (2017), Mevel, deAlba, and

Oulmane. (2016) argued that economic capacity is simply the goods and services that an economy can produce per time using its current stock of capital and entrepreneurial skills. It is important to note here that an increase in economic *capacity* does not translate to *GDP* increasing. This is so because if the population growth rate matches the GDP growth rate, there would be no *economic growth*. With economic capacity, African countries and firms via the internet are directly involved with managing outcomes for their economies. This means they also managing and optimizing knowledge, skills, and technology.

More so, eMoney is defined as a prepaid payment instrument drawn against available funds in a financial institution. Access to such funds is done remotely via a device (Bossone B., and A. Sarr 2017; Bachas, Gertler, Seira and Higgins (2016); Tuba 2014). While CPMI (2015) and IMF (2016) argued that it is simply a debit instrument which does not the characteristics an online money. Electronic Money Association (EMA) defines eMoney as the electronic value of funds held by depositors in participating financial institutions (Magaji and Eke, 2013). The concept of Bitcoin has been defined as simply as a form of eMoney with the full characteristics of physical money – store of value, unit of accounts and medium of exchange. The regulator's constraint is however its lack control by any international central bank and a single administration (Tee, and Ong, 2016; Cevik, Dibooglu, Kenc (2016); ECB 2014; Eke, 2020).

Theoretically, there is no singular theory that will be sufficient to explain the nexus between the eWorld and e-Macroeconomics. However, among several theories on communication and telecommunication this study anchored on both Information theory originally proposed by Claude Shannon in 1948 and Telecommunications Enhanced Community (TEC) theory by Wilde and Swatman (1997) both make an attempt to theorize the relationship between the need of telecommunications and communities' sustainability.

For instance, Information theory studies the quantification, storage, and communication of information. It was originally proposed by Claude Shannon in 1948 to find fundamental limits on signal processing and communication operations such as data compression, in a landmark paper entitled "A Mathematical Theory of Communication". Its impact has been crucial to the success of the Voyager missions to deep space, the invention of the compact disc, the feasibility of mobile phones, the development of the Internet, the study of linguistics and of human perception, the understanding of black holes, and numerous other fields. Information theory in sum studies the transmission, processing, extraction, and utilization of information. This theory is well fitted to the activities of telecommunications network which could be described as a collection of transmitters, receivers, and communications channels that send messages to one another. Similarly, Telecommunications Enhanced Community (TEC) theory by Wilde and Swatman (1997) make an attempt to integrate several theories on communication theory such as social interaction in a general computer network are discussed by Wellman (1997); Computer-mediated social networks by Sproull and Faraj (1997) as well as Romm and Clarke (1995), theory of Virtual Communities and Society.

Telecommunications Enhanced Community (TEC) theory proposed that if a community is to remain viable as a self-sustaining entity a necessary condition is that its component parts be supported by a critical mass of activity within the context of telecommunications network activities. The TEC is a community which has a variable mix of real and telecommunications services for reasons of community sustainability. According to Wilde and Swatman (1997), the growth in and diversity of computer networks since the mid-1970s has been truly astonishing. Since computing and communication technologies converged, the potential in both business and social networking applications has increased at an exponential rate, the social applications increasing at a rate unimagined in the early days of networking.

The development of social computer networks now affects whole communities, the practice outpacing the development of the theoretical concepts on which they may be based. The adoption of electronic networking by whole communities is often a survival strategy in an environment of economic rationalism and declining population. The form of these networks varies from computer networks or virtual communities in that a network of electronic services is superimposed upon an existing geographic community. The intention is not only to survive but to actually strengthen the community. This is achieved by adopting electronic services and communication methods not only to retain the current population but to increase it by structuring an attractive lifestyle of integrated real and virtual services.

Empirically, there are several literature on the effect of economic capacity on economic expansion/GDP and vice versa, however, there is a gap as regards its impact on the eWorld/eGDP let alone in Nigeria where there is little known on its impact as well. For instance, Akpan, Patrick, John and Udoka (2013) assessed the impact of the sugar industry on Nigeria's economic capacity utilization, using stochastic cobb-Douglas cost function for a period of 40 years, 1970 – 2010. The study discovered evidence that inflation rates, GDP and government influence economic capacity of the sugar industry positively and significantly.

Raimi L, Adeleke I (2009) did a review and measurement of capacity utilization in the Nigerian economy from the period of 1991 to 2003. The methodology was basically a descriptive statistics of the impact of economic capacity on economic growth for the period under review. The findings of the study reveal that firstly capacity utilization has impact on the economy and varies between 30% and 60%. Kim (1999) investigated the economic utilization and its determinants in America. The study used US manufacturing data. The study methodology involved deriving short run output supply and capital demand functions to generate a ratio of optimal to capital output. Findings of the study show that increased economic capacity of these firms does not contribute to economic growth.

3. Methodology

This section discusses the mathematical economic basis for the paper. The study employed pure mathematical derivation approach. This technique is applied to determine the existence of a long-run relationship in the model in order to investigate the phenomenon scientifically.

$$R = GM_c \quad (1)$$

A typical electronic world has electronic gross domestic product, eGDP denoted as M, c = economic capacity and rate of expansion, G.

$$c + 2M^G \leq M^e \quad (2)$$

The total digital resources replenished and eGDP are expected to satisfy equation 2 so as to sustain the population growth and M^e.

The limit of this global or super system to G (rate of expansion) is:

$$G \leq M^e/p \quad (3)$$

Allowing a chaotic expansion such as:

$$0 \leq M^e/p \leq 1$$

The extent of the fusing or miniaturization of our physical existence into an eWorld will be directly proportional to M^e through

$$R = GM^e_c \quad (4)$$

3.1 Economic growth in an eWorld

Once an eWorld is created where all biological species can equally coexist socially as in the physical world or pWorld. Whereas the resources of the pWorld is depleted faster than its replenished.

$$0 \leq pWorld \leq 1$$

The eWorld continues to growth:

$$-\varepsilon \leq eWorld \leq +\varepsilon$$

By recreating or replenishing itself based on the eWorld wide programme:

$$T = t * GM^{e}_{c} \quad (5)$$

Where:
T is the time in pWorld
t is the time in eWorld
therefore,

$$T = tR \quad (6)$$

3.2 Random nature of man in macroeconomics

Random quotient is the difference in man's destructive tendencies in pWorld and eWorld. The rules and freedom in pWorld causes man to "deform" the pWorld. In a typical eWorld, genetic codes, as well as other program codes will reduce or all be it erase this quotient:

$$Rq = (M^d/T)^{eWorld} - (M^d/T)^{pWorld} \quad (7)$$

3.3 Concept of the Internet/eWorld

An eWorld is a fully digitalized social ecosystem that has been predesigned. It has at its core a program software controlling resource regeneration and population. It has the capacity to recreate its resources. ePlants, eFood etc have been miniaturized into digital inputs.

At every point in time,

$$P = 2M \quad (8)$$

What the population required to sustain itself is twice its stock.

$$M = M^e \quad (9)$$

$$V_R - 2M^e + (M^d/T)^{eW} = 0 \quad (10)$$

When the virtual resources programmed to sustained life and gross domestic product over time is solved, it is expressed as:

$$V_R - 2M^e + (\alpha + M^d/T)^{eW} = 0 \quad (11)$$

Where e and α are critical constraints for the eW economic system's stability.

The internet is a gateway to the electronic world/eWorld which is an infinitesimal expansion of time frames and it's a distinct digital reality, whose essence is a direct function of human invention. Therefore, virtual reality is the new reality for mankind. The **internet** is a distinct social digital reality comparable to a physical city such as

Washington DC in the United states or Tokyo, Japan where all system socially co-exist. Increasingly, the **internet time** as a concept of time is also fused with our social interactions that preserves our existential continuum. The **internet of things** over the coming years will be widespread as all aspect of life in our physical and digital worlds will be merged by a common application. This will lead to a systematic miniaturization of our world as we know it now thereby fusing our collective existence with all digital realms.

A particular website, S with two surfers consuming the contents thereby obtaining utility over time. Let's assume the surfers are r and q respectively. Whose consumption is directly related their internet time acquired. The set of all such expenditure form a total expenditure (r,q) at S and denoted by:

$$[TE_{(r)} + TE_{(q)}]M \quad (12)$$

$$(TE)^{r}_{q}\, M \quad (13)$$

This n-dimensional matrix is shown that:

$$\dim (TE)^{r}_{q}\, M = n^{r+q} \quad (14)$$

using a component syntax, (r,q) may be written as:

$$T = T^{bi\ldots br} C_i \ldots C_s(\delta/\delta x^{bi}) + \ldots + \delta/\delta x^{bi} \quad (15)$$

Where,
$\delta/\delta x^{bi}$ is the basis for the i^{th} hit on a similar website referred by the previous website. In this paper, internet time is a concept of time as defined within the matrix of earth's planetary dimension and over time due to advances in science is now fused with our eWorld in a social continuum. The amount of internet time to be consumed will be three dimensional - time on the web, number of sites hit and of course, utility derived. In a matrix system, the total number of elements will only be 3^c, where C is the sum of columns and is the rank of the matrix. Therefore, since these economic characteristics can be captured by matrix such as income of the subscriber, budget and the propensity to consume, 3^c has introduced the constraints identified above. More so, in a rank three matrix,

TE satisfies $T_{\alpha\beta\gamma} = T_{\gamma\beta\alpha}$

and possess 3 column of independent values for variables, whereas the duration spent on the net,

N satisfies $N_{\alpha\beta\gamma} = N_{\gamma\beta\alpha}$

and possess equal number of independent values for variables. In cases where website surfing for economic purposes is as a result of a referral in which both participants are close by within eye contact range is quite faster than over the social media or online referrals.

Therefore, a convenient means of expressing the first scenario in terms of distance is adopting differential geometry, hence:

$$ds^2 = W_{r,q}\, dx^r + dx^q \tag{16}$$

Another crucial feature is the fact that once a website is located by surfers the speed of access is invariant. Therefore, for internet surfers r and q who are within each other's eye contacts with a given radius[ii],

$$R = R^{\alpha\beta\gamma}\, W^{\alpha\beta\gamma} \tag{17}$$

Assuming power constraints, energy challenges are constant, their utility derived from the consumption of online services is:

$$U^r = X^{(TE)r} \tag{18}$$

$$U^q = X^{(TE)q} \tag{19}$$

Now by definition, when sites have been discovered, consumed and saved for offline reference, the rate at which it is shared via Bluetooth, Xender, WhatsApp, etc is:

$$\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n [\boldsymbol{\rho}TE_{(r)} + \boldsymbol{\rho}TE_{(q)}] \to \boldsymbol{\rho}TE_i \tag{20}$$

Where,

$\boldsymbol{\rho}TE_i$ specifies that the rate at which linked sites are shared depends on their sharer's total expenditure over internet time.

Assuming that sharing is infinitesimal and only r and q have access to the web,

$$De_{(r)}e_{(q)} = \boldsymbol{\rho}^{TE}{}_{(r)(q)}\, e_{TE} \tag{21}$$

However,

$$\boldsymbol{\rho}^{TE}{}_{(r)(q)} = \boldsymbol{\rho}^{TE}{}_{(q)(r)}$$

If their rate of sharing does not involve any cost at all in terms of internet time, battery charging and call credit, a network offering an efficient service to subscribers has:

[ii] This is a key in unlocking the economic satisfaction derivable from online hacking.

$\frac{1}{3} D^2_{rq}(D - 1)$ (22)

For any particular network experience (ɤ) have two active subscribers surfing from point:

$X = ɤ (0)$

and sharing the information with another in point:

$X = ɤ (t)$

which gives rise to:

$X(t) = \Pi_{\alpha\beta ɤ} X(0)$

Which defines the economic influence and and benefits derivable from such experience over internet time. X(t) is solved by differential equation:

$d/dt[X'(t)] = D_{rq}(t)X^i(t)$
$= \boldsymbol{\rho}_{rq} X^i(t)$

$\boldsymbol{\rho}_{rq}$ being the slope specifying this economic impact/influence. Now, let the subscriber r be surfing the net at point A and q at B, the idea of differentiating B at r along the direction of A assuming the network is efficient:

$$D_A \rightarrow \beta(X) = \lim_{\varepsilon \to 0} \left(\frac{1}{\varepsilon}\right) \quad [\Pi_{\varepsilon,0,ɤ;}\, \beta\{ɤ(\varepsilon)\}] \quad (23)$$

now differentiating B at r along the direction of A can turn out a different set of results based on network efficiency, power constraints and phone efficiency. Therefore, using point X and Y as earlier specified:

$D'_{YX} = X^r b Y^q \, d/dx^r$
$= (X^r b + \boldsymbol{\rho}^q{}_r)$

The expression in bracket is called country specific coefficient with respect to the constraints identified. Therefore, the economic benefits of consumption and sharing of a website link over the internet per time is:

$LX\phi = X^r d\phi/dX^r$ (24)

$LX\phi = X^q d\phi/dX^q$ (25)

Within this framework, rate at which additional related sites will be picked up and shared by r and q is:

$$LX[TE_{(r)(q)}] = X^{r}D_{r}[TE_{(r)(q)} + (D_{r}X^{r}) \quad (26)$$

$$LX[TE_{(r)(q)}] = X^{q}D_{q}[TE_{(r)(q)} + (D_{q}X^{q}) \quad (27)$$

This is the exact condition for a typical mobile network to economically maximize subscriber's exposure to sites, download and share links.

$$LXU_{(r)(q)} = 0 \quad (28)$$

$$D_{r}X_{r} + D_{q}X_{r} = 0 \quad (29)$$

$$X^{D}U^{rq}{}_{\alpha\beta\gamma} + X^{D}U^{rq}{}_{\alpha\beta} + X^{D}U^{rq}{}_{\beta\gamma} = 0 \quad (30)$$

Having specified the condition on the network side, here is the condition for the surfer:

$$TE_{(r)(q)} + P'U_{rq} = TE/V(D_{r}{*}D_{q})$$

Where:
P' is power efficiency parameter, and
V is the speed of the internet at the location per time.

The economic realities of physical world science and technology has evolved over the decades to enable the creation of uniform virtual reality, V whose resources are not bound by our physical world constraints such as physical and economic infrastructure, non-renewable resources, population, poverty. By all accounts, the virtual world, vWorld or eWorld is inherently characterized by infinitesimal expansion on all conceivable fronts, -E(+E).

The infinitesimal resource possibilities of the macroeconomics M, of this eWorld will be simply be denoted:

$$M = V_{R}\{-E(+E)\} \quad (31)$$

Where V_{R} refers to the exponential and infinitesimal expansion capacity of economics resources in the virtual world.

Therefore, this rate of expansion can be solved over virtual time in an ideal context:

$$T_{(M)} = 0 \quad (32)$$

It should be noted that the economic condition for a sustainable virtual reality, $M \neq 0$:

$$T_{(M)} = f(M\delta t; R\delta t^2) \quad (33)$$

Since M represents earth's macroeconomics it can also denote the value of the earth's gross domestic product and the study only considers $M > 0$.

Note that M has been defined by assumption as $T_{(M)} = 0$ and used to ascertain the rate of expansion as the case maybe. In a virtual world where all biological species socially co-exist based on programs and its inherent constraints which factor in economic resources, virtual infrastructure, population growth and resource availability over virtual time, hence:

$$t^* = f(t, M) \quad (34)$$

This definitely suggests that we may redefine our equation 31 as

$$M = V_R \{-E(+E), t^*\} \quad (35)$$

eWorld macroeconomics defined by equation 35 yields a smooth progression from the three-dimensional resource constraints world to an infinitesimal resource "unconstrained" world.

From equation 35, it is obvious that resources created stored and utilized in M must remain within our global virtual world, GVM. That is:

$$-E(+E)\ V_R = M.$$

Therefore, this has created a capacity for resource renewal in equation 31.

That is $V_R = 2M$ and as $\delta V_R \rightarrow \infty$, this capacity defines the growth rate of the eWorld.

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