
# Regulation of complex adaptive digital systems: optimizing competition and consumer welfare outcomes in Nigeria's converging telecommunications market

**Raymond Okwudiri Onuoha**
**Student ID: ONHRAY001**

**Supervisor:** Adj. Prof. Alison Gillwald (NMSPG, University of Cape Town, South Africa)
**Co-Supervisor:** Johannes M. Bauer (Professor, Dept. of Media and Information, Michigan State University, United States)

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**Raymond Okwudiri Onuoha**
**Student ID: ONHRAY001**

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## DECLARATION

**I declare that the thesis for the degree of Doctor of Philosophy at the University of Cape Town hereby submitted has not been previously submitted for a degree at this or any other university, that it is my work in design and execution, and that all the materials contained herein have been duly acknowledged.**

Signed by candidate

**Raymond Onuoha** **Date**

## ABSTRACT

The thesis explores how emerging digital ecosystems would benefit from new regulatory approaches that differ from the traditional models applied in the telecommunications sector. The historical model is typically based on an analysis of static efficiency, which does not appropriately acknowledge the often complementary nature of the evolving digital ecosystem and its dynamic efficiencies. Informed by the increasing complexities of the converging telecommunications ecosystem, the corroboration of this core proposition required the examination of not just the technical but also the socio-economic and institutional elements of advanced communication systems. Findings from existing academic literature on pro-competition regulatory challenges of digital markets focus more on mature competitive markets in the Global North. There is a paucity of empirical studies on the predominantly pre-paid mobile markets of the South — where competition laws and institutional arrangements that facilitate market competition are still nascent. More so, extant studies of telecommunications market regulation were mostly supply-side focused, not taking into full consideration demand-side elements, especially the social and public value of the converged telecommunications ecosystem. In addition, most of the studies focused on quantitative methodologies largely based on econometric analysis. To fill a gap in the research literature, the thesis explores these issues within the context of a developing country, Nigeria. The research responds to the dearth of critical policy enquiry within the domain of applied social policy research that relies on qualitative interrogation to examine the interrelated ecosystem elements and arrive at answers to questions that generally cannot be understood through quantitative methods. Although there is a rich vein of literature regarding telecommunications market regulation, explaining network competition principles and the institutional conditions under which they thrive, instances of such research in a developing country context are few and far between. The thesis bridges these gaps by applying a systemic approach based on complexity theory and institutional analyses drawing on the institutional analysis and development (IAD) framework to answer regulatory questions of competition policy under conditions of constraint, such as in emerging markets. By developing a conceptual framework drawing on these two approaches, the effects of demand-side access and willingness to pay are assessed via an in-depth qualitative analysis to examine the resulting dynamic impact on social welfare. The thesis provides a case study of Nigeria to examine these issues in a developing country context. The research questions examine the complexities of regulating dynamic markets to achieve often competing objectives of competition, investment, innovation, and consumer welfare. The author deployed the conceptual framework to analyze the evidence for the case rather than for purposes of theoretical contestation or theory building. Therefore, the thesis methodology leans towards an inductive research paradigm within the episteme of interpretive constructivism. The author adopted a qualitative methodology for the study based on the nature of the research questions and the conceptual framework. However, empirical insights were generated by the author from a combination of methods. The research process comprised a country-specific cause-effect analysis of the regulatory challenges of OTT-MNO competition in the context of Nigeria's converging telecommunications industry and its imperatives for both innovation and investment policy outcomes. Incorporating in the methodology a process tracing mechanism allowed for the elucidation of critical junctures in the structural evolution of the country's telecommunications market and the path-dependent outcomes for alternative policy options. Consequently, the author undertook an initial step in mapping the converging Nigerian telecommunications ecosystem, which detailed its complex interrelationships in relation to ecosystem stakeholders and institutions, regulatory governance mechanisms, and outcomes to

complement the qualitative analysis. The ecosystem mapping was then used to identify critical opportunity pathways for regulatory evolution both in the short and long terms for effectively addressing the competition dynamics related to OTTs and MNOs within the converging Nigerian telecommunications market. The thesis contributes to the existing body of knowledge on regulating complex adaptive systems by exploring competition and consumer welfare optimization in Nigeria's converging telecommunications market. It does so by building on the literature on socio-technical systems' governance and policy design within adaptive external environments, deploying key concepts from complex adaptive systems theory. In extending and problematizing the domain discourse, a key regulatory challenge that crystallizes in assessing the converging Nigerian market is an appropriate regulatory structure that optimizes investment and innovation incentives on both sides of the market — infrastructure development and next-generation services provisioning. In addressing this regulatory challenge under conditions of institutional and resource constraint, the thesis considers the preconditions, necessary and sufficient institutional arrangements for effective competition regulation within Nigeria's converging telecommunications sector to maximize dynamic efficiency and social welfare. This contribution provides an evidence base in support of claims of the value of the converged telecommunications ecosystem for developing countries. It evaluates how ecosystem stakeholders can find an optimal balance along multiple emerging telecommunications policy trade-offs and their implications for competition policy and regulatory options.

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**Dedication**

**To my God, the Inspiration of my Spirit.**
**And to my wife, Agatha, and daughters, Michelle and Olachi; I am, because of your love and support in the often thankless journey of an academic!**

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## Chapter One: Introduction

### 1.0 Background to the Study

The rapid diffusion of Internet-based networks is altering the socio-technical communication system that enables the emerging digital ecosystem, including the institutional arrangements for national and global governance. Technically, the change is primarily driven by the convergence of the telecommunications ecosystem with the Internet due to increased digitization and network compression characterized by the deployment of the Internet Protocol (Wu, 2004). Economically, however, the shift in the digital ecosystem has been driven by the liberalization of markets that has spawned lower-cost technology innovation, ending natural monopoly elements of network infrastructure that provided the rationale for utility regulation and enabled competition in telecommunications infrastructure provisioning (Mueller, 1999; Singh, 2016). These shifts in the digital ecosystem have significant implications for consumer access and use, competition, innovation, and investment, especially in developing countries — where the cost of new-generation infrastructure rollouts limits the speed of convergence.[1] This situation challenges traditional regulatory arrangements and has led an increasing number of countries to explore novel regulatory and policy frameworks to adequately harness the opportunities that the emerging complex pathways of this change provide (Kling, 2000; Frischmann, 2004; Constantinides & Barrett, 2006; De Vries, 2008; Bauer & Tsai, 2014a; Head & Alford, 2015).

In the domain of public policy analysis, a critical question arises as to whether challenges arising from such systemic changes have attributes of "wicked" problems — in that they lack a clear definition. Within this perspective, according to Head (2008), "wicked" problems are characterized by sub-optimal scoping, transitionality, extreme diversity, and a fragmented knowledge position of stakeholders. In the worst case, they are not amenable to stakeholder-agreeable, practical solutions. Even if this outcome can be avoided within the ecosystem, such situations often result in unintended (desirable and undesirable) results and policy failures (Rittel & Webber, 1973). Rittel and Webber (1973) assert the significance of contextual relationships in policy solution formulation in addressing "wicked" problems to minimize the previously stated unintended consequences. The significance of complex systems in theory and practice as a solution frame is evident in the emerging

[1] South African Communications Forum Report. 2016. Industry Briefing on Over the Top (OTT) Services in South Africa. https://static.pmg.org.za/160126SACF.pdf

contemporary literature on "wicked" policy problems (Head, 2008). It has been deployed in evaluating collaborative planning (Innes & Booher, 1999), developing marketing theory (Goldenberg, Libai, & Muller, 2001a), communication studies (Goldenberg, Libai, & Muller, 2001b), technology research (Fleming & Sorenson, 2001), ecosystem and biodiversity studies (Norberg, 2004), supply chain management (Surana, Kumara, Greaves, & Raghavan, 2005), global health governance (Hill, 2011), the study of socio-ecological systems (Levin et al., 2013), and in most recent times — in entrepreneurship studies (Roundy, Bradshaw, & Brockman, 2016), comparative politics (Bednar & Page, 2016), strategy (Wollmann & Steiner, 2017), sustainability research (Missimer, Robèrt, & Broman, 2017), and complex adaptive systems analysis (Koliba & Koppenjan, 2015; Zivkovic, 2015; McBride & Draheim, 2020).

In parallel to these developments, the academic policy literature has explored the usefulness of concepts from complex adaptive systems (CAS) theory, such as self-organization, initially formulated in bio-physical sciences (Anderson & McDaniel Jr, 2003; Lansing, 2003; Markose, 2005). This CAS attribute refers to the intrinsic characteristic of all social systems that allows for the mutual adaptation of human responses to align with external and internal ecosystem changes in determining the quality of outcomes (Stacey, 1996; Cilliers, 1999). Another related central theme of CAS is the principle of emergent patterns as propounded by physicist Philip Anderson. This CAS property refers to developing far-reaching relational trends from small-scale interactions (Levin, 1998). In the long run, however, emergent patterns relate persistently to self-organization over time (Hagstrom & Levin, 2017).

In relation to telecommunications policy, insights from complex systems approaches have become even more significant. For example, as gaps in broadband quality and access are of increasing concern and new governance models are being assayed (Bauer & Tsai, 2014a; Bauer & Tsai, 2014b), debates as to the effectiveness of traditional policy levers in producing requisite outcomes in the short and long terms continue to abound (De Bijl, 2011). Markose (2005) contends that this situation is fundamentally underpinned by the critical issue of indeterminism — a problem of complex systems. Particularly in the telecommunications policy and regulation domain, four sets of interacting factors have been adduced by scholars as the drivers of broadband diffusion outcomes. Among others, Bauer and Tsai (2014b) distinguish supply-side, demand-side, access quality, and policy factors. Of the policy factors, the intensity of competition and broadband pricing on the

supply side, willingness to pay on the demand side, and the regulatory environment are fundamental (LaRose et al., 2012; Bauer & Tsai, 2014b). The complex causation patterns that arise because of the multifaceted, often non-linear, relations between these abovementioned factors raise new challenges for designing governance mechanisms to achieve socially desirable outcomes. Researchers since the late 1990s have recognized that the value system of digital service provision is changing and that this has implications for the analysis and design of telecommunications policy. The two main strands of research that tried to address this are inquiries into two-and multi-sided markets (e.g., Rochet & Tirole, 2006) and an emerging literature on complex adaptive systems and business ecosystems (e.g., Cherry, 2006; Parker et al., 2016). Although the jury is still out, traditional policy models no longer appear able to identify and balance market failures with the public interest and, therefore, are sub-optimal in unpacking the necessary and sufficient conditions for minimizing unintended policy outcomes (Gillwald, 2009; Whitt & Schultze, 2009; Bauer & Tsai, 2014b; Bauer, 2015; Schultze & Whitt, 2016; Stocker et al., 2017; Bauer & Latzer, forthcoming).

On the basis of the above prelude, this thesis explores the arguments for a shift from competition regulation in the telecommunications sector — that is based on static[2] analyses of efficiency — to a broader-based complex system synthesis, reflective of the complementary nature of players and processes in the evolving digital ecosystem. This perspective requires examining not just the technical but also the socio-economic and institutional elements within this increasingly complex ecosystem (Fowler, 2000; Kim, Bauer, & Wildman, 2003; Lee, O'Keefe, & Yun, 2003; Bauer & Tsai, 2014b; Bauer & Latzer, 2016). Conventionally, the academic literature on telecommunications policy and regulation has focused more on supply-side factors, not taking demand-side elements into full consideration, especially with respect to the social and public value of the Internet (see Cohen, 1998; Frischmann, 2001). In considering the Internet as an infrastructure resource that creates social value, the scholarly debate has continued regarding access control in relation to public use and its normative implications (Frischmann, 2004). This thesis bridges this gap by applying institutional analyses and elements of complexity theory as analytical lenses for addressing regulatory questions of

[2] By being static, the author infers that the traditional model of competition analyses in relation to the critical elements of pricing, innovation and investment does not respond optimally to long-term deviations from the equilibrium position as it affects the overall ecosystem (see Bauer, 1997). While a static competition model is not in itself necessarily erroneous, its simplification and abstraction for a converging telecommunications ecosystem that is evolving in a dynamic, non-linear pattern might lead to insufficient approximations in guiding telecommunications policy choices (see Bauer, 2014).

competition policy under conditions of constraint found in developing countries for the realization of global digital public goods[3] at the national level (Bauer & Herder, 2009; Kaul, 2013).

### 1.1 Research Problem

With the increasing complexity of digital ecosystems globally, regulation and policy face new knowledge gaps. For example, increasing levels of infrastructure investments and stricter (often static) regulatory requirements have not (as argued by the proponents of these measures) always led to a ubiquitous expansion of next-generation-access networks, both in high-and low-income countries (Eisenach, 2012; Rajabiun & Middleton, 2015). Much of this policy impasse has been attributed to the technological determinism of dominant paradigms, whether neoliberal or innovation-based (Mansell, 2017). Not sufficient attention has been paid to the transitional dynamics

[3] By public goods, the author infers having the intrinsic properties of demand-side non-excludability of non-payers, and non-rivalrousness of its benefits (or non-subtractability of its use); and on the supply-side, its aggregation imperative (see Holzinger, 2001; Sandler, 2006; Berg & Horrall, 2008; Ostrom, 2010; Sanz, 2015). Non-excludability exists when there is unconstrained access to the good for both payers and non-payers alike; non-rivalrousness implies that the good can be consumed by multiple individuals without diminishing the value of the good; and supply-side aggregation implies that the separate contributions of individual players (whether additive or substitutive) affect the total supply of the good. The implication of publicness is that there is usually a creation of market failure in the private provisioning of such goods, often arising as a result of free riding by non-payers in covering the cost of production (Stiglitz, 1986). In relation to pricing, providing public goods with some level of rivalrousness allows market pricing to optimally apportion the good in relation to paying value, which often leads to output expansion in the long term. In economic terms, public goods (such as air, forests, water, and defense) are distinguished from private goods as a rationale for regulation based on the unique characteristics that apply to digital goods. A public good is inherently non-rivalrous in consumption (it is infinitely usable without detracting from another person's ability to use it). While private goods are excludable, public goods are naturally non-excludable, meaning there are no natural barriers to using them. Free-to-air public broadcasting (spectrum) is often cited as a classic example of a public good in that the use of it by one person does not detract from another person's use (assuming no interference with the signal or congestion). It is also non-excludable, in that, unlike an encrypted subscription service, no one can be prevented from using a free-to-air service. Public goods are typically expected to be funded by means of a general contribution. However, the challenges of mobilizing public (state) resources for the provisioning of public goods have begun to focus attention on providing public goods through some form of exclusion, thereby allowing the market to play a much more significant role in delivering such goods. This mechanism effectively renders most public goods impure in that they have been made excludable, often through regulation or for purposes of commercialization, monetization, and profit at the expense of public-service obligations or access. Although, theoretically, debates over state and private provisioning have been polarised, in practice, state and non-state actors regulate each other's capacities to provide, access, and distribute public goods, often in ways that compromise the ideal of public goods.

of the socio-institutional environment, though some authors have examined its impacts on policy outcomes (Shin, 2007; Shin & Kweon, 2011; Xia, 2016). Others, however, have sought to understand the effect of asymmetries in information, resource intensities, and strategic interests of ecosystem stakeholders (Rajabiun & Middleton, 2015).

Other literature demonstrates the mixed results of competition regulation across countries at varying stages of broadband development in the short-and long-run (Liu, 2017). For example, while most of the OECD[4] member countries had promoted infrastructure-based competition over subsidization with limited success, many of the EU[5] member countries, on the other hand, had incorporated flexibilities for subsidy provisioning in promoting market competition, which increased service-based competition for unbundled local loop access (Höffler, 2007). From the preceding perspective, the complexities arising from transitory contextual market evolution may create misalignments and uncertainties in broadband governance frameworks and render them inconsistent with poor allocative and technical efficiencies in relation to equity[6] (Bauer, 2005a; Kemp & Rotmans, 2005; Cantwell, Dunning, & Lundan, 2010; Bandyopadhyay, 2011; Xia, 2012). These regulatory uncertainties affect industry stakeholders' capacity to build new-generation broadband infrastructure and access (Geels, Hekkert, & Jacobsson, 2008). These challenges provide hints that the traditional policy frameworks lack the requisite robustness to govern the emerging digital ecosystem in the presence of these interdependent factors, as they are less multi-perspective and adaptive to the dynamic systems changes highlighted (Ramírez, 2007; Bauer, 2014). This inability to take into consideration the often complex and uncertain changes of the socio-technical system begs the question of whether alternative frameworks can provide better analytic perspectives for more optimal problem assessment and for crystallizing policy outcomes that will be stakeholder-agreeable (Hitchens, 2011; Shin & Kweon, 2011; Bauer, 2014). In relation to this, this thesis will particularly explore approaches rooted in theories of complex adaptive systems.

Specifically, regarding the control of access to the Internet, the extant supply-side focus has skewed the arguments within competition analyses and innovation studies. Scholars attribute this

[4] Organisation for Economic Co-operation and Development

[5] European Union

[6] This relationship is often indirect, as poor allocative and technical efficiency creates disincentives for further investment and innovation on the supply side, with a cumulative long-term impact on social welfare (distributional effects) (see also Mishra & Kumar, 2021).

commercial focus on the appropriable returns from complementary regulatory interventions to the challenge of demand-side appropriation of the value created in output markets by the suppliers of the Internet infrastructure (Frischmann, 2004).[7] According to Frischmann[8], this supply-side focus has dominated telecommunications competition policy and market regulation (concerning licensing and allocation of electromagnetic spectrum) without recognizing the demand-side value of these social or public goods (including spectrum and the Internet). In his submission, he does not argue for substituting supply-side valuation in resource allocation with demand-side valuation but for a better balance between the two, as these social goods are critical economic downstream inputs. While demand-side network effects (both direct and indirect effects) are often generated in multi-sided markets, they do not always result in positive externalities for all sides of the market. This outcome is mainly because the externality effects do not automatically increase users' willingness to pay for accessing the network infrastructure (Lehr & Pupillo, 2009).

Furthermore, this policy problem creates systemic uncertainties with respect to infrastructure investment, market contracts, and managing demand contingencies, possibly inhibiting innovation and user welfare (Scotchmer, 1991; Frischmann, 1999). The optimization problem between network infrastructure openness and value becomes significant when the Internet (and the evolving telecommunications ecosystem) is considered a social or public good. This condition becomes imperative where regulatory interventions focus only on consumptive rather than productive dimensions of equitable access. Within that purview, economic producers do not entirely appropriate positive externalities that generate greater output value. Again, this is because users' willingness to pay for service typically does not reflect such externalities fully (Ayogu & Hodge, 2002). This market failure reduces the incentives of output producers to invest in greater access inputs that will engender social welfare and innovation, and strengthens the debate on the most efficient models for governing Internet access while optimizing innovation and investments for social welfare (Benkler, 2002; Frischmann, 2004; Ou, Lv, & Chen, 2018).

Considering these dynamics in the rapidly evolving telecommunication services era, the advent of over-the-top services (OTTs) from providers such as Facebook, WhatsApp, and Skype is causing significant disruptions in the emerging telecommunications ecosystem. This market evolution is

[7] Given the rivalrous nature and non-excludability of the services they provide.

[8] Who argues from a specific, infrastructure-as-a-commons perspective

leading to, in some instances, substitutive and, in some other cases, complementary product effects on the traditional telecommunication network providers (Telcos). Many Telcos regard OTTs as "free-riding" on their networks — although this is contested in the literature because network operators can capture part of the additional value generated by OTTs in subscriber data revenues (Renda, 2010; Brown, 2014; Kraemer & Wohlfarth, 2015; Ou, Lv, & Chen, 2018). Nevertheless, sharp differences in business models, geographic delimitation, and pricing create competition imbalances, especially in multi-sided markets (Hagiu, 2006). In this respect, the propensity of the often essential services offered by some OTTs — such as voice and messaging — to control market access through pricing (more significantly via zero rating) can create proprietary bottlenecks. This condition raises further questions as to the extent of ex-ante regulation required to allow for enhanced diffusion of broadband and telecommunication services (Ballon & Van Heesvelde, 2011). In particular, broadband diffusion as an outcome of the competitive environment depends on balancing out market competition attributes introduced by new entrants such as the OTTs that may lead to high concentration, including economies of scale, network effects, and sunk cost imperatives, all of which have significant imperatives for consumer welfare (Preta, 2018).

In leading African telecom markets, including South Africa, Nigeria, and Kenya, the increased uptake of smartphones is driving the prevalence of OTTs in the digital ecosystem (Gillwald et al., 2019). This trend is challenging traditional revenue streams in the predominantly pre-paid mobile domains, especially with respect to voice and SMS (Pestanes & Marçais, 2016). However, in the Nigerian market, the voice segment continues to contribute a large proportion of revenues despite the adoption of OTTs that are substitutes for voice services within the market. For instance, during the first two quarters of 2021, voice contributed about 62% of MTN Nigeria's total revenues.[9] While some experts argue that enhanced data usage increases the flow of revenues for the network providers[10], the jury is still out on whether this positive externality sufficiently counterbalances the investment requirements by operators (Bhawan & Marg, 2015). Arguments in this regard have focused on the impact of static regulatory frameworks and the effects of incumbency and market dominance.

[9] Accessed December 8, 2021: https://www.premiumtimesng.com/business/business-news/476766-flourishing-data-demand-helps-lift-mtn-half-year-profit-by-50.html

[10] As evidenced in markets that are successfully transitioning from voice to data, in comparison to markets where transition has not been enabled due to constraining telecom regulation (see Gillwald, Mothobi, & Rademan, 2018).

Within this discourse, findings from the World Bank's *World Development Report*[11] for 2016 indicated that regulatory uncertainty concerning platform competition policy impedes ubiquitous Internet and telecommunications service access provisioning and digital content innovation. At the root of this problem is balancing investment incentives in next-generation network infrastructure and optimizing access and service-based intra-platform competition in the multi-sided telecommunications market, consisting of the traditional operators and new-entrant over-the-top players (Choi, 2011). In a micro-analysis, the platform competition policy problem in multi-sided markets is mainly with respect to balancing three critically interlinked components — investment, innovation, and pricing — with strong social welfare imperatives. According to Garcia (2016, p3): "*The key challenge is finding a pricing model with the correct mix of incentives to boost competition in both markets so that the social welfare is maximized."* This policy challenge is imperative in developing country markets largely governed by ex-ante sector regulation and ex-post competition regimes (see Evans, 2003). In this context, lower prices might benefit consumers in the short term, especially in underserved areas. However, they may also constrain investment and market innovation in complementary markets in the longer term. Thus, an appropriate mix of policies to balance and optimize these critical elements makes the problem complicated and multi-faceted with social, economic, and technical policy implications (Quigley, 2004).

### 1.2 Identification of Research Gaps in the Literature

Research by De Bijl (2011) elucidated the complexities of optimizing regulatory policies for broadband quality and access in the context of the Netherlands, but critical insights apply to other countries. One major challenge is to balance regulatory incentives in a manner that would encourage infrastructure investment by both incumbent and new entrants. These matters are complicated if contextual market conditions are in flux. Accordingly, some authors have suggested addressing these transitionary optimization problems using complex systems theory, as static, deterministic[12] models

[11] World Development Report 2016: Digital Dividends. World Bank. Accessed December 8, 2021: https://www.worldbank.org/en/publication/wdr2016

[12] By being deterministic, the author infers a model where the parameters of regulation are non-optimally set ab initio being inflexible to changes due to technological innovation. For example, a price-cap regulation that may have been set to incentivize investment may in the long-term leave prices too high if the pricing cap is benchmarked to historical costs associated with a rate-of-return pricing regime. This situation may prevent the realization of maximum investment

cannot be used to govern them (see also Rotmans, Kemp, & Van Asselt, 2001; Cherry, 2006; Fiksel, 2006; Loorbach, 2007; Zhan, Zhang, Li, & Chung, 2009; Paperin, Green, & Sadedin, 2011; Xia, 2011; Oughton & Tyler, 2013).

A review of the extant literature on static and dynamic regulation of the telecommunications industry since the turn of the decade (see Table 1 in Section 2.1) reveals an almost exclusive focus on mature competitive markets in the Global North. Most of the empirical studies within the domain are not dedicated to the predominantly pre-paid mobile markets of the South, where competition laws and institutional arrangements are still nascent (Hoekman & Holmes, 1999; Bourreau & Doğan, 2001; Gayle & Weisman, 2007; Bauer & Bohlin, 2007; Bauer & Bohlin, 2008; Friederiszick, 2008; Robinson & Weisman, 2008; Lüftl & Cardona, 2009; Bauer, 2010a; Boyer, 2010; Distaso, Lupi & Manenti, 2010; Grajek & Röller, 2012; Lemstra & Melody, 2015; Grajek et al., 2019; Petit & Teece, 2021; Polemis & Tselekounis, 2021; Meena & Geng, 2022; Wang & Sun, 2022). However, three empirical papers — Wallsten (2001), Fink, Mattoo and Rathindran (2003), and Mothobi (2017) — examine developing country contexts. Most of the studies adopted quantitative methodologies and were often based on econometric analysis. There is only a dearth of critical policy enquiry that relies on qualitative interrogation of the complex elements as they interrelate within the domain of applied social policy research, especially with respect to "*those likely to be affected by a policy decision or thought to be part of the problem*" (Walker, 1985, p.19).

Furthermore, except for Bourreau, Kourandi and Valletti (2015), it appears that none of the previous studies have examined competition policy by assessing the dynamics of its relationship to the three constructs of pricing, investment, and innovation together as they affect social welfare, to elucidate a richer vein of understanding in the domain (see also Economides & Tåg, 2007; Shelanski, 2013). More so, while the research on the multi-sided nature of telecommunications markets was still at a relatively early stage in the 1990s, it has exploded in recent years (Rochet & Tirole, 2003; Eisenmann, Parker, & Van Alstyne, 2006; Teece, 2012; Bauer, 2014; Kraemer & Wohlfarth, 2015; Ondrus, Gannamaneni & Lyytinen, 2015; Teece, 2017; Teece, 2018a; Teece, 2018b; Sanchez-Cartas & Leon, 2019; Paelo & Roberts, 2022). However, extant studies in this area (see Table 1) are mainly

efficiencies due to the stranded historical costs and may not be realistic within systems of uncertain technological progress (see Dutton, 1992; Biglaiser & Riordan, 2000).

conceptual and require empirical interrogation to validate theoretical predictions, especially in developing country contexts (Sriram et al., 2015). It is imperative, therefore, to elaborate on the theoretical understandings established within prior research and the practical policy implications in the context of multi-sided competing networks (Sun, Gregor, & Keating, 2016).

In sum, although there is a rich body of studies with regard to telecommunications market regulation and policy in general, less research is available that explicates network competition principles and the institutional conditions under which competition thrives, especially in a developing economy context (Armstrong & Sappington, 2006; Bauer, 2014; Jacobides, Cennamo, & Gawer, 2018). Specifically, a critical social welfare prognosis of contemporary pricing structures, such as zero-rating online content in two-sided mobile markets, and its implications for innovation and investment, is urgently needed.

## 1.3 Overall Research Objective

Based on this narrative, the overall objective of this thesis is:

> *To examine the interrelationships between regulatory policy and market elements — pricing, investment, and innovation — within Nigeria's converging telecommunications market, understand their impact on social welfare, and specify alternate policy approaches that may achieve better outcomes within the unique national context.*

### 1.3.1 Sub-Research Objectives

The sub-research objectives emanating from the overall objective are two-fold:

a) *To assess alternate regulatory policies that consider the dynamic interrelationships in two-sided telecommunications markets, and their imperatives for investment, innovation, and social welfare.*
b) *To analyze the institutional conditions required for welfare-enhancing OTT-mobile network competition regulation in a developing economy context.*

## 1.4 Conceptualization of Overall Research and Sub-Research Questions

Within the context of a developing economy, an appropriate competition policy can promote more inclusive development, especially when unique institutional characteristics are considered. This process becomes more daunting in the wake of neo-liberalization policies that engender

privatization, deregulation, and commercializing economic institutions, altering socio-technical arrangements in these contexts (Singh, 2016; Picard & Pickard, 2017). In these telecommunications markets, market failures have amplified access gaps for broadband Internet and telecommunications services, especially in unserved and underserved areas. This condition is significant as economic efficiency considerations of infrastructure build-out had taken priority over social imperatives. Consequently, in considering the Internet (and the evolving telecommunications ecosystem) as a social infrastructure, resource allocation via classical market mechanisms becomes untenable as the exclusion of free-riders becomes more difficult for generating a sustainable revenue stream in a fast-changing socio-technical environment (Trogen, 2005; Eisenmann et al., 2006).

Based on the issues identified above, the challenge becomes that of re-framing regulatory policies, possibly in an adaptive way that can counterbalance efficient levels of investments and innovation on both sides of the two-sided market, to maximize social welfare. In this regard, the design of institutional arrangements and regulatory frameworks able to balance regulatory commitment with flexibility is a significant determinant of plausible configurations in the state-market interplay, whether ex-ante sector regulation or ex-post competition regime (Levy & Spiller, 1993; Newbery, 2004; Armstrong & Sappington, 2006). Therefore, the overarching research question for this thesis is:

> *RQ: How can regulatory policy optimize investment and innovation in Nigeria's converging telecommunications market while maximizing social welfare?*

The question will be interrogated by the author specifically via two interrelated sub-questions:

- *Which pricing structure in the two-sided telecommunications market in Nigeria can achieve the most optimal efficiencies for investment and innovation in the two interdependent markets — Internet infrastructure provision and Internet content supply — while maximizing social welfare?*

- *What institutional arrangements are necessary to sustain this configuration in the short and long term?*

The author will examine the questions conceptually and empirically, relying on the theoretical and methodological frameworks developed in Chapter Three.

## 1.5 Definition of Key Terms

This section provides fundamental definitional clarifications to the critical constructs engaged in the thesis, from sub-section 1.5.1 through 1.5.5.

### 1.5.1 Complex Adaptive Systems (CAS)

Defining complexity, and by extension, complex adaptive systems, has been a challenging science in relation to the thematic attributes of ecosystem creation, organization, and description across different disciplines. The domain has a historical analogue in Physics with respect to understanding the concept of electromagnetism, which comprises electric and magnetic forces — closely related dimensions of the fundamentally same physical quantity, but prior were considered different (Lloyd, 2001; Murphy, 2014). Proximately, a fundamental attribute of a complex adaptive system (CAS) is the characteristic of an evolving structure, dependent on an assemblage of varying simultaneous interactions in adaptation to an external environment (Holland, 1992; Dorogovtsev & Mendes, 2003; Cherry, 2006). Due to the constantly changing interaction dynamics of many parts with consequent new forms of emergent behaviour (which are often path-dependent[13]), the aggregate behaviour of the system concerning its non-linear outcomes is statically challenging to optimize. In understanding and resolving CAS problems, historical evolution and contextual institutional analysis for determining policy trade-offs are critical, as standard optimization theories are focused on optimal endpoints — which are impractical within a CAS, as there is no single controlling rule or classical equation that governs the system, unlike in linear systems (Ostrom, 2010; Colander & Kupers, 2014). The development of complex adaptive systems can be influenced if ecosystem leverage points are crystallized in creating large-scale sustainable changes (Brock & Colander, 2000; Room, 2011; Mansell, 2012).

### 1.5.2 Telecommunications Convergence

While a standout definition does not exist (Kaluza, Blecker, & Bischof, 1999; Steinmueller, 2000; Stieglitz, 2003), telecommunications convergence is a dynamic trend currently prevalent within the field of telecommunications and technology services as it relates to changes in the underpinning industry structures and adjacent policy and regulatory environment (Blackman, 1998). The fundamental change (concerning technological convergence) is with respect to the flow of different types of network information — voice, messaging, video, et cetera — over separate network media

[13] When a complex system evolves in reference to its unique precedence in providing an emergent behaviour that enables change, whether adaptive or maladaptive. According to David (2001b: 19), path dependence refers to complex processes that are "unable to shake free of their history".

(in traditional networks, requiring less bandwidth) and together (in IP (Internet-based) networks, requiring higher-order bandwidth). The latter mechanism is blurring the vertical sectoral market boundaries in the industry structures for telecommunications, broadcasting, computing, and content publishing industries, requiring some integration for their regulation, policy formulation, and implementation — even as the socio-economic forces of liberalization and globalization drive them further. Convergence for telecommunications policy implies that as traditional linear value chains (mostly infrastructure providers) evolve to non-linear value networks[14] — with its inter-dependent relationships — and new market entrants[15] begin to disintermediate the direct linkage between the mobile network operators and users[16], competition increases markedly within the complex ecosystem. This continuous evolution significantly affects innovation and investment on both sides of the dyadic market (Peppard & Rylander, 2006).

Nevertheless, according to Mueller (1999), while increasing convergence blurs the vertical separation of industry markets, it, on the contrary, increases the divergence in the horizontal segments of the markets. This mechanism necessitates enhanced market differentiation for sustained competition in response to variations in consumer demand and regulatory jurisprudence — from traditionally national to international boundaries — with consequent economic efficiency imperatives for investments and innovation. According to Perrucci and Cimatoribus (1997), technological convergence implicates regulatory convergence on the alternative schools of thought — whether for symmetric or asymmetric regulation of digital markets. These convergence mechanisms are characterized by non-linear, co-evolutionary developments that result in significant shifts in their governance structures, making convergence a complex adaptive phenomenon.

### 1.5.3 Platforms and Two-Sided Markets

Since the turn of the decade, the concept of platforms has gained considerable traction in academic research in the information technology domain (Thomas, Autio, & Gann, 2014; Sun et al., 2016; Mansell & Steinmueller, 2020). Hagiu (2014) defines the construct as value-creating technologies, products, or services that enable and leverage the direct interaction between external producers and

[14] In relation to IP-based systems

[15] Like the OTTs who are primarily content providers, initially.

[16] Leveraging their market power as the primary traffic drivers through the networks provided by the mobile operators.

consumers within a two or multi-sided market (see also Armstrong, 2006; Parker, Van Alstyne & Choudary, 2016; Jaque, Sarygulov, & Leitao, 2018). Critical characteristics of platforms include both cross-side and same-side network externalities (sometimes referred to as demand-side economies of scale), which improve the ability of platforms to create and appropriate increased value as more participants join. While the latter is referred to as direct, the former is regarded as indirect network effect (Figure 1). Together with supply-side economies of scale, these help to explain the platforms' strong and often dominant market position (see also Roson, 2005; Eisenmann et al., 2006). Another critical characteristic of platforms, according to Hagiu and Wright (2015), is the principle of affiliation, which refers to platform-specific investments by cross-side participants to sustain their mutual interaction. This property of two-sided markets is critical as costs and revenues are influenced by factors on both sides of the market, unlike in traditional business value chains. Therefore, changes in price structure, if total prices are held constant, affect the dynamics of the entire platform model when costs incurred on one side are not passable to the other (Roson, 2005; Eisenmann et al., 2006). This condition is rife when issues of regulatory asymmetry exist.

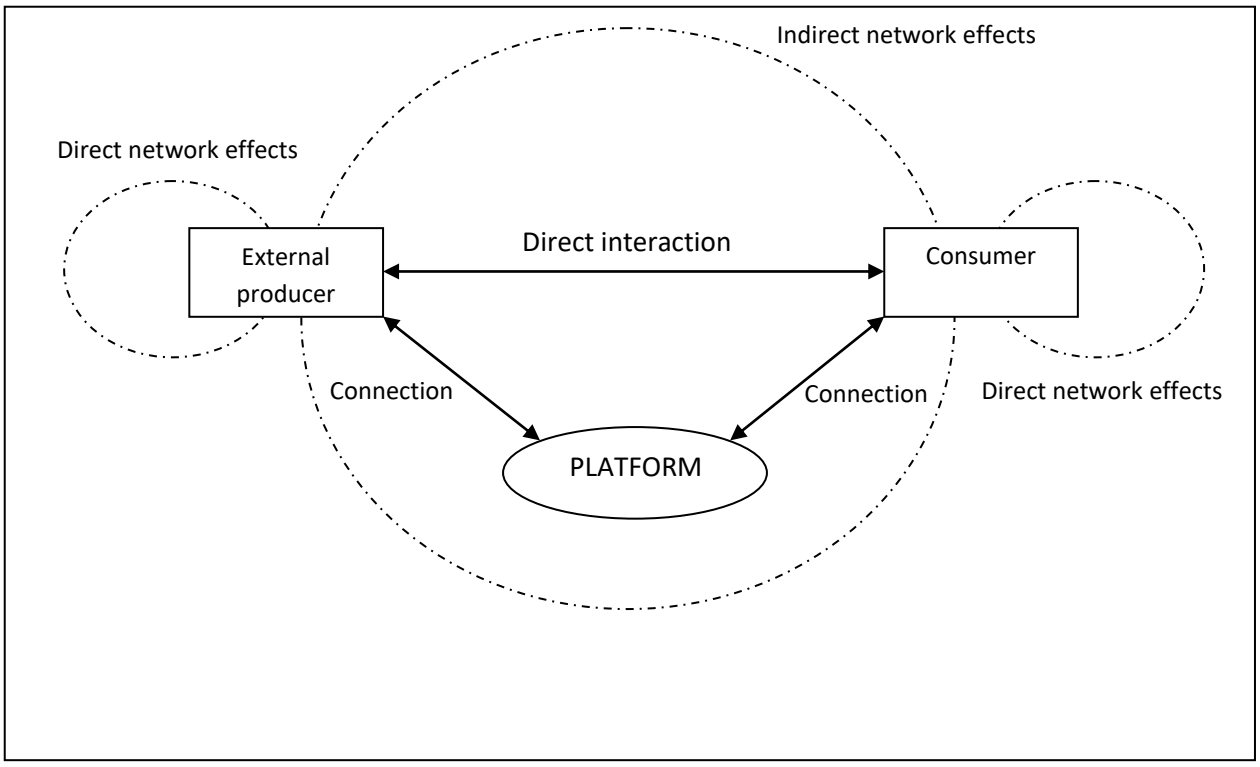


**Figure 1: Platform illustration. Source: Illustration by author**

In the 'classic' telecommunications industry, the conventional voice telephony and messaging services leverage the traditional circuit switching used for transmitting digitalized data packets independently and within defined market boundaries (Napoli, 2001; Robinson & Nachbar, 2009). However, in a converged telecommunications ecosystem, traditional telecom operators transit from providing just infrastructure and voice/messaging services to a content platform that integrates both IP services and applications, connecting the separate (but often substitutable) sides of mobile telephony and mobile internet as a two-sided market (Waverman, 2007; Calabrese et al., 2008; Calabrese et al., 2009; Gabszewicz, Resende & Sonnac, 2015; Karapantelakis & Markendahl, 2015; Hmoud, Salim & Yaakub, 2017). For OTTs, the market model can either be a one-sided or two-sided platform model (Hagiu & Wright, 2015b; Kraemer & Wohlfarth, 2015). A Type 1 OTT (such as Skype) offers digital services to users via a telecom operator or an ISP, either charging the users directly (freemium or premium) or as a bundled service via the operator or ISP, without any other market sides involved (Krämer & Wohlfarth, 2018). While a substitutive internet-based service such as WhatsApp is considered to operate a one-sided market model, its integration (via acquisition) by Facebook extends its data model to a two-sided market model (Wohlfarth, 2018). WhatsApp is therefore classified as a Type 2 OTT — which offers digital communications services to users on one side of the market without direct payments but has a contractual relationship with them to place data cookies, and so generate revenues indirectly via advertising on the other side of the platform market (Peitz & Valletti, 2015). A critical difference between Type 1 and 2 OTTs is that while both direct and indirect network effects characterize the latter, the former leverages only direct network effects. OTT Type 3 is similar to Type 2, but instead of advertisers, they connect content and app developers on the other side of the market apart from users (e.g., Apple iTunes). Hence, this thesis focuses on Type 2 OTTs as two-sided platform markets.

### 1.5.4 Competition Policy

Although the extant literature provides no single definition of competition policy, it generally entails the institutional mechanisms for ensuring the contestability of markets, the optimization of both allocative and dynamic efficiencies, and the maximization of social welfare (Hoekman & Holmes, 1999; Maskus & Lahouel, 2000; Encaoua & Hollander, 2002). In the purview of telecommunications policy, competition policy assessments have evolved over a century, elucidating its pricing imperatives for sector investments, innovation, and total social surplus in the bid to reflect market

failures (Weiman & Levin, 1994; Bilal, 2001; Voigt, 2009; Delp & Mayo, 2017). According to Markham (1950), an effective competition policy optimizes the structural characteristics of a market in congruence with the dynamic factors that shape it.

### 1.5.5 Over-the-Top (OTT) Telecommunications Services

While asserting that the definition of OTTs is an issue of national sovereignty, and as such, there is yet to be a single universally agreed definition of the construct, the International Telecommunications Union (ITU) defines an over-the-top (OTT) telecommunications service as "*an application accessed and delivered over the public Internet that may be a direct technical/functional substitute for traditional international telecommunication services"* (ITU, 2019:7). The range of services that can be provided over-the-top includes audio-visual content from Internet services such as YouTube, Amazon Video, and Netflix; and instant messaging services offered by platforms such as WhatsApp, Facebook Instant Messenger and Skype. In most cases, these Internet-based services are transmitted over the last-mile broadband infrastructure (fixed or mobile) provided by telecommunications companies with or without affiliations to these Internet-based service providers (Park, 2018).

## 1.6 Scope of Study and Unit of Analysis

The case study of Nigeria has been selected based on its profile as one of the largest markets in the telecommunications industry on the continent of Africa (UNCTAD, 2007; Bankole & Bankole, 2017). The specific unit of analysis for the research within this domain is the country's mobile broadband market, considering its rising significance and growth in Africa's technological landscape (Cameron, 2016; Dunn & Boafo, 2016; Atiyas, Levy, & Walton, 2017; Boateng et al., 2017). Significantly, Nigeria has a mobile subscription of over 150 million lines (NCC[17] Database). Regarding mobile broadband, Nigeria's Internet penetration continues to grow and is contemporarily at about 30% (RIA After Access Survey 2017[18]), while the broadband penetration is just around 20%, with an Internet subscription of over 90 million (NCC Database). Key mobile network operators in the Nigerian telecommunications industry include MTN, Glo Mobile, 9Mobile (formerly Etisalat), and Airtel[19], traditionally offering text, voice, and data services, as well as

[17]Nigerian Communications Commission: https://www.ncc.gov.ng/stakeholder/statistics-reports/subscriber-data
[18]https://researchictafrica.net/data/after-access-surveys/
[19] From ncc.gov.ng

providing Internet connectivity to their private and corporate subscriber bases. Aside from these traditional players, over-the-top (OTT) digital services such as Facebook, WhatsApp, and Skype are also very active in the country's telecommunications space, providing social networking, instant messaging, and voice and video calling. According to a 2016 report by *Sage,* Facebook alone has over 15 million active users in Nigeria. Furthermore, the contribution of these operators to the country's economy is quite significant at about 1.4 percent of GDP[20] to the tune of US$8.3 billion as of 2016 (Matinde, 2016). Therefore, the imperative of interrogating the policy frameworks in the country's fledgling digital ecosystem cannot be over-emphasized.

## 1.7 Structure of the Thesis

Having set out the introductory elements of the thesis in Chapter 1 from Sections 1.0 through 1.6, the dissertation is structured further into six chapters as described below.

Chapter 2 reviews the extant literature as it relates to competition regulation in the telecommunications industry, highlighting the two-sided market platform model that creates cross-externalities that are dependent on the participation of both sides of the market, the implications for social welfare, and the efficiency of the market outcomes with respect to pricing, innovation, and investments.

Chapter 3 develops a theoretical framework and a conceptual model for the thesis based on the critical foundations of complex systems and institutional analysis framework, as they intersect in interrogating 'wicked' policy problems within the domain of telecommunications policy. These were complemented with the theory of two-sided markets, propounded by Rochet and Tirole (2003), in providing the theoretical basis for analysis of platform price competition in two-sided telecommunication markets.

Chapter 4 provides the empirical basis for the thesis, explaining the dissertation's methods, methodology, and research design, as guided by the theoretical and conceptual underpinnings described in Chapter 3, as well as the ethical considerations that were adhered to in the execution of the research.

[20]Gross Domestic Product.

Chapter 5 elucidates the findings of the triangulated empirical assessments and provides an analysis based on the theoretical and conceptual framework developed to analyse the regulation of complex adaptive systems. It presents a case study of Nigeria's converging telecommunications market to explore how to optimize competition and consumer welfare outcomes. It does so through a thematic analysis of expert interviews, analysis of the unique institutional environment with respect to market structure, institutional arrangements, tracing of the policy process and outcomes, and cost-benefit analysis of policy actions and outcomes, concluding with a theoretical analysis.

Chapter 6 provides a comprehensive ecosystem mapping that provides insight into the dynamic approaches to the governance of complex systems concerning cause-effect relationships within a coherent framework that encapsulates the technical and socio-economic dimensions of the Nigerian telecommunications ecosystem.

Chapter 7 concludes the thesis by re-emphasizing the regulatory policy evolution within Nigeria's converging telecommunications market as it transitions from a more static regulatory regime toward a dynamic regulatory framework with the emergence of more complex and multi-sided elements within the industry. It crystallizes the implication of both the conceptual and empirical findings and their contributions to the extant body of knowledge within the domain of study for both theory and practice. It further highlights the general limitations of the dissertation and proposes recommendations for further research.

## Chapter Two: Literature Review

### 2.0 Introduction

In this chapter, I review the extant literature as it relates to competition regulation in the telecommunications industry, highlighting the two-sided market platform model that creates cross-externalities that are dependent on the participation of both sides of the market, the implications for social welfare, and the efficiency of market outcomes with respect to pricing, innovation, and investments. In executing the literature review, I summarize and synthesize the current relevant body of knowledge from prior research conducted within the domain of study pertinent to the reflective interpretation of the research questions established in Chapter One. To ensure objectivity, I review selected previous research that makes valuable contributions to the domain of study and refer to those as appropriate throughout the following sections of this thesis. In extending the prior base of relevant literature, I summarize their contributions, highlighting the strengths and weaknesses of the reviewed prior research in relation to the focus of the current work. The reviewed contributions were selected from relevant peer-reviewed journals and retrieved using relevant keyword searches (as typified by the key terminologies defined in Section 1.5) from scholarly databases, including Google Scholar, Emerald Insight, EBSCO web, and JSTOR online. I selected the literature review articles by prioritizing the general number of their citations and those with the most relevant innovative contributions to the knowledge base in relation to the thesis context.

Some of the journal sources included The Quarterly Journal of Economics, Telecommunications Policy; The Rand Journal of Economics; Journal of Contemporary African Studies, Information Economics and Policy; Journal of Information Technology, Communications & Strategies; Journal of Competition Law and Economics; Annual Review of Political Science; History of Political Economy, The Journal of Industrial Economics; Journal of Common Market Studies; Journal of Regulatory Economics; Information Systems Research; Journal of Network Industries; The Journal of Community Informatics; The Information Society; Oxford Review of Economic Policy; African Journal of Economic and Management Studies; Policy Studies Journal; and from globally renowned publishing houses including the University of Michigan Press; Duke Law Journal; Edward Elgar; Rowman and Littlefield; International Books; Oxford University Press; Palgrave Macmillan; Princeton University Press; and Taylor & Francis.

## 2.1 Competition Policy and Economic Regulation in the Converging Digital Ecosystem

Distinctively, economic regulation is justified in the broader public interest. In contrast, competition policy (known within the US context as "antitrust") is primarily concerned with the abuse of dominance in a market and the anticompetitive outcomes associated with that. During the past several decades, the rationale for sector and competition policy has emphasized consumer welfare as a regulatory objective and outcome. More recently, there have been moves toward a broader definition of the mission of competition policy, as illustrated in the EU with the Digital Markets Act and the ongoing discussion about new antitrust legislation in the U.S.

While in the traditional "classical" telecommunications markets, competition was often determined by levels of network access within institutionalized market arrangements (Sidak & Spulber, 1997; Suzumura & Yasaki, 1999), in the converging multi-sided platform markets, network effects and switching costs significantly determine competition (Evans & Schmalensee, 2005; Weyl, 2010). This proposition is especially true when multihoming is constrained, leading to market concentration with negative implications for social welfare (Caillaud & Jullien, 2003; Jullien, 2005; Frieden, 2018; Haucap, 2019). In this regard, a key question for competition policy in a converging industry is under what conditions and institutional arrangements should incumbent network access ("essential facilities") be granted to market entrants in a manner that does not negate the incumbent's competitive advantage as related to the entrant's market power (Ballon & Van Heesvelde, 2011; Oprescu & Eleodor, 2014)? Another critical question for competition policy in the converging digital ecosystem is the (re-)definition of the relevant market, for example, establishing as to whether WhatsApp creates a new market, whether it competes or not with traditional telecommunications services, or whether it is a complementary (social networking) rather than a competitive market (to telecom) (see Russo & Stasi, 2016; Broos & Marcos, 2017).

These questions are very much related to the characteristics of the different services and their unique pricing structures (Russo & Stasi, 2016). Regulatory authorities often address these issues by economic regulation via ex-ante intervention for sector-specific regulation or competition law within an ex-post competition regime. For market definition purposes, while demand-and supply-side substitutability are critical for market definition, the challenge of market convergence in relation to

network effects and switching costs creates significant distortions for competition policy assessment and the need to adapt further traditional assessment tools such as the SSNIP[21] test (Jacobides & Lianos, 2021; Petit & Teece, 2021). Concerning network access, the optimal thresholds for mandatory access have supply-side implications for investment and innovation incentives, especially if the market entrant does not share network infrastructure investment risks in the fast-changing digital ecosystem (Ballon, 2009; Gupta & Tyagi, 2015).

In the African context, sectoral regulation of the telecommunications industry emerged in the 1990s. It focused on realizing consumer welfare outcomes in relation to competition effectiveness assessments (with regard to costing, pricing, interconnection, etc.). However, as most citizens were not online then, this was trumped by public interest considerations of universal access. This regulatory posture allowed for some rather uncompetitive policies — extending monopoly exclusivity periods with no price regulation for periods of time, with mostly very poor overall policy outcomes. Within this emerging market context, and with undeveloped tools and weak practical policy expertise for regulatory intervention to the issues highlighted prior in relation to platform markets, the author argues that a conceptual analysis within a country-level context with regard to the competition policy and regulatory challenges that may emerge is imperative, significantly as it impacts investments, innovation and ultimately social welfare.

Along these policy outcome dimensions, schools of thoughts around competition policy had earlier emerged around the 1990s. Of note is the renewed attention paid to the more historical "Schumpeterian School"[22], but from a more practical approach emphasizing innovation over price competition in realizing economic investments and social welfare (Shelanski, 2012; Jacobides & Lianos, 2021). This competition policy paradigm evolved from the earlier theoretical-based 'Chicago School' of the 1970s that had its focus on consumer welfare (Dorsey et al., 2019; Hovenkamp, 2019), significantly dismissing the political economy of concentrated market power (Holt, 2011; Popiel, 2020; Jenny, 2021; Kuenzler, 2022), with congruent implications for platform markets (Wu, 2018). In recent years, this competition policy paradigm has gradually transitioned into what scholars now refer to as the dynamic competition paradigm. Nevertheless, this emerging paradigm is not yet

[21] Small but significant and non-transitory increase in price

[22] Named after political economist, Josef Schumpeter

fully embraced, as the scholarship still struggles to integrate insights from the study of dynamic competition. The major shift in the theoretical balance, however, is the refocusing on both "competition and innovation as co-determinants of changes in market structure and firm positions" in the realization of social welfare in the long term (Petit & Teece, 2021: 1169).

### 2.2 Infrastructure-and Services-based Competition in the Telecommunications Industry

The traditional modes of competition within the telecommunications industry regarding access can be mandatory or non-mandatory network access (Bouckaert, Van Dijk & Verboven, 2010). In a non-mandatory network access regime, competition is typically inter-platform. In this regime, competition exists between an incumbent (traditionally a fixed line operator), digital service line (DSL) operator, and other infrastructure-based operators, for example, wireless and fibre-to-home on a commercial contractual basis. On the other hand, for mandatory network access, competition can exist either inter- or intra-platform between different DSL operators on an incumbent's infrastructure via a regulated access network, such as an unbundled local loop (ULL) or incumbent DSL services reselling. Therefore, an intra-platform regime can either take the form of facilities-based or services-based competition.

For facilities-based competition, market entrants lease the unbundled local loop infrastructure of the incumbent, with further investments in their own complementary transmission equipment and network traffic backhaul facilities (Gruber, 2010). However, for services-based competition, market entrants only resell the incumbent's network services without the need for further infrastructure investments. While some scholars considered the facilities-based competition to be more favourable in the long run with respect to dynamic efficiencies of investment and innovation with a more negligible social cost of regulation, the services-based competition was deemed better at realizing static efficiencies in the same regard (De Bijl & Peitz, 2005; Gayle & Weisman, 2007; Briglauer, Ecker & Gugler, 2013).

In the context of developing countries, the International Telecommunications Union (ITU) proposed a focus on infrastructure-based competition. According to the ITU, this proposition will provide greater scope for next-generation access network build-out (ITU, 2013). The argument

contrasts a services-based regime where lower prices and higher adoption rates might be realized in the short term but with negative long-run implications for investment and innovation (Houpis et al., 2016; Falch & Laskio, 2022). However, in the context of developing markets, the experience within the South African telecommunications industry indicated that with an infrastructure-based competition regime (which also incorporated a monopolized fixed market and a duopolistic mobile market), the expected long-run investments were not realized even as prices remained relatively high, requiring further policy prognosis, especially in the African context (Hawthorne, Mondliwa, Paremoer & Robb, 2016).

Historically, within the African telecommunications context, a fixed-line monopoly existed where there was often no competition. Hence, most market reforms introduced were often via inter-platform competition regimes (sometimes between incumbent and new fixed-line operators, but often between incumbent and new mobile operators). Usually, within this regime, there was a mandatory aspect in that operators were required to interconnect (and often share leased facilities, particularly with respect to roaming requirements). Mandatory wholesale access such as ULL and reselling are considered deeper sharing requirements (typically on an intra-platform basis) where full access and operation within a single physical network (though they may be virtually separate) requires far more intensive competitive mechanisms to deal with profoundly entrenched market dominance. ULL is hence considered an intensive form of facilities-based competition (within a mandatory access regulation); however, competitors can lease facilities (as mobile operators did before they were permitted to do their network backhaul in many African jurisdictions without ULL or reselling relations).

### 2.3 Infrastructure- and Services-based Competition in the Era of Convergence

Within the telecommunications industry, access regulation has evolved from primarily monopolistic industry infrastructure regimes to more contemporary competitive market arrangements (Bauer & Bohlin, 2008). This shift is especially with regard to bottleneck network infrastructure unbundling as it influences the competitive intensity of market segments, with often direct impacts on investment and innovation for both incumbents and market entrants and consequent indirect effects on telecommunications services demand (Noam, 2001; OECD, 2003; Bauer, 2010a; Garrone &

Zaccagnino, 2012). From the traditional ladder-of-investment (LOI) approach as advanced by Cave (2006), market competitors — both incumbents and entrants — are under some form of necessity to progressively commit to new generation network infrastructure investments from the foundational basis of essential bottleneck facilities (Bauer, 2010a). The LOI approach seeks to create enabling regulatory conditions leading market players to move from service-based to facilities-based competition. However, market players often do not consider this transitional pathway a necessity, and thus, the approach has often failed. Nevertheless, for this infrastructure-based competitive mechanism to effectively be incentivized, the regulatory system must show the requisite institutional adaptability capacity for access regulation over time in relation to access charges (Bauer & Bohlin, 2008; Bourreau, Doğan & Manant, 2010). This proposition, according to its proponents, would ensure the complementarity of a simultaneous service-based and facility-based market entry rather than a substitutional one in the longer-term consumer welfare consideration in relation to network access, balancing both static and dynamic efficiency considerations (Cave & Vogelsang, 2003; Oldale & Padilla, 2004; Distaso, Lupi & Manenti, 2010).

In the converging digital ecosystem, this access regulation mechanism presents a qualitatively different policy problem in contrast to the infrastructure regime transition from monopolistic to competitive market structures, as previously highlighted (see Bauer & Bohlin, 2008). This policy situation is with respect to the dynamic regulation challenges of facilitating high capital investment in deploying new generation network infrastructure optimally and sustaining large-scale innovation in applications and services. The requirements in the emerging dispensation differ because, unlike the previous industry transition, the core network infrastructure for all-IP next-generation access networks is largely absent. This condition is complicated by the substitutionary effects of new entrant platforms on market incumbents, for which traditional access regulation mechanisms such as unbundling begin to effuse contradictory implications on the investment incentives of the multiple ecosystem players (Renda, 2007; Bauer & Bohlin, 2008; Koboldt, 2013; Savin, 2018a).

Next-generation network infrastructure investment requirements become even more substantial for a primarily mobile-based broadband ecosystem such as the Nigerian telecommunications market, with a near-zero fixed broadband penetration. This situation may require scoping the same level of necessity for both incumbent operators and market entrant platforms in realizing ubiquitous

broadband penetration (Koboldt, 2013). In this regard, access regulation policies that incentivize infrastructure co-investments by mobile network operators (MNOs) and OTTs become imperative, especially for downstream market segments, but would have to be assessed on a contextual market basis (Koboldt, 2013).

### 2.4 Platform Competition in the Telecommunications Industry

Beyond the classical industry arrangements that govern market transactions between traditional telecommunications providers, the emerging digital ecosystem is built on a telecommunications broadband network connecting users and virtual content providers in a two- or multi-sided market platform business model. In these ecosystems, cross-externalities depend on the participation of both sides of the market (Weyl, 2010). Regulating the competitive tensions that arise in these markets raises new challenges for regulators because, in these unique dynamic ecosystems, imbalances could have significant implications for social welfare and the efficiency of market outcomes (Economides, 2006; Tardiff, 2007). In this emerging digital ecosystem, pricing is critical to platform competition (Rysman, 2009). This construct has, therefore, been the subject of rigorous research since the turn of the decade (Evans, 2003; Rochet & Tirole, 2003, 2006; Armstrong, 2006; Economides & Katsamakas, 2006; Eisenmann, Parker, & Van Alstyne, 2006; Weyl, 2010; Sriram et al., 2015; White & Weyl, 2016).

While pricing has traditionally been a critical aspect of competition regulation, it raises new challenges in two-sided markets, where the prices that operators can command on one side of the market depend on the ability to deliver positive externalities on another. Within the paradigm of a discriminant pricing strategy, arguments for telecommunications networks to subsidize price-sensitive users while charging over-the-top content providers a premium for accessing the users who connect on their platform are presumed economically viable. This proposition is to leverage surplus for more investments and innovation, lowering prices in the long term and further enhancing social welfare. In this regard, the pricing structure is dependent on the relative magnitude of positive cross-group externalities (Armstrong, 2006; Sriram et al., 2015) while also having the potency to reduce the innovative capabilities of new entrants on the content provider side of the market (Economides & Salop, 1992). In the African context, research in this domain has been focused mainly on the South African telecommunications market, interrogating the price-innovation dynamics of platform

competition to establish a negative correlation effect (Lee & Lee, 2014) and its consequences for social value (Ayogu & Hodge, 2002; Gillwald, 2017).

Concerning this, the dominant themes in the academic literature pertaining to competition policy in the telecommunications industry align within the context of studies that focus on the relationship to telecommunication investments and, subsequently, sector innovation dynamics. In this perspective, the thematic paradigms transition from the phase where scholars appraised competition as not having a considerable impact on incumbents' investment (Bortolotti, D'Souza, Fantini, & Megginson, 2002; Jung, Gayle, & Lehman, 2008) to a more contemporary establishment of significant relationships between competition, investment, and innovation at socially optimal pricing and openness conditions. The author summarizes key findings from this new discourse strand in Table 1.

**Table 1: Synopsis of research on the effects of pro-competitive regulation in the telecommunications industry**

| Domain interest | Literature | Method | Context Scope | Key findings |
|---|---|---|---|---|
| ***Pro-competition regulation and telecommunication investments*** | Hart, Shleifer, and Vishny, (1997) | Conceptual (economic) | N/A | *Market competitiveness has a positive relationship with firm-level private investments.* |
| | Jorde, Sidak, and Teece (2000); Valletti (2003) | Conceptual (economic) | Europe | *Cost-based access pricing is inimical to socially optimal investment by incumbents.* |
| | Cave and Vogelsang (2003); Cave (2006) | Theoretical and econometric analysis; conceptual | Netherlands | *The relationship between open access, incumbent investment, and service quality depends on new entry barriers to entry and expansion.* |
| | Bortolotti, D'Souza, Fantini, and Megginson (2002); Jung, | Mixed (comparative analysis and panel data estimations) | 31 countries (14 mature and 11 Developing; I African - | *Competition has a weak or null effect on incumbent investment, especially when investment persistence is* |

| | | | | |
|---|---|---|---|---|
| | Gayle, and Lehman (2008) | | South Africa); United States | *modelled appropriately* |
| | Grajek and Röller (2012) | Econometric analysis | 70 fixed-line operators in 20 European countries | *In both incumbent and new entrants, pro-entry regulations have a negative or null effect on investments; conversely, an increase in incumbents' investment engenders regulated access requirements. The authors find evidence for a regulatory commitment problem: "Higher investments by incumbents encourage regulated access provision."* |
| | Lestage et al. (2013) | Econometric analysis | OECD Countries | *Greater intensity of competition enhances infrastructure investments by state-owned incumbents while reducing investment by privately owned incumbents (in deference to Hart et al. (1997)* |
| | Garrone and Zaccagnino (2015) | Empirical; employs various methods; micro-econometric model | OECD Countries | *Mixed findings: the relationship between sector unbundling and investments is only temporary, as evidenced in some countries; this could be positive or negative.* |
| | | | | |
| ***Pro-competition regulation & Telecommunication innovation*** | Wallsten (2001) | Econometric analysis | Africa and Latin America (30 countries) | *Competition is positively correlated with innovation and the reduction of prices.* |

| | | | | |
|---|---|---|---|---|
| | Fink, Mattoo, and Rathindran (2003) | Econometric analysis | Africa, Asia, the Middle East, Latin America, and the Caribbean (86 countries) | *Competition leads to significant improvements in innovation performance.* |
| | Li and Xu (2004) | Panel estimation | Global dataset (177 countries) | *An increase in competition intensity has a significant correlation to innovation growth.* |
| | Chang, Koski, and Majumdar (2003) | Econometric analysis | United States and Europe | *Lower access pricing promotes incumbents' innovation performance* |
| | Aghion et al. (2005); Weisman (2005) | Panel estimation; Conceptual | United Kingdom | *An inverted U-shaped function describes the nature of the relationship between innovation and competition.* |
| | Bauer and Shim (2012) | Theoretical and econometric analysis | OECD Countries | *Stringent regulation (access and pricing) had a statistically significant negative effect on innovation.* |
| | Gruber, H., and Koutroumpis, P. (2013) | Econometric analysis | Global dataset (167 Countries) | *Innovation and adoption are accelerated when there is a higher level of intra-platform competition within an incumbent's platform.* |
| | | | | |
| ***Pro-competition regulation, Telecommunication investments & innovation*** | Bourreau, Kourandi, and Valletti (2015) | Conceptual (economic) | N/A | *Investments and innovation are higher under a discriminant pricing regime than under a net neutral price control.* |

## 2.5 Review of Platform Competition Models in the Telecommunication Industry

Within the context of economic theory, scholars have adopted several models to analyse the welfare effects of pricing regulation in relation to innovation and investment in the telecommunication market. Most relevant to this research is the two-sided market model. According to Armstrong (2006), the socially optimal pricing structure for any side of a platform should equal the cost of service to a user on that side of the market, adjusted downward by the positive externality that an extra user on that side brings to the cross-side on the platform. Thus, in the case of intra-platform competition, Armstrong (2006) hypothesizes either an entry charge for consumers or a restricted platform competition for retailers under exogenous conditions to generate the optimal user utility. In a monopoly regime, Economides and Tåg (2012) argue that since the platform may not entirely appropriate consumer value due to non-corresponding willingness to pay, the positive price mark-up is shifted to the content providers, especially where consumers are more valuable to the platform than the content providers. According to them, this proposition has obverse implications for the platform and social welfare. While it is in the platform's interest to charge the content provider, it is, on the contrary, more welfarist to subsidize them in order not to reduce content provision (which portends a source of critical innovation). However, in a duopoly, this incentive to charge the content provider is higher when another traditional competitor platform does not charge than when it charges a positive fee to content providers. In instances where there is a simultaneous incentive to charge the content providers by the duopolies, collusion on the part of the platforms is usually suspected. Economides and Hermalin (2012) posit that a neutral network portends greater social welfare than a non-neutral regime.

Regarding investment-innovation dynamics, Njoroge, Ozdaglar, Stier-Moses, and Weintraub (2013) developed a model within the context of neutral and non-neutral network regimes. They propose that platform investment incentives (considered a longer-term market variable than price) are higher in a non-neutral regulatory control. According to them, this proposition is due to higher efficiency in extracting positive externalities via commensurate content provider pricing. The condition leads to complementary increases in innovation on both sides of the market and the highest consumer surplus. Nevertheless, their model did not consider investment imperatives on the content provider side of the market. Their model propositions corroborate those of Becker, Carlton, and Sider (2010) and Choi, Jeon, and Kim (2014).

In contrast to the Njoroge et al. (2013) model proposition, Economides and Tåg (2007) suggest that there could be a lower total surplus in a non-neutral condition, even though consumer surplus and platform profits are higher when the relative size of the cross-side externalities are considered. This latter argument is in line with the positions of Canón (2009), Cheng, Bandyopadhyay, and Guo (2011), and García, Castro, and Fuentes (2017) that total welfare is indeed higher in a net neutral regime. According to them, this proposition is because there will be more users and, therefore, higher investments, especially when content provider surplus closely matches or becomes even higher than consumer surplus, leading to fewer user exclusions. This conclusion, according to its proponents, is based on the proposition that higher investment levels on the network platform will increase innovation efficiency on the content producer side, increase user satisfaction and positive network externalities, and, in the long term, maximize the platform surplus (see also Van Schewick, 2006). Again, this contradicts the position of Caillaud and Jullien (2003), which opine a higher consumer surplus under an exclusive regime, albeit with lower efficiency.

An older approach to competition analyses in the telecommunication industry uses the congestion management model to analyse social welfare in the context of resource scarcity for Internet infrastructure (Garcia, 2016). In this condition of resource scarcity, user traffic is considered in relation to unique bandwidth usage density and, therefore, should be correlated to usage charges on the communication network to balance out the social costs of congestion externalities (Lehr & Weiss, 1996; He, Xu, & Liu, 2012). This adjusted revenue from the congestion management model can then be applied to offset network capacity costs that will engender lower access charges in the long run, maximizing social welfare in the two-sided market (MacKie-Mason & Varian, 1995a, b; Krämer & Wiewiorra, 2009). This argument corroborates the position of Gupta, Jukic, Stahl, and Whinston (2011) that a congestion-based pricing structure will generate the greatest net social surplus compared to flat-rate pricing at all capacity levels. A non-exclusionary pricing structure, in this case, can only be optimally constrained, according to Jullien and Sand-Zantman (2012, p.9), "*if the proportion of the high cost to low-cost content is neither too high nor too low*." Price optimization can also be possible in the above condition in the instance of high-capacity levels concerning investment incentives, in alignment with the position of Choi and Kim (2010).

Overall, the author summarizes the strengths and weaknesses of the models highlighted above in Table 2. The author further incorporated the insights from the assessments in conceptualizing the research questions for the study.

**Table 2: Strengths and weaknesses of the models highlighted**

| Model | Literature | Strengths | Weaknesses |
|---|---|---|---|
| ***Two-sided market model*** | Choi, Jeon, and Kim (2014) | Robust theoretical argument on net neutrality regulatory effects on infrastructure provider's network capacity investments incentives, elucidating trade-offs for social welfare | *Non-empirical and lacks institutional considerations.* |
| | Njoroge et al. (2013) | Qualitative economic analysis shows competition-social welfare trade-offs concerning quality investment levels by service providers in neutral and non-neutral regimes. | *Results are suggestive and stylized and, therefore, require further empirical testing.* |
| | Economides and Hermalin (2012) | Analysed social welfare imperatives of tiered pricing in the multi-sided market within the restricted schema of the overall content flow (innovation) | *A simplified assumption model that does not consider price discrimination on the consumer side of the market* |
| | Economides and Tåg (2012) | Analyses both price and non-price discrimination strategies in a non-neutral multi-sided regime | *Does not incorporate the innovation dynamics on non-linear platform pricing* |
| | Cheng, Bandyopadhyay, and Guo (2011) | Develops a theoretical framework for the social welfare-competition imperatives concerning the network neutrality debate, highlighting the relative magnitude of revenue generation capacity as the most significant determinant of market equilibrium | *It does not consider network capacity allocation and investment imperatives.* |
| | Becker, Carlton, and Sider (2010) | Examined the dynamic and complex imperatives of the regulatory and competition factors in the context of net neutrality | *Limited to the context of the United States telecommunications market* |
| | Canón (2009) | Analyses competition-social welfare imperatives in the context of vertically differentiated content providers and | *Non-empirical* |

| | | | |
|---|---|---|---|
| | | end-users | |
| | Van Schewick (2006) | Integrates principles of industrial organization and evolutionary economics in interrogating the economic merits of net neutrality | *Non-empirical* |
| ***Congestion management model*** | He, Xu, and Liu (2012) | Elucidates network resource pricing models in the context of incentivizing the technological process | *It does not consider the more complex multi-sided network market.* |
| | Jullien and Sand-Zantman (2012) | Analyses efficient pricing concerning network capacities and its social welfare implications | *It does not consider market power imperatives on the content producers' side of the market.* |
| | Gupta, Jukic, Stahl, and Whinston (2011) | Derived analytical relationship between network resources investment and Internet access pricing in the context of social welfare | *A simplified model that does not address the complex and multi-sided telecommunications landscape* |
| | Krämer and Wiewiorra (2009) | Integrates elements of the congestion model and the two-sided market principles for net neutrality analysis in both the short and long-run | *It does not provide appropriate regulatory options for broadband infrastructure investments.* |
| | Lehr and Weiss (1996) | Examines usage-based pricing in multiple network markets | *The simplified model assumes static contextual conditions.* |

### 2.6 Two-Sided Markets and Complex Adaptive Systems in the Emerging Mobile Telecommunications Ecosystem

Researchers since the late 1990s have recognized that the value system of digital service provision is changing and that this has implications for the analysis and design of telecommunications policy. A first wave within mainstream economics has proceeded along the notions of two- and multi-sided markets (e.g., Armstrong, 2006; Rochet & Tirole, 2006). A second complementary development was the exploration of concepts from the theory of complex adaptive systems and their application to telecommunications policy (Whitt & Schultze, 2009; Schultze & Whitt, 2016; Stocker et al., 2017; Bauer & Latzer, forthcoming). Epistemologically, the multi-sided market approach is a unique case (i.e., it reflects a subset of relations among players) of the more general complex adaptive systems framework. Most recently, there has been some overlap between the two in the emerging discussion

of how emerging digital ecosystems can be governed (e.g., Parker, Van Alstyne & Choudary, 2016; Krämer, Schnurr & Wohlfarth, 2019; Petit & Teece, 2021).

Within the above context, the mobile broadband telecommunications market is evolving in a highly dynamic pattern, with emerging technological convergence leading to a flurry of new participants (content service providers) in the mobile ecosystem and a consequent re-alignment of business models by the traditional players (network infrastructure operators) in the provision of voice and data services (Li & Whalley, 2002; Peppard & Rylander, 2006; Basole, 2009; Basole & Karla, 2011). As the former linear value chains evolve to non-linear value networks of interdependent relationships and new content providers disintermediate the direct linkage between the mobile network operators and users, competition effects in the increasingly complex ecosystem have increased markedly with a significant impact on both innovation and investment of both sides of the dyadic market elements. In this ecosystem, the content service providers have become the primary traffic drivers through the networks of the infrastructure providers.

Regarding pricing, the supply-side characteristics of two-sided digital markets with respect to their network effects and economies of scale relate to their cost structures — a high fixed cost relative to marginal cost (assuming there is capacity) (see Veljanovski, 2007). While this is not precisely the same dynamics for pricing in traditional telecommunications markets (with high fixed and variable costs), for example, in the pricing of mobile data by MNOs, it has complexity implications for consideration in relative areas such as in QoS arrangements between OTT content providers and network operators, and for voice call termination requirements in relation to social welfare (Armstrong, 2001; Crandall & Sidak, 2004).

A widely used pricing structure in the two-sided mobile broadband market is the zero-rating of Internet content services, which is more prevalent in developing economies. The pricing design enables connected users to access online content without being charged for data usage, with zero effects on data usage limits where applicable (Eisenach, 2015). The model leverages the demand-side network effects generated by more users signing onto the platform to create higher economies of scale and scope — a key characteristic of two-sided markets. This characteristic has a unique application in developing countries, especially regarding Internet access and service adoption in underserved and unserved areas. Nevertheless, the question remains of how a mobile network

operator can "*adopt a socially optimal pricing structure by internalizing cross-group externalities"* considering the imperatives of innovation and investment in the networked ecosystem (Preta & Peng, 2016, p.26).

In the Nigerian context, a practical example is the Free Basics launched by Airtel in partnership with Facebook, which provides access to local and international online content as well as several websites (up to 100 websites including Wikipedia, BBC News, et cetera) at zero cost to the user. The network offers the Wireless Application Service Provider (WASP), which provides content and services on a reverse billing pricing structure comprising partially zero-rated products at competitive data usage prices for subscribing content providers. Another partially zero-rated, more recent product in the Nigerian mobile market is the Express Wi-Fi connectivity, also provided by Facebook. It evolved from Free Basics following the controversy around it, notably after the regulatory authorities in India banned it. The service uses public Wi-Fi hotspots to provide low-cost Internet access (much cheaper than the average mobile data plans) to subscribers on phones with just an SMS capability, currently in partnership with two Internet service providers in the country — Tizeti Network and Coollink.ng. The service also provides complimentary access to Facebook Flex and Free Basics. Currently, this service is available in select underserved remote regions and outdoor hubs in Lagos, with plans for ubiquitous expansion throughout the country. Google Station (launched in Nigeria in July 2018) also provides free Internet connectivity via public Wi-Fi hotspots under a revenue-sharing arrangement with a local fibre-optic telecommunications service provider — 21st Century. 9mobile (formerly Etisalat) has data bundle offerings incorporating free access to select social media platforms, including Facebook, Instagram, Twitter, and Snapchat. They also have Smarpaks — designed explicitly for unlimited access to WhatsApp and WeChat. MTN offers similar bundles that provide access to the following social media platforms: WhatsApp, Facebook, Eskimi, WeChat, 2GO, YouTube, and Instagram.

### 2.7 Platform Pro-Competition Regulation in Two-Sided Mobile Telecommunication

In the telecommunications industry, effective regulation of platform competition for traditional mobile operators and over-the-top (OTT) Internet players would optimize private investment and innovation within the sector while maximizing social welfare. The state of debate in this domain with respect to competition policy since the mid-1980s has elucidated dominant streams of thought in the different perspectives of developing and advanced countries or economies (Garrone &

Zaccagnino, 2015). In the domain of competition policy for advanced economies, proponents (Hughes, 1992; Amsden & Singh, 1994; Scherer, 1994; Waverman, Comanor, & Goto, 1997; Hoekman & Holmes, 1999; Böheim & Friesenbichler, 2016; Cummins, Rubio-Misas, & Vencappa, 2017) have highlighted three different approaches: the structural approach, which prioritizes the competitive process over the competitors; the trade-off approach, which counterbalances competition with social welfare; and the pragmatic approach which incorporates strategic national interests (Okimoto, 1989; Singh & Dhumale, 2001). While the first two approaches lower prices and maximize allocative efficiency, the third approach emphasizes increasing dynamic efficiency to maximize investment rates and technological innovation (Amsden & Singh, 1994; Quigley, 2004). For competition policy in developing countries, even though the theoretical definition of perfect competition assumes zero social externalities and asymmetries in information and resource distribution, proponents in this domain[23] argue that competition policy for developing economies should be embedded with some form of restraint. According to scholars, this cautionary provision is based on the realization that the assumptions for perfect competition within the scope of welfarist economics are largely unmet in these resource-constrained contexts (Singh, 2016). According to its proponents, this process is more like the pragmatic approach of competition policy in the advanced economies highlighted earlier. While incorporating the pricing factor of the structural approach, it has to be implemented to maximize the social welfare that developing countries critically require. This crucial argument that is somewhat missing in the discourse on competition policy is the crux of this thesis. The thesis seeks to interrogate the systemic factors necessary to realize this optimal equilibrium with respect to the telecommunication industry while promoting overall economic progress within a developing country context. This understanding is imperative to maximize the complementarities of the two-sided telecommunications market. The interests of ecosystem participants, including network infrastructure providers, content services, and users, need to be aligned within balanced institutional arrangements (Heeks, 2008; ITU, 2017: 116). Therefore, understanding their complex interrelationship dynamics in unique historical and socio-technical contexts can limit unintended negative policy consequences.

[23] See Rodrik (1988), Graham and Richardson (1997), WTO (1997), Laffont (1998), Hoekman and Holmes (1999), Jorde, Sidak, and Teece (2000), Maskus and Lahouel (2000), Singh and Dhumale (2001), and Singh (2013).

## 2.8 Regulatory Challenge: Optimal Pricing and Investment Recovery in the Converging Telecommunications Industry

In assessing pricing and investment recovery in the telecommunications industry, from an industrial organization perspective, firms allocate capital investments in new-generation access network infrastructure to drive revenues. This revenue drive is generated by operators from increased adoption due to enhanced consumer welfare effects of broader coverage and improved quality of service over costs that enhance their profitability (Powell & Dent-Micallef, 1997; Gaffard & Krafft, 2001; Sabat, 2005; Banker et al., 2013). However, rapid technological changes that intensify market competition from industry-specific actors may have significant adverse pricing effects. This market condition may have the potential to erode the capacity of firms to recover their investments, regardless of innovation efficiencies (both infrastructural, especially on the side of the incumbent mobile operators, and digital services innovation, especially on the side of new entrant OTTs) provided in the long run within the two-sided market (Gimeno & Woo, 1996; Barnett & McKendrick, 2004; Waverman, 2007; Derfus et al., 2008; Calabrese et al., 2009; Kraemer & Wohlfarth, 2015).

In particular, for the mobile telephony industry, a comparative overview of mobile and wireless telecommunication networks, from the first generation (1G) to the fourth generation (4G), is relevant to the discourse concerning the Nigerian telecommunications industry. The author summarizes this assessment in Table 3.

**Table 3: Comparative between 1G, 2G, 3G, and 4G telecommunication networks**

| Comparative Factors | 1G | 2G | 3G | 4G |
|---|---|---|---|---|
| | | | | |
| ***Network speed (peak data rate)*** | Very slow (2.4 kbit/s) | Slow (40 kbit/s) | Fast (200 kbit/s - 2 Mbit/s) | Fastest (100 – 200 Mbit/s) |
| ***Functional attribute*** | Voice transmission | Voice + Messaging | Voice + messaging + data transmission | Voice + messaging + data transmission |
| ***Transmission technology*** | Analogue circuit switching | Digital circuit switching | Digital circuit + packet switching | Packet Switching/ All IP-based |
| ***Network infrastructure cost*** | Lowest | Low | Higher | Highest |
| ***Tariff cost*** | Lowest | Low | Higher | Highest |
| ***Licensing cost*** | Lowest | Low | Highest | Lower than 3G |
| ***Maintenance cost*** | Lowest | Low | Higher | Highest |

In reference to Table 3, traditionally, circuit-switched voice telecommunication services are often delivered via a differentiated pricing structure (either by traffic volume-, value-, or location-dependent) that guarantees revenues above total production costs (Gruber, 2005). However, with the transition towards a converged digital ecosystem that enables simultaneous voice and data services via a net-neutral Internet, a key policy challenge arises concerning data services pricing structure that will stimulate user adoption without jeopardizing operator revenues (Cushnie, Hutchison & Oliver, 2000; Hui & Yeung, 2003; Wu, 2003; Johansson, 2007; Ortiz, 2007; Adeyinka, 2008; Ojugo et al., 2013). In this regard, the traditional cost-based pricing structure that is typically on a subscription plus call charge basis with no flat rates has become at odds with the pricing and recovery for packet-switched services (often priced via a flat fee access-based mechanism) (see

Crowcroft, Hardman & Lewis, 1996; Borgermann & Lackes, 2009). The pricing challenge becomes more complex in the dynamic converging telecommunications ecosystem when considered within the purview of bundled and zero-rated telecommunications services — which are emerging as critical competition strategies by operators within the African market (see Calandro, 2016). This challenge is, in particular, concerning disaggregating cost effects for voice, SMS, and data separately. The preceding optimal outcome will, therefore, be based on price recovery mechanisms that can optimally overcome the free-rider problem of public goods — the so-called "tragedy of the commons" in guaranteeing the long-term stability of the increasingly complex ecosystem (Gaffard & Krafft, 2001; Johnson-Freese & Weeden, 2012; Krancke, Vidal & Fier, 2012; Johnson et al., 2021). In the Nigerian telecommunications context, regulatory developments concerning the issues raised are still in their infancy, and current industry policy provisions are not yet robust nor comprehensive enough to deal with the emerging global phenomenon and thus warrant a deeper policy analysis to avert negative unintended regulatory consequences in the longer term.

Within this purview, sharp differences in business models, geographic delimitation, and pricing create competition imbalances, especially in evolving multi-sided markets (Hagiu, 2006). In this respect, the propensity of the often essential services offered by some OTTs — such as voice and messaging — to control market access through pricing (more significantly via zero rating) can create proprietary bottlenecks. This condition raises further questions as to the extent of ex-ante regulation required to allow for enhanced diffusion of broadband and telecommunication services (Ballon & Van Heesvelde, 2011). While pricing has traditionally been a critical aspect of competition regulation, it raises new challenges in two-sided markets, where the prices that operators can command on one side of the market depend on the ability to deliver positive externalities on another. Within the paradigm of a discriminant pricing strategy, arguments for telecommunications networks to subsidize price-sensitive users while charging over-the-top content providers a premium for accessing the users who connect on their platform are presumed economically viable. This proposition is to leverage surplus for more investments and innovation, lowering prices in the long term and further enhancing social welfare. In this regard, the pricing structure is dependent on the relative magnitude of positive cross-group externalities (Armstrong, 2006; Sriram et al., 2015) while also having the potency to reduce the innovative capabilities of new entrants on the content provider side of the market (Economides & Salop, 1992). However, the supply-side characteristics

of two-sided digital markets with respect to their network effects and economies of scale are related to their cost structures — a high fixed cost relative to marginal cost (assuming there is capacity) (see Veljanovski, 2007). While this is not precisely the same dynamics for pricing in traditional telecommunications markets (with high fixed and variable costs), for example, in the pricing of mobile data by MNOs, it has complexity implications for consideration in relative areas such as in QoS arrangements between OTT content providers and network operators, and for voice call termination requirements in relation to social welfare (Armstrong, 2001; Crandall & Sidak, 2004).

### 2.9 Social Welfare Imperatives

This section introduces the critical social welfare considerations within the context of the thesis, particularly regarding universal service obligations in the convergence era and the contextual implications for universal service provisioning within the evolving Nigerian telecommunications market.

#### 2.9.1 Universal Service Obligations (USO) in the Era of Convergence

Within the context of competition policy, universal service obligations have traditionally been a contentious subject, with arguments against its adoption with regard to constraining economic efficiency and innovation in guaranteeing optimal social welfare distribution of telecommunications infrastructure, especially from a neo-classical market economy perspective (Browning, 1994; Verhoest, 2000). This position means that its adoption from a regulatory perspective may just be apt for natural monopolist economic structures where a single operator is entrusted with the social objective of ensuring universal service access. This condition is often realized within those markets by leveraging cross-subsidization to guarantee ubiquitous service affordability, which counterbalances its monopolistic market power (Gasmi, Laffont & Sharkey, 2000; Picot & Wernick, 2007; Xia, 2016). However, the above rationale becomes questioned when a market transitions from a monopolist structure to a stricter competition regime, such as under a liberalized market, where the continuous imposition of a non-market obligation is considered a contradictory policy that distorts competitive market conditions. This situation is especially concerning distributing the costs of universal service provisioning across multiple market operators (Xavier & Ypsilanti, 2007;

Frischmann, 2012) and consequently constraining universal service provisioning (Banerjee & Dippon, 2006).

In the era of digital convergence, as the telecommunications ecosystem transits from voice-centric public switched telephone networks (PSTN) to datacentric IP-based new generation networks, the constraint on universal service provisioning will likely be accentuated. This proposition, according to scholars, is based on the argument that given the increased requirement for new generation access network investments by operators and innovation by OTTs, implementing cross-subsidization practices in support of USO becomes more unsustainable (Graham, Cornford & Marvin, 1996; Li, Ning & Zhu, 2008; Vogelsang, 2013; Bauer, 2014). The non-sustainability of USO provisioning becomes even steeper for incumbent operators who bear the brunt of increased regulation in contrast to market entrant OTTs to compete fairly (Banerjee & Dippon, 2006). The consequent market outcome of more constrained USO provisioning in a converged digital ecosystem amplifies the theoretical position of the digital inequality paradox that as "more people connect to more advanced services, the digital divide between and within countries increases" (see Gillwald & van der Spuy, 2019: 1).

### 2.9.2 Universal Service Provisioning in Nigeria

The Universal Service Provision Fund (USPF) was established in 2003 for the Nigerian telecommunications industry as Part IV of The Nigerian Communications Act No. 19, 2003, to facilitate ubiquitous access to telecommunications services for underserved and unserved market domains (USPF, 2015). While the USPF has been operational since 2006, significant unequal access to digital services for unserved and underserved communities still exists, especially concerning the urban-rural divide (Mgbeokwere, 2022). As of March 2022, the NCC estimates that over 35 million Nigerians cannot access telecommunications services (Elebeke, 2022). In concurrence with this situation, the nationally representative demand-side survey conducted by Research ICT Africa (RIA)[24] in Nigeria in 2018 indicated that the urban-rural divide was a significant determinant of digital access in the country, with an estimated 41 percent of the urban population connected to

[24] https://researchictafrica.net/

digital services and only about 2 percent of the rural population connected (Gillwald, Mothobi & Rademan, 2018).

## 2.10 Thesis Context: Historical Development of the Nigerian Telecommunication Industry

This section provides an initial landscape of the historical developments within the Nigerian telecommunications industry. In particular, it situates the industry evolution from traditional telecommunications services to the more recent OTT services adoption in the market and the complementary development of regulatory institutions within Nigeria's telecommunication industry.

### 2.10.1 Evolution of Telecommunications and OTT Services in Nigeria

The evolution of telecommunications services in Nigeria as an independent, sovereign entity began with the introduction of digital transmission systems and switches in the 1980s (Alabi, n.d.). The services comprised internal and external telecommunications delivered mainly via radio and optic fibre transmissions. The Posts and Telecommunications Department (P&T) managed the internal market, while the external market was handled separately by the Nigerian External Telecommunications Ltd (NET). This institutional market arrangement was fraught with problems concerning efficiently managing the National Telecommunications Network. First, while the Posts and Telecommunications Department had an essentially social welfare focus, the NET, on the other hand, had an economic, commercial focus. Second, the two operating entities had an existential lack of coordination. These conditions often led to a greater demand for the scarce resources of the Federal Government and sometimes to duplication of infrastructure investment requirements. The institutional market structure also incentivized cross-subsidization between the more profitable external (international) market segment and the not-so-profitable internal market for universal access provisioning, with consequent challenges for internalizing infrastructure investment costs (Alabi, n.d.). This scenario culminated in the merger of both entities towards establishing NITEL in 1985. The structural shift improved market outcomes by centralizing network investment planning and tariff structures. The resultant market outcomes led to further innovation, introducing newer telecommunication technologies, including an integrated services digital network and electromagnetic satellite fibre optic system in 1989. Concerning network capacity, NITEL was also

able to double its size from about 450,000 subscriber lines in 1991 to about 1 million lines in 1995 (Hassan, 2011).

Until 2000, the Nigerian telecommunications market was monopolistic under the government-backed NITEL. According to Nigeria's National Policy on Telecommunications[25] (Pg. 5), "*The main objective of establishing NITEL was to harmonize the planning and coordination of the internal and external telecommunications services, rationalize investments in telecommunications development, and provide accessible, efficient, and affordable services.*" Its services included fixed telephony, electronic mailing (telex/telegram), and paging. However, given the size and the distribution of the country's service demand, the entity was resource-constrained in efficiently delivering ubiquitous network coverage to meet its social and economic objectives in a capital-intensive market. While NITEL tried to bridge this deficit via a phased network expansion approach, it still was not profitable, mainly due to its intrinsic social welfare focus (Obutte, 2014). Due to the non-profitability of the entity after operations for almost a decade, the Nigerian government commercialized it in 1992.

Nevertheless, this economic re-orientation did not significantly improve the quality of services it provided nor the financial viability of the enterprise in relation to the Nigerian telecommunications market. In this regard, the Federal Government deregulated the sector in 1996 to allow for some private sector participation, even though NITEL maintained market power dominance over international and national long-distance fixed telephony (Ndukwe, 2003; Adesanya, 2020). To bridge the enterprise's continued capacity inefficiencies, especially for long-distance calls, the government also set up MTEL as the mobile arm of NITEL to provide mobile telephony services (cellular) under the deregulated market regime. MTEL crashed before it barely took off, as it could not survive a competitive market environment and consequently could not pay the required interconnection charges to NITEL (Nkordeh, Bob-Manuel & Olowononi, 2017). In culmination, the government consequently enacted a decree establishing an industry regulator — the Nigerian Communications Commission (NCC) that paved the way for the full liberalization of the sector in 1999 and the development of the National Telecommunications Policy (NTP) in 2000[26] (Adesanya, 2020). The industry liberalization opened up the telecommunications market for broader private-

[25] https://researchictafrica.net/countries/nigeria/National%20Policy%20on%20Telecommunications.pdf

[26] https://researchictafrica.net/countries/nigeria/National%20Policy%20on%20Telecommunications.pdf

sector competition. NITEL was consequently privatized by the Nigerian Government, starting in 2001, as the hitherto state-owned enterprise did not improve in relation to allocative and productive efficiencies, even with repeated cycles of government interventions (Jerome, 2002; Ojiako & Maguire, 2006).

On the other hand, the NTP was to set Nigeria in tandem with the emerging global trends in the telecommunications industry, with the overriding objective of modernizing and expanding access networks and telecommunication services ubiquitously (Adesanya, 2020). The economic window of sector liberalization ushered in the GSM[27] revolution in the Nigerian telecommunications market in 2001, with the licensing of mobile network operators (MNOs) — first, ECONET (which has subsequently metamorphosed into Airtel), and then MTN following suit, both operating within the 850 MHz and 1900 MHz spectrum frequency bands. This development intensified market competition and ensured mobile network infrastructure investments and an exponential growth in demand subscriptions from about 1 million to 100 million subscribers within ten years (Nkordeh et al., 2017). Market competition was further intensified with the licensing of a third MNO, Globacom, as the second national carrier in 2003, disrupting the market pricing structure with its per-second billing. Nonetheless, MTN has maintained a grip on market share dominance since 2001, as they expanded coverage quickly, controlling critical segments of bottleneck network infrastructure (including the backbone transmission system for which it accrues the highest interconnection charges) within Nigeria's telecommunications market (NCC, 2010; Hassan, 2011).

The advent of over-the-top (OTT) services in the Nigerian telecommunications market began around late 2010 (Mahola & Erasmus, 2015; Gillwald, Odufuwa & Futter, 2016). Until then, no fully zero-rated products were offered in the market, as incumbent operators were generally unwilling to open up their networks to OTT competition. While the MNOs at the time were reluctant to leverage the demand for social networking by offering zero-rated services to attract customers, they still demanded revenue sharing from OTTs running on their networks. It was only in 2016 that Airtel launched the first zero-rated offering into the Nigerian market — Facebook's Free Basics under a bespoke reverse billing pricing structure that allowed sponsoring entities to pay for

[27] The Global System for Mobile Communications

aggregated consumer access data. With decreasing mobile data tariffs in relation to competition, other MNOs were compelled to launch their own zero-rated offerings, and the consequent upswing in data subscriptions for bundled MNO products as a factor of mobile subscriptions grew from under 30 percent in 2012 to about 70 percent in 2017 (NCC Database).

### 2.10.2 Evolution of Regulatory Institutions within Nigeria's Telecommunication Industry

The overall executive supervision of the Nigerian telecommunications industry is under the auspices of the Federal Ministry of Communications and Digital Economy[28] (Akwule, 1991; Ojiako & Maguire, 2006). The Ministry determines the overall policy development of the industry in tandem with regulatory parastatals of government, which is chiefly the Nigerian Communications Commission (NCC). The NCC, on its part, is responsible for operator and services provisioning licensing, industry standardization, sector competition regulation, and tariff regulation — a role it took over within the deregulation regime from the then Utilities Charges Commission, which had a more social rather than an economic utility function (Hassan, 2011; Nkordeh et al., 2017).

In the context of the evolution of convergence discourse, media and content regulation in Nigeria has traditionally been regulated separately from the telecommunications industry, the former under the regulatory purview of the Nigerian Broadcasting Commission (NBC)[29] within the provisions of the Nigerian Broadcasting Commission Act of 1992[30] (Adesanya, 2020). Within this institutional arrangement, both regulatory authorities granted licenses to their appropriate operators based on the unique service they offered. However, with the dynamic imperatives of convergence, this licensing structure is being reviewed in alignment with the sector's evolution to lower market entry barriers and enhance competition. This institutional realignment began with the NCC introducing the technology-neutral Unified Access Services License (UASL)[31] in 2006 to cover both voice and ISP services, and data-based applications and services (Onyechi, 2020). The ultimate objective was to enhance network resource utilization efficiency in line with technological convergence. The

[28] https://fmcde.gov.ng/

[29] https://nbc.gov.ng/

[30] Amended in 1999: http://lawsofnigeria.placng.org/view2.php?sn=276

[31] https://www.ncc.gov.ng/docman-main/licensing-documents/licensing-frameworks/434-licensing-framework-for-unified-access-service/file

telecommunications market leader, MTN, further drove this incentive by piloting the first fully converged digital television broadcasting video-on-demand TV service in the Nigerian market via OTT platforms such as Twitter, Facebook, and WhatsApp. MTN provisioned the innovative service based on a digital broadcast license operated within the 700MHz frequency band it obtained from the NBC in 2015 for 34 billion Naira (~USD200 million) (Ubabukoh, 2020). This market entry heralded the emergence of the triple-play telecommunications ecosystem in Nigeria, covering digital broadcast services, telephony, and broadband internet applications in response to the competitive incursions of OTTs.

On the institutional regulatory front, the NCC in 2019 released official guidelines for the adoption of television white spaces for broadband connectivity in underserved rural areas in Nigeria.[32] These unassigned frequency spectrums are domiciled under the control of the NBC for the provision of TV broadcast within the 470 - 694 MHz end of the UHF[33] band (Adesanya, 2020). Like the historical institutional structure that preceded the market failure of the telecommunications industry in Nigeria in relation to the Post and Telecommunications Department (internal communications) and the Nigerian External Telecommunications before their merger in 1985, the regulation of the emerging digital ecosystem in Nigeria separately by the NCC and NBC is once again at risk of similar market failure. This negative potential will likely result from resource allocation inefficiencies concerning spectrum management and operator interconnection, with the latter critically in variance as the interconnection rates for the traditional circuit-switched voice services regulated by the NCC were time-based. In contrast, the digital services regulated by the NBC were IP packet switch-based. The consequent inefficiencies concerning resource allocation with respect to their separate cost structures will, therefore, crystallize an ultimate net social welfare loss (see Feintuck, 2010). Evidence of the emerging context above was the market tensions that arose when, in 2021, the Nigerian Government, in the heat of its spat with Twitter, directed the NBC to commence the licensing process for OTTs operating in the country. The NCC challenged this move, arguing, in variance, that such regulation was under its statutory mandate (Adepetun, 2021). From a consumer welfare perspective, however, arguments for holding off this regulatory move have been made by ecosystem stakeholders on the basis that some of the services, such as zero-rated products, enhance internet

[32] https://www.ncc.gov.ng/docman-main/legal-regulatory/guidelines/draft-guidelines/876-draft-guidelines-on-the-use-of-television-white-spaces-2019/file (Amended in 2020).

[33] Ultra-high frequency

access opportunities for especially price-sensitive users (Gillwald et al., 2016; Fowora et al., 2018). In particular reference to pricing, zero-rated and other OTT services are buoyed in the Nigerian market by a pro-regulation stance of the NCC regarding the market entrants in contrast to overt protection of the incumbent operators. However, this regulatory posture is gradually shifting communication services to commodity levels with respect to pricing as its competition-inducing effects intensify within the Nigerian market (Odufuwa, 2012).

In relation to the discourse on the management of telecommunications infrastructure as a common-pool resource, while historically, the telecommunications infrastructure within the Nigerian ecosystem was under the control of monopolist NITEL[34], the sector restructuring (or liberalization) eroded this institutional right, unbundling the value chain with a more diffuse resource management structure under a stricter competition policy regime (see Noam, 1992; Künneke & Finger, 2009). This restructuring mechanism created an even more significant coordination requirement for the now multiple actors with diversified economic and social interests in managing the common-pool resource. As the market shifts towards a converged ecosystem, the common-pool resource management problem becomes even more complex, considering the technological complementarities of a multi-sided digital market, with jurisdictional transitioning from local and national boundaries to global institutional structures (see Cherry, 2006).

### 2.11 Chapter Two Summary

This Chapter has analysed the extant literature on platform competition policy, establishing pricing as a critical underpinning element within the paradigms of discriminant pricing strategy and social optimality in price regimes relating to innovation, investments, and social welfare from a global and African context. The Chapter also crystallized the dominant themes in academic literature as it concerns competition policy in the telecommunications industry, as the thematic paradigms transitioned from the phase where competition was appraised not to have a considerable impact on incumbents' investment to a more contemporary establishment of significant relationships between competition, investment, and innovation, at socially optimal pricing and openness conditions. The competition models assayed included the two-sided market model, the congestion model, and the

[34] Which operated as a vertically integrated firm controlling the entire services value chain of the resource system in the pre-deregulation era.

non-neutral competition regime. In relation to the contextual institutional environment, the Chapter further highlighted the different approaches to competition policy comprising the structural approach, which prioritizes the competitive process over the competitors; the trade-off approach, which counterbalances competition with social welfare; and the pragmatic approach, which incorporates strategic national interests.

In reflection, while the reviewed models and approaches provide critical insights into understanding competition policy issues within the telecommunications industry, they fail to address the regulatory challenges of optimizing competition and consumer welfare outcomes in a converging telecommunications ecosystem. For these emerging regulatory challenges to be tractable, there is the need to simplify the complexity of relations between ecosystem players as they interrelate within the evolving multi-sided market systems with regard to the external policy environment. This thesis explores the insights that can be gained by building on the extant models and framing the policy issues through a complex systems lens. Therefore, while the Chapter elucidates the pros and cons of the several models and approaches reviewed, it asserts that unintended policy consequences and outcomes can be limited by understanding their complex interrelationship dynamics in unique historical and socio-technical contexts. As such, the author will further interrogate these dynamics and their interrelationships within the thesis based on the conceptual and theoretical framework that follows in Chapter Three. The author extends the discourse in-context by making a first step toward formulating an ecosystem model of the Nigerian telecommunications sector in Chapter Six.

## Chapter Three: Theoretical and Conceptual Framework

### 3.0 Introduction

This Chapter lays out the theoretical framework and conceptual model for interrogating the interrelationships between the domain constructs as defined within the thesis' research questions, upon which the author will underpin the research propositions and analytic outcomes. The theoretical framework draws on concepts from, first, complexity theory — for the interrogation of complex policy challenges that stem from dynamic gaps in the nested and interdependent interactions between socio-technical and institutional factors and second, the Institutional Analysis and Development (IAD) Framework — which is applied to identify the critical structural elements for optimal institutional analysis in diagnostic inquiries for appropriate institutional arrangements. The author then uses the theoretical framework to construct the conceptual model for the thesis, which will be the analytical mechanism for assessing the governance of the telecommunications ecosystem in focus. The author will explain the ensuing arguments as complex interdependencies of market supply and demand factors nested within the external frame of a contextual, transitionary socio-technical environment.

### 3.1 Theoretical Foundation 1: Complex Systems and "Wicked" Policy Problems

As briefly mentioned in Chapter One, within the domain of public policy research, "wicked" problems are complex challenges that stem from the dynamic gaps in the nested and interdependent interactions between socio-technical and institutional factors (Head, 2008; Hämäläinen, 2013; Ketter, Peters, Collins, & Gupta, 2015). The exchanges are characterized in relation to their coupling effects by "weak" linkages — in that a minor perturbation might result in large-scale effects. At the same time, a significant change may produce just a small systemic difference (Pascale, 1999). These processes build significant systemic uncertainty levels, making cognitive policy framing and management difficult (Hämäläinen, 2015). Scholars attribute these gaps to factor differences in stakeholder interests, values, knowledge, technological changes, and evolving institutional changes (Head & Alford, 2015). In the seminal postulations of Rittel and Webber (1973), "wicked" problems are unique. According to the scholars, they are characteristically identified by disputable problem definitions that give rise to non-absolute, subjective outcomes and lack ultimate verifiability (see also De Vries, 2008). This situation often leads to weak governance mechanisms that result in failure to

achieve policy objectives and the extrication of unintended outcomes both in the short and long runs, and therefore demands more complex and adaptive frameworks in mitigating those with higher levels of predictability, resilience, and robustness (Andersen & Sornette, 2005; Bankes, 2002; Head, 2008; Levin et al., 2013). These complex adaptive frameworks are non-linear systems characterized by hierarchical convolutions, dynamic multi-stable states, cyclical responses, and historical path dependencies (Rittel & Weber, 1973; Arthur, 1994; De Vries, 2008). These attributes are fundamentally driven by the intrinsic properties of self-organization and emergent patterns, as earlier stated (see also Cilliers, 1999; Anderson, Issel, & McDaniel Jr, 2003). While much complexity theory analysis operates contemporarily on a highly formalized level for developing mathematical models, the thesis leverages the critical concepts of interdependence, non-linearity, path-dependence, coupling, and emergent properties within the theoretical framework for interrogating platform competition dynamics in two-sided markets evolution in the telecommunications industry.

Within this context, technological changes, economic changes, and innovations in business models have transformed the emerging telecommunications industry into a more dynamic and interdependent system that shows many features of a complex adaptive system. To re-emphasize, the rapid diffusion of Internet-based networks is altering the socio-technical communication system that enables the emerging digital ecosystem, including the institutional arrangements for national and global governance. Technically, this change is primarily driven by the convergence of the telecommunications ecosystem with the Internet due to increased digitization and network compression characterized by the deployment of the Internet Protocol (see Wu, 2004). Economically, however, the shift in the digital ecosystem has been driven by the liberalization of markets that has spawned lower-cost technology innovation, ending natural monopoly elements of network infrastructure that provided the rationale for utility regulation and enabled competition in telecommunications infrastructure provisioning (see Mueller, 1999; Singh, 2016). These shifts in the digital ecosystem have significant implications for consumer access and use, competition, innovation, and investment, especially in developing countries — where the cost of new-generation infrastructure rollouts limits the speed of convergence.[35] This situation challenges traditional regulatory arrangements and has led an increasing number of countries to explore novel regulatory

[35] South African Communications Forum Report. 2016. Industry Briefing on Over the Top (OTT) Services in South Africa. https://static.pmg.org.za/160126SACF.pdf

and policy frameworks to adequately harness the opportunities that the emerging complex pathways of this change provide (Kling, 2000; Frischmann, 2004; Constantinides & Barrett, 2006; De Vries, 2008; Bauer & Tsai, 2014a; Head & Alford, 2015).

Specifically, telecommunications convergence is a dynamic trend currently prevalent within the telecommunications and technology services field related to changes in the underpinning industry structures and adjacent policy and regulatory environment (Blackman, 1998). The fundamental change (concerning technological convergence) is with respect to the flow of different types of network information — voice, messaging, video, et cetera — over separate network media (in traditional networks, requiring less bandwidth) and together (in IP (Internet-based) networks, requiring higher-order bandwidth). The latter mechanism is blurring the vertical sectoral market boundaries in the industry structures for telecommunications, broadcasting, computing, and content publishing industries, requiring some integration for their regulation, policy formulation, and implementation — even as the socio-economic forces of liberalization and globalization drive them further. Convergence for telecommunications policy implies that as traditional linear value chains (mostly infrastructure providers) evolve to non-linear value networks[36] — with its inter-dependent relationships — and new market entrants[37] begin to disintermediate the direct linkage between the mobile network operators and users[38], competition increases markedly within the complex ecosystem. This continuous evolution significantly affects innovation and investment on both sides of the dyadic market (see Peppard & Rylander, 2006). In principle, considering the non-linear interactions, a short-term policy focus on social welfare might be counterproductive in the long term, as policymakers cannot predict the outcomes of policy interventions with absolute accuracy since the interventions may influence the ecosystem in unanticipated directions to produce unintended consequences (see Walker & Abel, 2002; Quigley, 2004; De Vries, 2008; Bauer, 2013).

In relation to the converging telecommunications ecosystem, many attributes of IP-based digital networks do not emerge directly from the behaviour of a particular ecosystem element. For instance, the volume of network traffic is an emergent ecosystem property dependent not just on the network

[36] In relation to IP-based systems

[37] Like the OTTs who are primarily content providers, initially.

[38] Leveraging their market power as the primary traffic drivers through the networks provided by the mobile operators.

infrastructure capacity and the application technologies that run on them but also on the business models and arrangements between service providers and the demand-side pull effects of the applications and services. Nevertheless, according to Mueller (1999), while increasing convergence blurs the vertical separation of industry markets, it, on the contrary, increases the divergence in the horizontal segments of the markets. This mechanism necessitates enhanced market differentiation for sustained competition in response to variations in consumer demand and regulatory jurisprudence — from traditionally national to international boundaries — with consequent economic efficiency imperatives for investments and innovation. According to Perrucci and Cimatoribus (1997), technological convergence implicates regulatory convergence on the alternative schools of thought — whether for symmetric or asymmetric regulation of digital markets. These convergence mechanisms are characterized by non-linear, co-evolutionary developments that result in significant shifts in their governance structures, making convergence a complex adaptive phenomenon.

Economically, market operators often deliver voice telecommunication services via a differentiated pricing structure (traffic volume-, value- or location-dependent) that guarantees revenues above total production costs (Gruber, 2005). However, with the transition towards a converged digital ecosystem that enables simultaneous voice and data services via a net-neutral Internet, a key policy challenge arises concerning data services pricing structures that will stimulate user adoption without jeopardizing operator revenues (Cushnie, Hutchison & Oliver, 2000; Hui & Yeung, 2003; Wu, 2003; Johansson, 2007; Ortiz, 2007; Adeyinka, 2008; Ojugo et al., 2013). The preceding outcome will be based on price recovery mechanisms that can optimally overcome the free-rider problem of public goods — the so-called "tragedy of the commons" — in guaranteeing the long-term stability of the increasingly complex ecosystem (Gaffard & Krafft, 2001; Johnson-Freese & Weeden, 2012; Krancke, Vidal & Fier, 2012; Johnson et al., 2021). In the Nigerian telecommunications context, regulatory developments concerning the aforementioned issues are still in their infancy. Current industry policy provisions are not yet robust nor comprehensive enough to deal with the emerging global phenomenon and thus warrant a deeper policy analysis to avert negative unintended regulatory consequences in the longer term.

The current traditionally static competition regulation within the Nigerian telecommunications industry is inappropriate under the highlighted conditions for enabling the horizontal and vertical relations between the emergent players in the converging ecosystem. This regulatory constraint is because, in a dynamic interdependent ecosystem, regulatory policy focused on a specific aspect of the ecosystem layer (for example, network infrastructure access) often has competing and counteracting effects on players across the other interrelated layers (see Bauer & Bohlin, 2022). In this respect, a static regulatory policy regime does not assess the ecosystem competition effects, especially concerning their investment, innovation, and social welfare imperatives (see Parcu & Silvestri, 2014; Crémer, De Montjoye & Schweitzer, 2019).

A complex systems approach is therefore considered an appropriate research lens. Within the context of the thesis, the author will leverage the complex systems approach to frame the thesis inquiry metaphorically and not explicitly to build a formal mathematical model. This approach provides a mechanism to interrogate beyond the immediate policy problem to ascertain the underlying cause-effect relationships critical in crystallizing leverage points for transitioning the ecosystem to a better state at scale in both the short and long terms. The adopted approach is considered pertinent within the domain of policy research, especially in contexts with a divergence of opinion among ecosystem stakeholders and experts on agreeable policy pathways forward in making sustainable large-scale ecosystem changes (Andrew & Petkov, 2003; Cherry, 2006). Concerning the thesis focus within the domain of telecommunications policy, the theory of complex systems is pertinent for addressing regulatory policy challenges concerning OTT-MNO competition dynamics because of the significant complementarities between the different value chain layers within the converged and more complex telecommunications ecosystem (Peitz & Valletti, 2015).

More so, this qualitative theoretical perspective is promising for understanding the adaptive substitutability effects created due to the complementarities for optimal market segmentation and definition, as well as market power assessment in evolving digital markets — given the implications of non-price competition (see OECD, 2022). This perspective is a significant part of the foundational process for developing regulatory pathways for competition governance in relation to balancing market outcomes for both the supply and demand sides in the short and long terms. This understanding is significant given that the traditional quantitative market definition methods, such as the *Small but Significant Non-transitory Increase in Prices* (SSNIP) test and the standard *Hypothetical*

*Monopolist Test* (HMT), are currently impracticable in analyzing the converged multi-sided telecommunications industry (Bauer, 2004; Baldry, Steingröver, & Hessler, 2014; Krämer & Wohlfarth, 2018). This constraint crystallizes based on the aforementioned, often asymmetric substitutive effects[39], implying that the relevant market's definition intrinsically depends on the considered service. While some of these challenges have developed within competition assessment in traditional telecommunications policy[40], the convergence phenomenon in the emerging digital ecosystem significantly increases the complexity of quantitative data requirements necessary for this assessment via conventional quantitative methods. This constraint is mainly because the dynamic competition effects in relation to the key elements of investment, innovation, and pricing are currently difficult to measure as directly observable economic statistics. Therefore, the emergent ecosystem behaviour with regard to their non-linear outcomes becomes increasingly challenging to optimize statistically (see Petit & Teece, 2021).

Furthermore, complexity theory can help interrogate the complex interactions between ex-post competition law and ex-ante sector regulation, especially considering the jurisdictional applicability of the regulatory frameworks for the converged telecommunications industry as it transits from localized national boundaries to global institutional structures (Cherry, 2006). From an ecosystem perspective, complexity theory provides a grounded basis for concise ecosystem mapping. This approach helps establish plausible leverage points for optimizing policy trade-offs in realizing large-scale impact — critical for effective short- and long-term policy design (Longstaff, 2003). Summarily, complex systems thinking facilitates a dynamic, systemic regulatory approach, enabling policymakers to characterize and diagnose often "wicked" policy problems before attempting a solution (De Vries, 2008). A complexity approach in dealing with the competition regulatory challenges of the converging telecommunications industry provides an ecosystem perspective that helps identify the critical interrelated processes and mechanisms that significantly control the ecosystem's emergent properties at various scales in a hierarchical structure. This process substantiates the socio-technical reconfigurations concerning regulatory trade-offs and policy options necessary to realize the ultimate objective of maximizing social welfare within the realities of

[39] For example, the substitutive effect on a service with simpler features (such as a voice call) in contrast to a service with multiple features (such as a WhatsApp call) can be more evident than conversely.

[40] For example, in relation to fixed telephone services and telecommunication substitutability.

competing economic interests in relation to investment and innovation by the ecosystem players. Nevertheless, a dynamic systems regulatory approach within ecosystem models with relatively unstable constituents and unclear boundary conditions, such as in the converging telecommunications market, still comprises significant attributes of uncertainty and would, therefore, require some levels of policy flexibility, experimentation, and adaptation (see Cherry & Bauer, 2004; De Vries, 2008; Bauer, 2013). Within an institutional context, however, for policy interventions that require clear decisiveness and steer direction with some degree of certainty, traditional regulation might still be preferable as a second-best solution because we know better how it works, given that only experience will ultimately crystallize whether a chosen policy pathway within a dynamic systems approach is tractable or not (Bunge, 1979; Evans, Quigley & Zhang, 2003; De Vries, 2008; Bauer, 2010b).

### 3.2 Theoretical Foundation 2: Institutional Analysis and Development (IAD) Framework

According to Bauer (2004: 38), "while the theory of complex evolving systems provides a fresh framework, it is best used in addition to established policy analysis tools," especially concerning institutional structures. The IAD framework is a prominent theoretical framework for complex policy research and scholarship (Ostrom, 2011). While scholars in market competition policy analysis have not traditionally applied the IAD, the author asserts that the framework can be used to identify the critical structural elements for optimal institutional analysis in diagnostic inquiries for appropriate institutional arrangements. As a complement to complex systems theory — which helps explain specific phenomena to predict outcomes — the IAD helps to contextualize the analysis within unique governance arrangements. This process helps assess historical and current empirical evidence in generating new knowledge about the phenomenon.

For this study, the IAD analysis focuses on the collective-choice tier of the framework, where policymakers will have to select policy options within collective-choice constraints — factors that influence the initial structural arrangements and outcome-based influences on structural changes over time (Kiser & Ostrom, 2000). Within the context of the Internet as a public good, the IAD

framework interrogates common-pool resource[41] policy analysis based on the following factors as established by Ostrom (2011):

i. The Actor set: ecosystem stakeholders within a resource system
ii. Institutional arrangements: resource governance mechanisms, policies, and processes
iii. Policy-process outcomes
iv. Resource information availability and asymmetries
v. Cost-benefit of policy actions and outcomes

These factors will guide the analysis of policy outcomes, the development of alternative policy options, and anticipating future pathways within the study context. The evaluative criteria within the focus of this study will comprise the following:

- Economic efficiency (static and dynamic)[42]: net surplus of resource allocation with a focus on investment and innovation.

[41] When a public good is delivered with some level of rivalrousness and excludability (often via institutional pricing structures) to allow for output optimization with respect to investment and innovation, it becomes classified as a common-pool resource (see Ostrom, 1990; Hess, 1995; Hess & Ostrom, 2003; Künneke & Finger, 2009; Ostrom & Ostrom, 2019). From a policy governance perspective, common-pool resources are sometimes referred to as socio-technical systems, with a focus on overcoming the free-rider problem of public goods — the so-called "tragedy of the commons" — balanced with a strong consideration of social welfare imperatives (Johnson-Freese & Weeden, 2012; Krancke, Vidal & Fier, 2012; Johnson et al., 2021). As a common-pool resource, telecommunications infrastructure (inclusive of the Internet) is considered a complex socio-technical system with complementarities that create the need for telecommunications policy cordination via appropriate governance structures and institutional arrangements across its multi-layers and user end (Bernbom, 2000; Picot & Wernick, 2007; Künneke & Finger, 2009). This cordination has implications for infrastructure network capacity management and quality of service in relation to investment and innovation, and ultimately user welfare, especially within a converging internet-based ecosystem in which the complexities increase (Hess & Ostrom, 2003; Mueller, 2010). Within the context of two-sided markets, the network effects generated are considered as externalities (whether positive or negative) in common-pool resource infrastructures, and their internalization will have to be assessed within unique local contexts to account for their complex cascading effects (Frischmann, 2012).

[42] The economic efficiency criterion is appropriate within the thesis context for determining the short and long term efficiencies of net benefits associated with resource allocation. The resource allocation mechanism in this case is in particular relation to the pricing mechanisms adopted within the extant policy regime of the Nigerian telecommunications market. The efficiency assessment plays a central role in estimating the benefits and costs in relation to the pricing mechanism, whether via rates of return to investments or otherwise, which is then used to determine the economic feasibility or ecosystem plausibility of such policies. According to Frischmann (2004), when considering alternative institutional arrangements, it is crucial to consider how revisions in these ecosystem rules will alter behaviour and hence the allocation of resources, in particular, regarding access control in relation to public use and its normative implications, and how it enhances network resource utilization efficiency in line with technological convergence. Resource allocation via a pricing mechanism in this context yields multiple outcomes that can be assessed only by a

- Redistributional equity[43]: capacity for inclusive access with a focus on demand-side value; and
- Sustainability[44]: future change responsiveness and adaptability.

In the final analysis, the levels of policy trade-offs will be important in selecting the best-option institutional arrangements, considering a balance between the abovementioned factors. This process is in alignment with public goods analysis in relation to not just excludability and the free-rider

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dynamic approach based on historical evidence. In the context of this thesis, the net surplus of resource allocation will focus on investment and innovation imperatives.

[43] The redistributional equity criterion is appropriate within the thesis context with respect to evaluating the capacity of telecommunications policies to redistribute resources to poorer segments of the ecosystem, which are of critical importance within a social welfare perspective. While efficiency considerations would normally indicate that telecommunications resources be implemented where they produce the highest net benefit, redistributional equity objectives may misalign with this objective, with a focus on the provision of telecommunications services that benefit particularly poorer groups. In assessing the redistributional objectives in the thesis context, the complexities arising from transitory contextual market evolution may create misalignments and uncertainties in broadband governance frameworks and render them inconsistent with poor allocative and technical efficiencies in relation to equity (see Bauer, 2005a; Kemp & Rotmans, 2005; Cantwell, Dunning, & Lundan, 2010; Bandyopadhyay, 2011; Xia, 2012). This relationship is often indirect, as a poor allocative and technical efficiency creates disincentives for further investment and innovation on the supply side, with a cumulative long-term impact on social welfare (distributional effects) (see also Mishra & Kumar, 2021). Within the context of competition policy, universal service obligations have traditionally been a contentious subject, with arguments against its adoption with regard to constraining economic efficiency and innovation in guaranteeing optimal social welfare distribution of telecommunications infrastructure. This situation is especially concerning distributing the costs of universal service provisioning across multiple market operators (see Xavier & Ypsilanti, 2007; Frischmann, 2012) and consequently constraining universal service provisioning (Banerjee & Dippon, 2006). However, given the size and the distribution of the Nigerian telecommunications services demand, resource-constraints in efficiently delivering ubiquitous network coverage to meet its social and economic objectives in a capital-intensive market becomes significant. In this respect, a strategic provision of the Nigerian National ICT Policy is the enhancement of equitable distribution of the value of telecommunications infrastructure amongst the active stakeholdership, as they interrelate within the Nigerian telecommunications ecosystem, especially regarding system bottlenecks across all market layers.

[44] The sustainability evaluative criterion is appropriate within the thesis context because, unless institutional arrangements are optimal in responding to continuously adapting and evolving technology environments, the long term sustainability of telecommunications policy outcomes is likely to suffer, in particular, for underserved rural areas that are often faced with highly localized commercial circumstances. If the specific institutional arrangement is significantly inflexible to cope with these unique conditions, it is unlikely to catalyze long term social welfare surplus. Within this consideration, policy trade-offs become necessary for selecting and adapting alternative institutional arrangements in balancing the objectives of economic efficiency and redistributional equity (see Ostrom, Schroeder & Wynne, 1993; Eggertsson, 2009). In considering the Internet (and the evolving telecommunication ecosystem) as a social infrastructure, resource allocation via classical market mechanisms becomes untenable as the exclusion of free-riders becomes more difficult for generating a sustainable revenue stream in a fast-changing socio-technical environment (see Trogen, 2005; Eisenmann et al., 2006).

problem (Olson, 1965) but also the consumers' willingness to pay. The premised rules configuring the institutional arrangements will encompass the following:

a. Market entry and exit: market participants, their resources, and attributes in relation to entry and exit conditions
b. Market competition dynamics; and
c. Regulatory structures

In reference to ITU (2018:1), "a regulatory framework that combines dynamic and structural perspectives with the current approach to competition regulation creates fertile ground for collaborative regulation between telecommunication and competition authorities." This mechanism has the potential to create regulatory pathways that are agreeable to ecosystem stakeholders. The above proposition will consider the complex interactions between the supply, demand, and institutional factors — that will require some optimal levels of coordination mechanisms, more so as institutional arrangements shift from national to global within the converged telecommunications industry.

Therefore, within the above purview, the IAD framework provides an apt analytical frame for evaluating policy effectiveness or initiating policy reform in designing alternative regulatory pathways (Polski & Ostrom, 1999). In the context of telecommunications policy analysis, this provides leverage for a paradigm shift from the traditional supply-side-focused approaches to a more institutionally grounded perspective that assesses demand-side valuation for allocating resources within regulatory and policy reform and implementation incentives, optimal for a converged and complex industry.

### 3.3 Theoretical Synthesis in Relation to the Research Problem

A complementary synthesis of complexity theory and the Institutional Analysis and Design (IAD) framework facilitates the assessment of efficient competition policy within optimal institutional arrangements that consider the increasingly complex convergence dynamics for investment, innovation, and social welfare concerning the thesis context. In particular, the IAD provides a guiding framework to analyse the institutional conditions within which existing telecommunication policies and regulatory mechanisms in relation to dynamic situations where market interactions of both incumbents and new entrants create new dimensions that alter the incentives for investment and innovation on both sides of the market, with significant imperatives for long term consumer welfare. The critique of the static competition policy assumptions, as they relate to emerging market dynamics, then forms the basis of a comprehensive ecosystem mapping that provides insight into the dynamic approaches to the governance of complex systems. In relation to the cause-effect relationships between pricing, investment, and innovation, the analysis crystallizes a coherent institutional framework that encapsulates the Nigerian telecommunications ecosystem's technical and socio-economic dimensions.

### 3.4 Conceptual Framework

The macro-level theories - complex systems theory and the institutional analysis and development framework (IAD), developed by Ostrom (2010), were adopted to explain the interrelationships between the empirical constructs. While the IAD helps to interrogate the external institutional structure in which actors interact and its influences on their decisions, complex systems theory helps to assess the complex adaptive dynamics that these interactions may generate. These frameworks will be complemented with the concept of two-sided markets, as propounded by Rochet and Tirole (2003), in providing the conceptual basis for analysing platform price competition in two-sided telecommunication markets.

The policy research paradigm relying on complex systems theory is an academic domain with a significant growing interest (Cherry, 2006). As an evolution from systems theory, complexity theory posits that the satisfaction of dynamic efficiency by the necessary and sufficient conditions in a multiplicity of constraints within a system is contingent on the initial conditions and path

dependence (Cherry, 2006: 378; Espinosa, 2016). This outcome is consequent on the fixed or cycle points within the system when influenced by external factors (Holland, 1992; Christensen and Albert, 2007). In complex adaptive systems, these outcomes evolve sustainably with optimal balance between stability and uncertainty on contextual fitness landscapes (Tyre & Von Hippel, 1997; Sprauer, Blackburn, Blessner & Olson, 2015).

In applying this theoretical framework in developing the conceptual model (Figure 2), the determinant mechanism of regulatory policy is explicated by the author as a complex interdependence of not just market supply and demand factors but also as nested within the external frame of a contextual, transitionary socio-technical environment (Bauer, 2010a; Bauer & Tsai, 2014a; Chiva, Ghauri, & Alegre, 2014; Arlinghaus et al., 2017). The internal interactions combine top-down and bottom-up processes (Barrientos & de la Mota, 2016), while the socio-technical environment comprises the technological landscape, socio-demographics, and institutional arrangements as they coevolve with the supply and demand factors.

Specifically, in resource-scarce environments, price structuration within unique institutional arrangements plays a significant part in counter-balancing innovation and investment trajectories to avoid competition lock-in by dominant technologies (Van den Bergh, Truffer, & Kallis, 2011; Safarzyńska, Frenken, & van den Bergh, 2012). A more stringent competition policy, especially at early stages, will engender recombinant innovation but increase investment uncertainty, requiring a hybrid solution. Resource allocation via a pricing mechanism in this scenario yields multiple outcomes that can be assessed only by a dynamic approach based on historical evidence (Arthur, 1989).

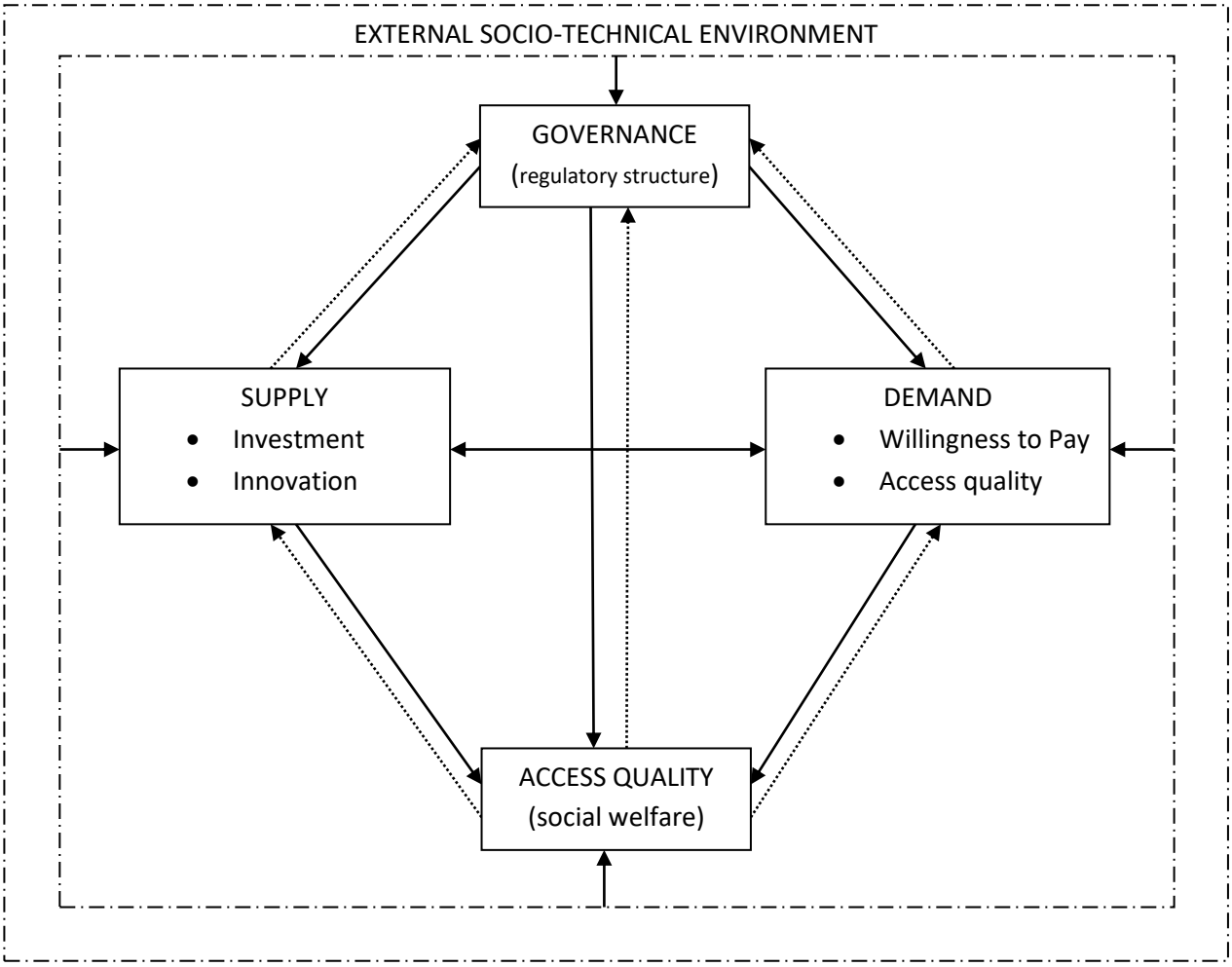


**Figure 2: Conceptual model of regulatory policy as a CAS, adapted from Bauer and Tsai (2014a)**

In considering the two-sidedness of the telecommunications market in relation to network externalities and cross-side complementarities, platform theory, as espoused by Rochet and Tirole (2003), seeks to determine price allocation effects in different governance structures. The extent of the interdependence of innovation and investment in the two-sided market within these institutional arrangements determines the social welfare effects. These effects could be contradictory or complementary and have significant imperatives on demand-side value appropriation in relation to consumers' willingness to pay and access quality (Baranes, 2014; Wareham, Fox, & Cano Giner, 2014; Adner, 2017). According to Jacobides, Cennamo, and Gawer (2018), this ecosystem perspective cannot be interrogated using the classical supply-demand relationship.

More so, variations in the ecosystem interdependencies in different institutional climates depend on developmental history with respect to structural and socio-economic evolution (Shafaeddin, 2016). The analysis of price structures for innovation and investment dynamic efficiencies in the two-sided telecommunications market leverages the institutional analysis and development framework (IAD) developed by Elinor Ostrom to govern common-pool resources (Figure 3). The IAD framework provides a theoretically rich lens for diagnosing, analysing, and prescribing contextual capabilities for common-pool resource management in relation to historical structural evolution (Ostrom, 2007a). This understanding is of particular significance to developing economy contexts where weak institutional structures are not adequate to align allocative and dynamic efficiencies and, therefore, lean more towards the requirements of industrial policy rather than competitive markets economics in maximizing social welfare (Levy & Spiller, 1993; Laffont, 1998; Greenwald & Stiglitz, 2013; Mayo, 2013).

Specifically, the IAD framework provides a diagnostic mechanism to identify combinatorial patterns between ecosystem elements' interactions under diverse governance arrangements (Ostrom, 2007b). The framework establishes these patterns by examining the nested attributes between a resource system, its units, and governance systems, as they affect the incentives of ecosystem players and the policy outcome effects on resource users over time. As the ecosystem evolves, emergent patterns are imperative for crystallizing adaptive policies based on critical ecosystem feedbacks. Hence, the IAD framework provides a nested mechanism for analysing ecosystem interactions and their outcomes beyond the immediate policy problem to ascertain the underlying cause-effect relationships within socio-ecological systems (Berkes, Folke, & Colding, 2000; Ostrom, 2007b).

Figure 3 conceptualizes the IAD framework for common-pool resource analysis (also known as the SES (social-ecological system), showing the interrelationships between the ecosystem sub-elements within an external socio-economic environment. While Ostrom initially developed the IAD framework for common pool resource analysis, the author extends this mechanism by adapting the framework for infrastructure policy analysis. Within the context of the thesis research, the resource system typifies the converging telecommunications market; the resource units include the Internet, telecommunication products and services, and network infrastructure; the governance systems typify the regulatory policies and institutional arrangements; and finally, the resource users, who are most

impacted by policy outcomes and action situations of ecosystem players (Ostrom, 2009). As stated before, this conceptual framework provided the basis for the analytical interrogation of the research questions and for the empirical assessment using the methodology that follows in the next section.

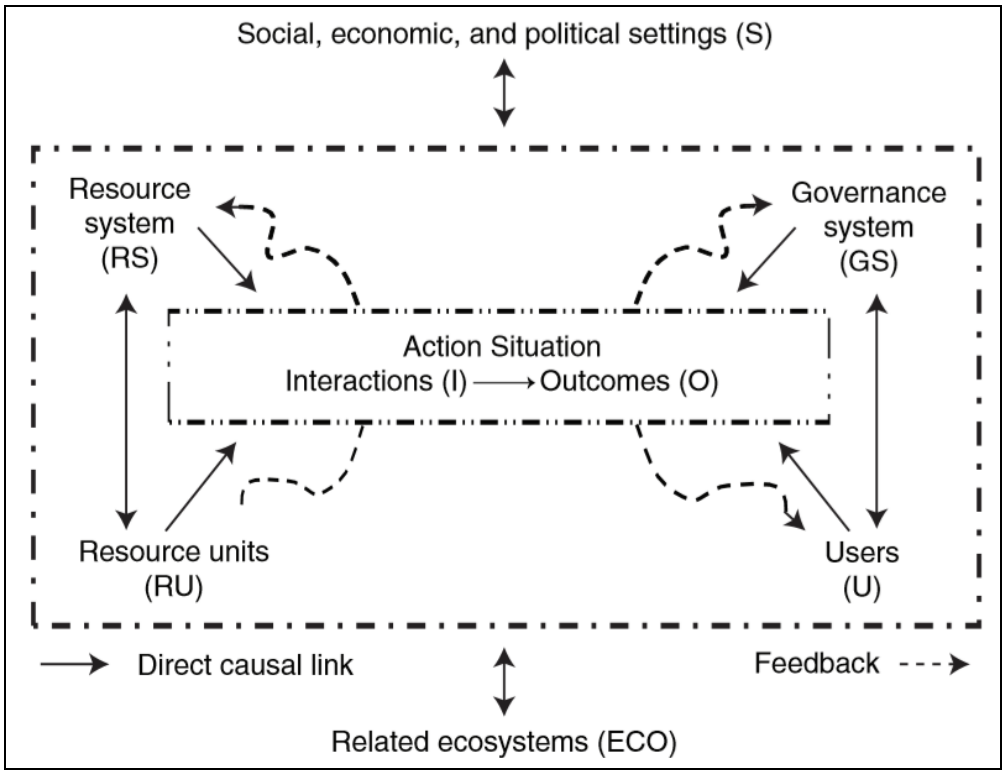


**Figure 3: IAD framework for common-pool resource analysis (also known as the SES (social-ecological system) framework; source: Ostrom (2010)**

### 3.5 Chapter Three Summary

This Chapter has established the imperative of a theoretical framework underpinned by complexity theory and the institutional analysis and development framework (IAD) as an appropriate research lens for interrogating the research questions within the domain of study. In particular reference to telecommunications policy, the theory of complex systems is found pertinent for addressing regulatory policy challenges concerning OTT-MNO competition dynamics because of the significant complementarities between the different value chain layers within the converged and more complex telecommunications ecosystem. More so, the author asserts that this qualitative theoretical evidence

is promising for understanding the adaptive substitutability effects created as a result of the complementarities for optimal market segmentation and definition, interrogating the complex interactions between ex-post competition law and ex-ante sector regulation, and providing a grounded basis for establishing plausible leverage points for optimizing policy trade-offs within a complex ecosystem for large scale impact.

The author clarified the IAD framework as an apt theoretical perspective for evaluating policy effectiveness or otherwise in initiating policy reform and designing alternative regulatory pathways within a unique institutional setting. Applying this theoretical framework for the generation of the conceptual model was established as imperative for competition policy assessment, specifically in resource-scarce environments, with respect to price structuration, as it plays a significant part in counterbalancing innovation and investment trajectories to avoid competition lock-in by dominant technologies. This conceptual framework provided the basis for the theoretical interrogation of the research questions stated above and for the empirical assessment using the methodology that follows in Chapter Four.

# Chapter Four: Research Design and Methodology

## 4.0 Introduction

This Chapter describes the research design, methodology, and methods for empirically interrogating the thesis' research questions. It encompasses the philosophical disposition of the researcher in the construction of knowledge from the collection and analysis of empirical data in relation to the research questions under interrogation. This philosophical perspective shapes the empirical framework for the thesis.

## 4.1 Research Design

The thesis adopted a single case study design. As knowledge in this domain is still very limited and conceptual, the study required an in-depth exploration of the phenomenon of interest in context (Yin, 2013). The case study approach is particularly heuristic for exploring new idea pathways within the unique case analysis (Mohajan, 2018). This research process comprised a country-specific cause-effect analysis of the regulatory challenges of OTT-MNO competition in the context of Nigeria's telecommunication industry and its imperatives for both innovation and investment policy outcomes. The process involved the assessment of the country-specific market structures and stakeholder ecosystem, as they are affected by the global ecosystem conditions. The author retrospectively carried out this process, elucidating the critical junctures of structural evolution for the country's telecommunications market and the path-dependent outcomes for alternative policy options using the process tracing technique. A detailed analysis of the competition regulation regime and supporting institutional arrangements for the mobile broadband market was carried out regarding the regulatory structures at both wholesale and retail levels, as they impacted innovation and investment in the telecommunications market.

## 4.2 Methodology

Complexity theory and the IAD analytical framework scholars recognize that socio-technical systems are embedded within contextual environments. Both co-evolve over time and must be considered in the empirical regulatory analysis (Polski & Ostrom, 1999; Bauer, 2004; ITU, 2018).

Therefore, the empirical focus of the thesis was an in-depth interrogation of the research question(s) in context. The author implemented this process as a reconstruction of history in mapping the market and regulatory policy developments that elucidated the complexities of the interrelating constructs under study and less on theoretical contestation or building. Therefore, the thesis methodology leaned more towards an inductive research paradigm within the confines of interpretive constructivism (Cresswell, 1998; Checkel, 2006). The principal attribute of the philosophical disposition of constructivism is that knowledge is fundamentally derived and shaped by the context and its stakeholder elements rather than exogenously generated (Delanty, 1997; Pouliot, 2007). In dialectical alignment, the constructivist reasons from an intrinsically historical perspective as the context of knowledge generation evolves rather than being determined statically (Adler, 2005). Complementarily, an interpretivist dimension infers knowledge from the contextually generated data with the added element of self-interpretation, in contrast to a purely positivist philosophical approach (Giddens, 1984; Neufeld, 1993; Jackson, 2015).

Within this purview, the author adopted a qualitative methodology for the study based on the nature of the research questions and the conceptual framework. The author assessed the current state of the market and institutional arrangements in Nigeria by analysing available secondary information from sector-specific reports of the NCC and data from the Research ICT Africa (RIA) *ICT Access and Use Surveys* to establish the current state of the telecommunications ecosystem. The underlying socio-economy of the country provided a context for the sectoral analysis.

The author applied the aforementioned methodological framework in conceptualizing the governance problem of OTT-MNO competition regulation in relation to social welfare to assess the underlying drivers of observable patterns — especially the invisible or unexpected ones (see Busetto, Wick & Gumbinger, 2020). Furthermore, the author used empirical tracing based on this method to substantiate insights from complex systems theory concerning the governance problem (Espinosa, 2016). The author considered this approach appropriate for interrogating complex or dynamic constructs with deeper comprehension (Golicic & Davis, 2012; O'Reilly, Paper, & Marx, 2012; Espinosa, 2016: 9), especially as the theoretical basis has scarcely been empirically tested by scholars in the domain of competition policy, and in particular relation to developing country contexts.

Data collection relied on semi-structured, in-depth interviews based on a purposive sampling strategy, in combination with archival data sources, to gain an in-depth exploration of the research questions. A sample scope of 30 interviewees was intended by the author (to ensure that representatives of all major ecosystem stakeholders were incorporated), out of which 25 interviews were successfully conducted, even though data saturation was reached much earlier, with no further new ideas of interest emerging (Glaser & Strauss, 1967; Francis et al., 2010; Saunders et al., 2018; Busetto et al., 2020). The interviewee sample comprised private players (including MNOs and OTTs), telecommunication policy experts, civil advocacy groups, research think tanks, and public policymakers within the mobile digital ecosystem of the country in context (see Ritchie et al., 2014). A detailed breakdown of the interviewee sample is given in Appendix 2 and was coded by the author to ensure anonymity and confidentiality. The purposive sampling strategy was focused on the conceptual fit with respondent experiences in relation to the research questions rather than demographic 'representativeness' (Miles & Huberman, 1994; Morse, 2012).

Interview questions were pre-tested using expert reviews to ensure higher levels of instrument validity while incorporating the branching and building technique where appropriate to enhance flexibility. Data collection using interviews was conducted online (constrained mainly by the COVID-19 pandemic restrictions) for seven months, from March through September 2020.[45] All interviews were conducted in English language, with sessions lasting about 45 minutes on average. Informed consent was collected using a signed consent form approved by the UCT Faculty of Commerce Research Ethics Committee. The sample consent form is depicted in Appendix 3. The author used an interview guide (Appendix 4) to facilitate the interviews to ensure consistency within the semi-structured interview design.

### 4.3 Ethical Considerations

Ethical concerns were put into consideration when collecting data from the study participants. The author adhered to the critical elements of informed consent, anonymity, privacy, confidentiality, and clarity of purpose to enhance respondents' confidence (Whiting, 2008) while adhering strictly to the

[45] A supplemental round of interviews was carried out, analysed and integrated into the dissertation in response to Examiner feedback in 2023.

overall protocols of research ethics. Furthermore, participants reserved the volition to discontinue the interview process at any phase (DiCicco-Bloom & Crabtree, 2006). As institutionally required, prior to data collection and analysis, the requisite approval from the UCT Faculty of Commerce Research Ethics Committee was duly obtained [REF: REC 2019/10/036].[46]

### 4.4 Coding, Data Analysis, and Validation

Interview data were recorded and transcribed immediately after each session in conjunction with interview notes. The transcribed data were then manually coded at both first and second thematic levels and merged into higher-level codes relevant to the research questions in an iterative process to generate the thematic categories explained in the findings section (5.4). The author details the Thematic Categorization in Appendix 5.

The interview findings were then triangulated with secondary policy reports and archival documentation in the traditions of Lounsbury and Ventresca (2002), Golicic and Davis (2012), and Charmaz (2014) to ensure convergent validation. The historical policy documents provided insights and information as supplementary research data for critical analysis, together with primary interview data for developing the case study. Notably, the historical sources provided a vital source for tracking substantial developments within Nigeria's telecommunications market in relation to the constructs under investigation and corroborating primary interview evidence or otherwise for further analysis (see Bowen, 2009).

The author validated the historical data sources internally and externally to reduce confirmation bias using source and internal criticism (Jonas, Schulz-Hardt, Frey, & Thelen, 2001; Kipping, Wadhwani, & Bucheli, 2014). This validating mechanism incorporated verifying the accurate source and authority of the historical reports and sense-checking the validity of the report contents in relation to the contemporary events that occurred within the same period in context. This approach facilitated contextual reflection on the exact and inferential meanings of the report contents and the accuracy of the references included in the reports (see Lune & Berg, 2017). Case study arguments were then developed qualitatively using a process tracing technique that is empirically outcome-explanation-

[46] This was also renewed for the supplemental interviews carried out in 2023.

focused and validated based on existing data evidence to understand the causal mechanisms between the domain constructs (Checkel, 2006; Beach & Pedersen, 2013).

Within this purview, process tracing is an increasingly adopted qualitative research design in policy research. The approach provides an interpretative methodological framework adopted in within-case research for in-depth analysis of causal mechanisms of alternative outcomes in historical frames (Bennett & Elman, 2006; Hall, 2006; Tansey, 2007; Vennesson, 2008; Kay & Baker, 2015; Mahoney, 2015; Norman, 2015; Trampusch & Palier, 2016; Lorentzen, Fravel, & Paine, 2017; Voltolini & Eising, 2017). This analytic technique is highly imperative when the research parameters and domain constructs are not adequately measurable quantitatively, considering the contextual perceptions of the actors involved, especially in under-researched policy domains. Operationally, it can be used by policy scholars to evaluate time-dependent historical observations that could predict concurrent choice-generating mechanisms (Schulte-Mecklenbeck et al., 2017). Methodical tools employed in the evidential analysis of processes, sequences, and conjunctures include archival documents and elite interviewing (Tansey, 2007; Bennett & Checkel, 2014).

This methodology is congruent with traditional policy research frameworks (Levy & Spiller, 1994; Gillwald & Stork, 2008; Kabanda & Brown, 2017; Kumi & Seidu, 2017) and critical in assessing rival explanations in social inquiry (Collier, Brady, & Seawright, 2010). The author leveraged the qualitative data generated from interview data analysis and secondary sources to examine propositions descriptively in a nested manner. This process explored the general and specific interrelationships of the research constructs within the Nigerian case, leading to the development of an ecosystem map (see Lieberman, 2005). The author implemented this process to optimally balance the trade-off between conceptual generalizability and empirical validity (Mahoney, 2010; Baker, Edwards, & Doidge, 2012). The author presents the data analysis and ecosystem mapping results in Chapters Five and Six.

### 4.5 Chapter Four Summary

This Chapter has elaborated on the research design, methodology, and methods that the author applied in empirically assessing the thesis' research questions. The author clarified that on the basis of the exploratory nature of the research questions and the theoretical framework imperative, a

single case study design was appropriated for the study, adopting a qualitative methodology that guided the data collection and analysis via a triangulated mechanism incorporating process tracing, semi-structured expert interviews, thematic coding and analysis, theoretical analysis, institutional analysis, and a comprehensive ecosystem mapping. In addition, the author duly incorporated research mechanisms for ensuring higher levels of outcome validity and ethical considerations within the empirical framework in providing the thesis findings, as detailed in Chapter Five.

## Chapter Five: The Case Study of the Nigerian Telecommunications Market

### 5.0 Introduction

This Chapter presents empirical evidence to answer the thesis research questions and build the case for optimizing competition and consumer welfare outcomes in Nigeria's converging telecommunications market. The Chapter begins by analysing the broader institutional context of the Nigerian telecommunications market. This assessment concerns the market structure and institutional arrangements in relation to resource governance mechanisms, policies, and processes. The author carried out the evaluation via a policy documents analysis approach. The author further assessed the policy processes and outcomes via a process tracing mechanism and further analysed them with respect to their cost-benefit imperatives. The Chapter then proceeds to present the findings from the high-level interviews. The author analysed these expert inputs based on the thematic categorizations of market segmentation, OTT-MNO market disruption dynamics, embedded regulatory structures, imperatives for investment and innovation, and implications for social welfare — identified in the data coding process in combination with the secondary policy documents data. The Chapter triangulates the above data in culmination with a conceptual analysis of the empirical findings drawing on complexity theory. The conceptual analysis is applied to the Nigerian telecommunications market within the broader digital ecosystem, encompassing the MNOs, OTTs, network infrastructures, processes, policies, applications, services, users, and other ecosystem stakeholders within the domain of study.

### 5.1 Institutional Analysis

The plausibility of the empirical analyses elucidated in this Chapter depends critically on their fitness to the contextual institutional setting within the country case for success or failure (Levy & Spiller, 1994). The Nigerian case is analysed institutionally within the context of telecommunications services (provided by both the MNOs and OTTs) as a public good. In relation to public goods analysis, this conceptual positioning centres the users at the core of the converged telecommunications ecosystem for the realization of demand-side policy interventions in addition to the more classical supply-side approach to telecommunications market developments (Gillwald, 2017). Within this purview, the institutional arrangements broadly refer to structural interactions

between the actor set — state and market (basically referring to market structure, which, in regulated sectors, is governed by a delegated/specialized agency or regulator). From a socioeconomic perspective, the analytical framework concerns state-market relations, interests, structure, and agency and how it ultimately affects the user within a unique socio-economic context. This understanding allows the author to adopt the IAD framework to interrogate the telecommunications ecosystem as a common-pool resource based on the following factors established by Ostrom (2011).

### 5.1.1 The Actor Set: Market Structure of the Telecommunications Industry in Nigeria

The telecommunications market in Nigeria began with the process of liberalization in 1992, leading to the participation of the first private telephone service provisioning by Multi-Links Communication Nigeria (MCN) in 1997. This arrangement was brokered as a partnership with the then state monopoly, the Nigerian Telecommunications Limited (NITEL), relying on the latter's national telephone grid system (Mawoli, 2009). Inevitably, the full liberalization of the country's telecommunication industry in 1999 and the consequent establishment of the Nigerian Communications Commission (NCC) as its regulatory body catalysed the deregulatory processes in the sector. This industry evolution began in earnest by the year 2000, following the resumption of democracy in the country in 1999 (Ojo, 2017). Following the privatization of the hitherto monopolistic NITEL, the NCC issued licenses to private telecommunication firms and Internet service providers. These new market players comprised both local and foreign consortia seeking to operate both fixed and mobile telephone services, as well as Internet-based telecommunication services in the country, opening up the competition landscape in the telecommunications market.

The privatization process divided the telecommunications industry in Nigeria into four sectors: fixed wired/wireless, code division multiple access (CDMA), global system of mobile communication (GSM), and voice-over-Internet protocol (VoIP). However, for significant market power (SMP) determination, the regulator still defined just two markets — mobile telephony services (including voice, SMS/text, and data connections) and international Internet connectivity (Koboldt, 2012). The ensuing competition grew the market exponentially from about 500,000 subscribers in 2002 to over 150 million in 2016 — emerging as the fastest-growing telecommunications industry in Africa and

one of the highest[47] globally (ITU, 2017; Ukpabi, Karjaluoto, Ikaba, & Piabari, 2017). Currently, subscriber statistics from the NCC for February 2023[48] indicate over 300 million connected lines and over 200 million active lines, with a teledensity (subscriptions per 100) of 119.01 (Table 4).

**Table 4: NCC subscriber statistics for February 2023.**

| February-2023 | Operator | Subscriber Stat. |
|---|---|---|
| | | |
| Active Lines | Mobile (GSM) | 226,835,732 |
| | Mobile (CDMA) | - |
| | Fixed Wired/Wireless | 96,766 |
| | VoIP | 247,448 |
| | Total | 227,179,946 |
| Connected Lines | Mobile (GSM) | 323,622,847 |
| | Mobile (CDMA) | - |
| | Fixed Wired/Wireless | 218,500 |
| | VoIP | 1,214,142 |
| | Total | 325,055,489 |
| | Teledensity | 100.56 |

A breakdown of the NCC subscriber figures as of February 2023 shows the absolute dominance of the mobile (GSM) category – having over 99% of the subscriber base (Figure 4)[49].

[47] In particular reference to market growth

[48] Accessed April 24, 2023: https://ncc.gov.ng/statistics-reports/subscriber-data

[49] Percentages indicated the % in relation to market subscription

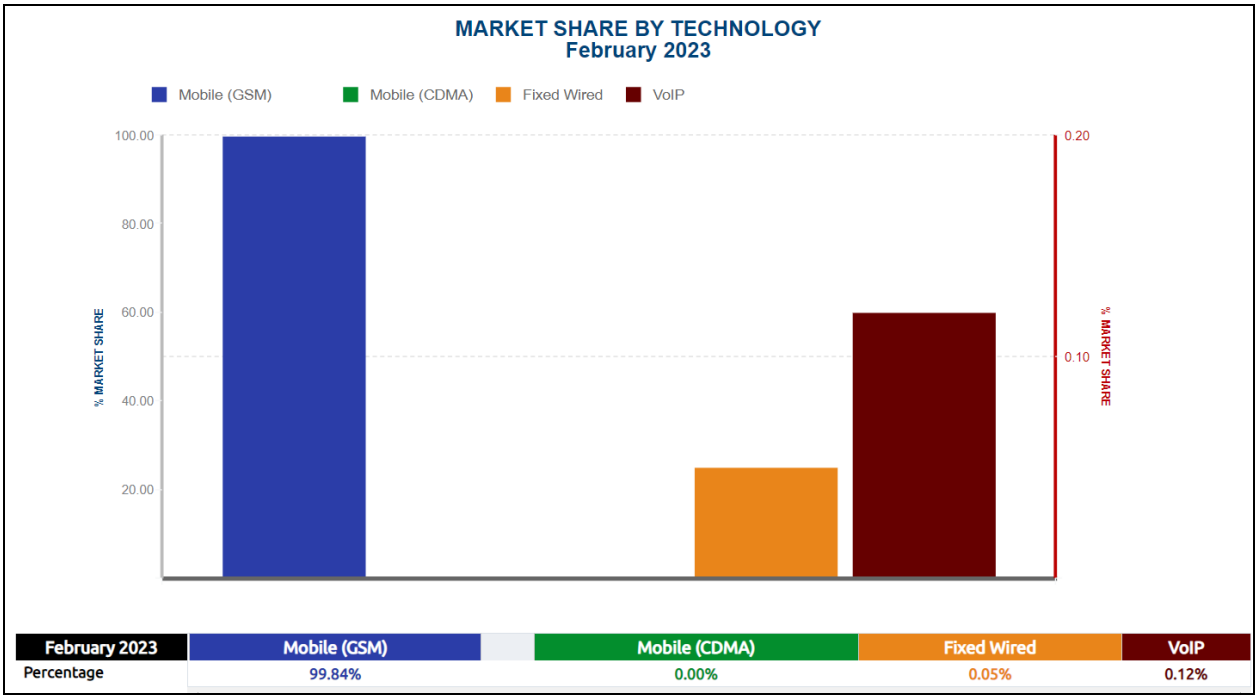


**Figure 4: Nigeria telecommunications market share by technology (February 2023). Source: NCC database[50]**

Concerning operatorship, the NCC statistics for March 2022 indicate that MTN continues to dominate the GSM category with more than 40 percent of the total subscriber base, followed by Globacom and Airtel at approximately 27 percent each, and EMTS (9mobile, formerly Etisalat) at around 6 percent. The author gives a breakdown of the total figures in Table 5. According to Hassan (2011) and Nkordeh et al. (2017), the dominant position of MTN is due to its first-mover advantage, being the earliest operator to build out infrastructure around the country, leading to the earliest capture of base subscribers. Since newer entrants had to share and pay for their infrastructure platforms, they have about the lowest interconnection rates across networks. In congruence with Pierson (2004), MTN's "first-mover advantage" crystallized the contours of engagement for competitors within Nigeria's telecommunications industry, setting positive feedback processes in motion to reinforce its dominant position in the market.

[50] Accessed December 2, 2021: https://www.ncc.gov.ng/statistics-reports/industry-overview#view-graphs-tables-4

**Table 5: NCC subscriber operator data for March 2022**[51]

| Operator | March-2022 |
|---|---|
| MTN Nigeria Communications | 75,177,563 |
| Globacom Limited | 55,881,893 |
| Airtel Nigeria | 55,370,983 |
| EMTS Limited (9mobile) | 12,770,917 |
| **Sub-Total (GSM)** | 199,201,356 |
| VGC/MTN | 7,462 |
| 21st Century Technologies | 94,236 |
| IPNX | 1,265 |
| Globacom Limited | 2,710 |
| **Sub-Total (Fixed/Fixed Wireless)** | 105,673 |
| Smile | 249,200 |
| Ntel | 2,311 |
| **Sub-Total (VOIP)** | 251,511 |
| **TOTAL** | 199,558,540 |
| % of Mobile (GSM) | 99.82 |
| % of Fixed/Fixed Wireless | 0.05 |
| % of VOIP | 0.13 |

### 5.1.2 Institutional Arrangements: Resource Governance Mechanisms, Policies, and Processes

This section analyses the evolution of resource governance mechanisms, particularly concerning pricing, within the Nigerian telecommunications industry via a policy documents review.

#### 5.1.2.1 Pricing Policy within Nigeria's Telecommunications Industry

The inefficiency of Nigeria's moribund national telecommunications monopoly — Nigerian Telecommunications Limited (NITEL) — to cope with the increasing developmental requirements of the country led to a reform in the government's competition stance within the country's

[51] Accessed April 24, 2023: https://ncc.gov.ng/statistics-reports/subscriber-data#quarterly-subscriber-operator-data

telecommunications industry (Udechukwu & Maguire, 2006). This developmental need and dwindling government funds for sustaining public enterprises were the key drivers that necessitated the deregulation of the Nigerian telecommunications market in 1992 via the promulgation of the Nigerian Communications Commission (NCC) Decree, No. 75 of 1992 (Jerome, 2002). This mechanism led to a massive inflow of foreign and local investments into the market with increased competition (Ndukwe, 2005). Before this phase, the country had a total teledensity of 0.4 lines per 100 people. This teledensity was concentrated in corporate and public offices, connecting about 25,000 analogue mobile phone lines and 400,000 telephone lines, with no significant access in rural hinterlands, underpinned by an infrastructure base that was highly inadequate with limited investment (Hassan, 2011). There were more than 500,000 waiting subscription applications, reflecting a weak capacity utilization of resources by NITEL (Jerome, 2002). The reform process in Nigeria's telecommunications industry culminated in the auction-based licensing of four GSM network operators in 2001 and the introduction of facility-based competition into the telecommunications market by the Nigerian Communications Commission (NCC) within a proportionate ex-ante regulatory framework in facilitating market access for broadband services (Koboldt, 2012).

Regarding pricing, before the commercialization era, NITEL's tariffs were priced below business costs on a rate-of-returns model. The Utilities Charges Commission determined this tariff based on a monthly fixed access charge and a distance-dependent pulse rate (calculated as the total cost plus mark-up margin divided by the total number of lines). This pricing model led to an inefficient bias towards capital investment and engendered cross-subsidization of costs from competitive to unregulated services (see Galal & Nauriyal, 1999; Jerome, 2002).

In the contemporary market environment, the NCC tariff guidelines stipulate a cost-based approach prohibiting cross-subsidization, with exceptions only to promote universal access. According to the agency, this pricing model was intended to help generate sufficient revenues for telecom operators (see World Bank, 2007). This pricing model meant that the tariff for data services became expensive, especially in the wholesale segment. According to estimates by Gillwald, Odufuwa, and Mothobi (2018), wholesale bandwidth data service tariffs range from about USD300/Mbps to USD500/Mbps. With the pricing strategy by the operators aimed at encouraging more consumer data usage, effective data tariffs are reviewed downwards frequently and have been a potential target

market for discriminatory cross-subsidization schemes based on negotiation (Gillwald et al., 2016). This pricing strategy contrasts with the relatively lower pricing regime in Nigeria's mobile retail segment, where the country ranks 6th out of 49 countries in sub-Saharan Africa in terms of the affordability of prepaid mobile products with reference to a mixed basket pricing methodology according to RIA's Africa Mobile Pricing (RAMP) Index (Gillwald et al., 2018).

A regulatory intervention within this purview in deference to consumer welfare and market competition was the introduction of price cap regulation by the NCC in 2013 with more stringent requirements in the wholesale segment (Okom & Enyia, 2018). The agency saw this policy regime as a significant improvement on the rate-of-returns pricing model with optimal incentives for further market investment and innovation (see also Bauer & Bohlin, 2008). With Nigeria's telecommunications market maturing, there has been a continuous consumer shift from traditional GSM services to data bundles that allow cheaper over-the-top (OTT) services. This market evolution has generated increased competition among telecom operators in delivering more affordable voice and Internet data services, resulting in revenue decline over time. Consequently, smaller players in the country's telecommunications industry are being skewed out of the market, leading to increased concentration and market dominance of few players. The competition price effect was further exacerbated in the market when the NCC in 2015 cancelled the proposed floor price regime on mobile data services, which it said was to "deepen the growth and development of data services in the country" (Vanguard, 2015), as well as improve market competition (Gillwald et al., 2016); albeit making a flexible proviso for the floor price restoration if the consequences of its removal were not in favour of consumer welfare in relation to price shifts (see Gillwald, Odufuwa, & Futter, 2016). The short-term impact of the price floor policy as a consequence of the stifling data market competition was that Internet access for consumers became a lot cheaper with an increase in online activities and the rise of online platform startups. However, on the downside, quality of service (QoS) continued to trend downwards as the increase in broadband traffic did not match the existing telecommunications infrastructure.

In another contrasting market development, a proposed increase in mobile data tariffs by telecom operators in Nigeria in 2016, which the NCC had earlier approved, was denied by the Ministry of Communications, citing consumer protection, in contravention of the tenets of independence for the agency from the Ministry as enshrined in the NCC Act 2003 (Chapter III, Part 1, Sections 24-

25). The regulator had supported the data tariff increase on the premise of protecting consumers and smaller telecom operators from market tendencies toward data pricing monopoly (as there was the possibility that the fierce data price competition would result in consolidation towards monopoly). The Association of Licensed Telecommunications Operators of Nigeria (ALTON) has described the current pricing regime as unsustainable. According to them, their position was to the effect that consumers would suffer in the long run if operators were "unable to recover the cost of providing data services and reinvest in capacity expansion to accommodate the increased usage arising from lower tariffs" (see Alan Burkitt, 2016). While the resultant data bundle prices in Nigeria remain among the lowest in sub-Saharan Africa (see Mothobi, Gillwald, & Rademan, 2018), they are priced by operators below actual costs. Although this might benefit consumers temporarily, the overall negative impact on the industry might impede consumer welfare in the long run, especially with the tendency of concentration to increase prices drastically in the long run.

#### 5.1.2.2 Policy Documents Review – Nigerian Telecommunications Industry

This sub-section analyses the critical policy documents in relation to Nigeria's telecommunications industry and provides indicative policy prognosis with respect to the relevant concerns of competition, innovation, and investment as they impact social welfare within the market.

##### 5.1.2.2.1 Background Context

The 2012 Nigerian National Information and Communication Technology (ICT) Policy is a harmonization of existing policies in the country's ICT industry, intending to guide the sector's efficient development in the face of global technological evolution and market convergence. In this purview, the primary objective of the National ICT Policy is to facilitate an enabling regulatory environment for the ubiquitous build-out and access of ICT networks and broadband services (voice and data) in the country at reasonable pricing. Concerning this universal access objective, the situational analysis for the country indicates that, like in many developing countries, significant segments of the country's population are still underserved or unserved, especially in rural areas. This situation requires critical regulatory intervention on both the supply and demand sides to incentivize network infrastructure investments in the industry, even with increased competition in the liberalized ICT market. In this regard, a strategic provision of the National ICT Policy is the enhancement of equitable distribution of the value of telecommunications infrastructure amongst

the active stakeholdership, as they interrelate within the Nigerian telecommunications ecosystem, especially regarding system bottlenecks across all market layers. Concerning an appropriate institutional arrangement to foster the realization of the objectives of the National ICT Policy, the document specifies a converged regulator to administer the overall ICT regulatory regime by encouraging and protecting investments in the sector within a fair and competitive market environment. The converged regulator will do this by guaranteeing equal market access to all participants and balancing regulatory concerns of market stakeholdership, especially concerning pricing structures.

To promote the implementation of the national telecommunications policy, the Nigerian Communications Act 2003 (NCA 2003) was created to establish an independent regulatory authority — the Nigerian Communications Commission (NCC). Aside from promoting investments and fair competition in the country's ICT market, the Act also aims to encourage the development of innovative services in the market following global trends and protect consumers' welfare against unfair pricing practices while safeguarding the national interests. It hopes to achieve this requirement by protecting network infrastructure and services from market power abuse by infrastructure and service providers in a non-discriminatory manner. According to the Commission's 2017 Internet Industry Code of Practice in Support of Net Neutrality[52], "an Internet Access Service Provider shall not engage in paid prioritization under any circumstances." Exceptions provided in the code that may permit "reasonable" network management practices are stipulated thus (Pg.7):

1) *In order to preserve the integrity and security of the network, of services provided via that network, and of the terminal equipment of Internet users;*
2) *In order to prevent impending network congestion and mitigate the effects of exceptional or temporary network congestion, provided that equivalent categories of traffic are treated equally;*
3) *In order to comply with a legal instrument, court order, or regulatory obligation.*

In line with the provisions of the code, "reasonableness" in this context shall demonstrate the following characteristics:

a. *There shall be a legitimate and demonstrable technical need for the practice;*
b. *The practice shall have a specific and stated technical goal;*

[52] Accessed May 5, 2023: https://ncc.gov.ng/docman-main/internet-governance/878-internet-code-practice/file

c. *The effect of the practice shall be proportional to the need it intends to address and considered a reasonable effect by the majority of end-users;*
d. *There shall be full disclosure with regard to the practice in a manner that is sufficient for end-users to form an informed opinion on whether, when, and how the practice will affect their service.*
e. *The practice shall be based on techniques approved by the Commission.*

Therefore, regarding the economic regulation of competition practices in the market, the Act empowers the regulatory agency to counteract significant lessening of competition within relevant telecommunications markets in relation to global dynamics, especially as it relates to pricing structures and their impact on services provisioning. In this respect, the Act stipulates the adherence to international organizational principles[53] of fairness, non-discrimination, and the elimination of cross-subsidies that may lessen the competitive opportunities of other providers; these will be in order not to disincentivize investments in the telecommunications industry. This provision is in tandem with the country's National Information Technology Policy (NNPIT, 2001: iv) — which has two critically related objectives in this context:

1. *To create an enabling environment and facilitate private sector (national and multinational) investment in the IT sector; and*
2. *To establish an appropriate institutional framework to achieve the goals stated above (also a key activity area of the Nigeria ICT Roadmap 2017-2020)*

Within this purview, the National Telecommunications Policy also stipulates that competitive market forces would be the principal determinant of appropriate pricing to guarantee the highest levels of market sustainability for consumer welfare (Oki, 2014).

#### 5.1.2.2.2 Policy Analysis

This background indicates that the Nigerian telecommunications policy framework tells us little about the emerging competition policy concerns in relation to two-sided telecommunications markets. Therefore, it is inadequate to understand the complex interrelationships between pricing, investment, and innovation in two-sided telecommunications markets as they affect social welfare. Hence, the reality of market evolution and its attendant complexity of the ICT ecosystem and institutional arrangements mean that the extant policy framework in Nigeria's telecommunications sector needs critical adaptations to the current state of the market. This requirement is imperative if

[53] Nigeria is a member of the United Nations (UN) and the World Trade Organization (WTO) and therefore committed to adhere to the respective principles.

the social welfare effects of technological advancements in the industry are to be maximized while minimizing unintended consequences of the new market dynamics. In adapting the regulatory processes and institutional arrangements in this regard, the regulatory environment might benefit from a unified policy approach. The proposed approach integrates both the basic policy design (in this case — institutional mechanisms and structures for regulatory constraints and discretion concerning competition policy in Nigeria's multi-sided telecommunications market) and the detailed design (rules that govern the interrelationships between the critical market elements — in this case pricing structure, investment, and innovation in the multi-sided telecommunications market as they affect social welfare). As the basic policy design is fundamental to the performance of the detail design (Levy & Spiller, 1994), there is a critical need for a basic policy design that constrains discretionary pricing structures. This requirement is in order not to disincentive investments into the industry. Still, it should also be flexible enough not to hamper innovation — a critical source of competition in information technology markets.

Considering the emerging market structure of the Nigerian telecommunication industry, there is a need to review the regulatory pricing model so that the correct mix of incentives enhances competition in the multi-sided market. This proposition aims to facilitate the maximization of users' social welfare, uninfluenced by market distortions that arise due to imperfect competition. These market distortions, for instance, might occur when an incumbent's price structure is not reflective of the cost base or constrained by static regulation of non-discriminatory pricing across different geographic locations (Mason and Valletti, 2001). Unlike in some traditional markets, in multi-sided markets, prices are also influenced by demand-side conditions, not just cost. This pricing mechanism is challenging in market segments where incremental costs are low or zero (i.e., all costs are fixed within the market). A rule that prices should be more cost-oriented will fail in that context. This challenge is significant contextually, considering that the telecommunications market in Nigeria is still in its early stage of market liberalization. Within this phase, pricing regulation is fundamental to accelerating dynamic regulation in retail and wholesale markets. Addressing this constraint will be essential for sustaining innovation in core segments of the telecommunications industry — such as the mobile market — and engendering significant infrastructure investments in next-generation network expansion across the country with a lower degree of risk and uncertainty.

Regarding market contestability beyond market structures and shares, pricing regulation would benefit from considering the efficiency of entry and exit conditions within the evolving telecommunications market (see Baumol, 1986; Bauer & Bohlin, 2008). As obtainable within Nigeria's telecommunications market, the entry of the OTT service providers is mainly free, and their exit is essentially costless with regard to production and service quality relative to market incumbents. This situation creates an opportunity for low-cost and sometimes zero-pricing strategies by market entrants, especially when room for cross-subsidization exists. This condition becomes even more agonizing considering the uncertainty associated with the incumbents' high sunk costs of network investments. With this constraint in a multi-sided market, price differentiation for dynamic break-even above incremental costs becomes almost impossible. This market condition is because new entrants may force market incumbents into non-competitive pricing below incremental costs even with the prospect of services bundling (as they may not be able to leverage these complementary services more efficiently than the new entrants). If left unregulated, this does not bode well for future infrastructure investments, as it is within a dynamically efficient market.

In a perfect market, two regulatory options suffice — an unrestricted or regulated pricing regime for OTT entrants to the mobile telephony market or a hybrid of both options. On the one hand, the first option can create an equilibrating price effect on consumer welfare both in the long and short term — achieving both static and dynamic efficiencies with respect to product innovation (Blees et al., 2003). On the other hand, a regulated pricing structure for OTT players in Nigeria's mobile telephony market poses a significant barrier to entry for players. It may also lead to higher prices and/or lower product innovation — which is detrimental to social welfare (see Oladipo, 2014). Therefore, a regulatory trade-off that optimizes static and dynamic efficiency is imperative in balancing both positions. This requirement is even more significant considering the sunk investment costs (infrastructure and licensing) of mostly tenure-based incumbents in order not to disincentivize further new-generation infrastructure investments critical for ubiquitous broadband access. In promoting competition, therefore, all players (incumbents and entrants) within the market segment should be subject to similar regulatory commitments ab initio before allowing market forces — hinged on unique firm efficiencies and scale advantages — to determine market outcomes.

#### 5.1.2.2.3 Indicative Policy Prognosis

In proffering reform pathways for addressing the pricing regulation challenges highlighted concerning Nigeria's evolving telecommunications industry in the more complex digital era, the NCC needs to design a tariff regulation regime that facilitates a dynamically efficient market in such a way that social welfare is maximized both in the short and long terms. This requirement is critical as future market competition conditions will shape the innovation and investment incentives of incumbent telecommunication networks and new entrant OTT service providers in the Nigerian market. Within this purview, what regulatory approach the regulatory authority takes, or even a no-regulation approach, will have significant imperatives for a workable or non-workable competitive market state concerning investments and innovation on both sides of the market. This provision will depend on the degree of risk aversion in relation to the institutional arrangements within which the regulatory agency operates. Furthermore, with the changing technological landscape, there may be a need for a market re-classification of broadband access services predominantly within the mobile market segment with regard to determining price discrimination effects in relation to inter-modal competition regulation in the public interest.

### 5.1.3 Policy-Process Outcomes

This section traces the policy evolution within Nigeria's telecommunications industry, in particular, with respect to pricing mechanisms and structures and the cost-benefit analysis of policy actions and outcomes.

#### 5.1.3.1 Process Tracing of Pricing Policy Evolution in Nigeria's Telecommunications Industry

The author traces the policy evolution within Nigeria's telecommunications industry between the timeline of critical historical events as the market ecosystem transits from the pre-deregulatory juncture of the 1990s to the more recent pricing regime as of 2019, highlighting the essential policy mechanisms and their outcomes.

**5.1.3.1.1 Timeline of Historical Events (1992 – 2019):**

*1992* Promulgation of the Consumer Protection Council Decree (Jacob-Obi, 2018)
*1999* Nigeria Subscriber Statistics – total fixed telephone lines: < 400,000; Internet users - < 200,000 (FRN, 2012)
*1999* Private investments in the telecommunications sector: US$50 million (FRN, 2012)
*2000* Full liberalization and deregulation of Nigeria's telecommunications Industry (FRN, 2012)
*2000* Adoption of National Telecommunications Policy (FRN, 2012)
*2001* Inception of Global System for Mobile Communication (GSM) in Nigeria (Okonji, 2018)
*2002* Deregulation of the Nigerian Telecommunications Sector (Jacob-Obi, 2018)
*2003* Enactment of Nigerian Communications Act, 2003. FGN Official Gazette, 62(90).
*2004* Subscriber Statistics – Total connected mobile lines: 9,174,209 (NCC Database1)
*2006* The NCC introduced the Unified Access Service Licenses (UASLs)
*2010* The NCC introduced price cap regime in the telecom sector
*2010* Emergence of OTTs in the Nigerian Telecommunications Market
*2010* Telecom operators began selling off parts of their network infrastructure to third parties
*2013* Inauguration of the Nigerian National Broadband Council (NNBC) (Shittu, 2017a)
*2013* Launch of the Nigerian National Broadband Plan (NNBP) 2013 - 2018 (FRN, 2017)
*2013* Broadband penetration: 6%; projected by the NNBP to reach 30% by 2018 (Shittu, 2017b)
*2013* Initiation of the cost-based pricing model and wholesale price cap regulation by the NCC; definition of open access framework (NNBP, 2013)
*2013* Competition assessment of telecom operators: the NCC identified MTN and Globacom as dominant players in the voice and data segments, respectively; regulatory obligations imposed with the removal of on-net and off-net disparity to ensure fair pricing (New Telegraph, 2018)
*2013* NCC introduced a price floor for voice calls (Oluwanifemi, 2020)
*2015* NCC announced the withdrawal of floor price on all data products in Nigeria (Gillwald et al., 2016)
*2017* Launch of the Nigeria ICT Road Map 2017 - 2020 (FRN, 2017)
*2017* NNBP was reviewed (Shittu, 2017b)
*2017* ICT Infrastructure: 50,000 base stations; still requires 70,000 to 80,000 base stations to substantially cover the base market (Shittu, 2017a)
*2017* Broadband penetration reaches 11% (Shittu, 2017b)
*2017* Approval of the stakeholder consultation on the establishment of an Internet industry code of practice by the NCC (Shittu, 2017c)
*2017* Private investments in the telecommunications sector: US$32 billion (FRN, 2012)
*2017* Subscriber Statistics – Total Internet connections: 97 million (FRN, 2017)
*2017* Establishment of Internet Industry Code of Practice in support of net neutrality by the NCC (NCC, 2017)
*2018* Subscriber Statistics – Total connected mobile lines (i.e., GSM and CDMA): 242,925,907; Total active mobile lines: 162,524,912 (NCC Database2)
*2018* NCC adjudges that regulating OTTs would stifle innovation in the telecom industry, citing also corresponding externality of increasing data consumption (a service provided by the traditional operators), despite forecasts by UK analyst firm – Ovum – that their adoption by Telco subscribers would engender a $386 billion global revenue loss from 2012 to 2018 for

the traditional operators, endangering investments for next-generation access network development (New Telegraph, 2018)

*2018* NCC validates the findings from the Commonwealth Telecommunications Organisation (CTO)'s OTT study, asserting the imperative of establishing novel regulatory approaches to addressing peculiar challenges in the Nigerian context (Communications Week, 2018)

*2018* NCC appoints KPMG as Consultant for the determination of cost-based pricing for retail broadband and data services in Nigeria (NCC, The Communicator 2018)

*2019* President Muhammadu Buhari assents to the Federal Competition and Consumer Protection Act 2019 (Vanguard, 2019)

#### 5.1.3.1.2 Trace Mechanism

For the process tracing analysis concerning Nigeria's telecommunications market, the author adopted an outcome-explanation focus based on context-specificity to interpret the causal mechanisms linking pricing policies and their complementary outcomes (see Beach & Pedersen, 2019). This analysis framework is as summarized in Figure 5.

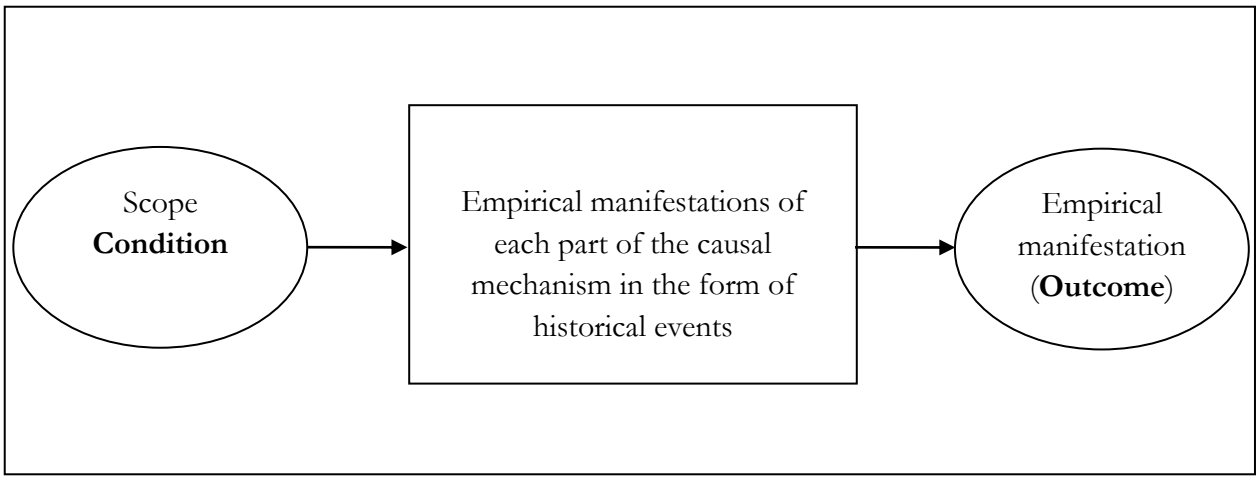


**Figure 5: Empirical mechanisms in explaining outcome process tracing.**
**Source: Adapted from Beach and Pedersen (2019)**

Based on the scope condition of the pricing evolution in Nigeria's telecommunications industry as punctuated by the timeline of events given in section 5.1.3, the author elucidates the following critical trace mechanisms:

- (2000) Liberalization/deregulation (led to) ⟶Opening up of competition for mobile and fixed telephony and Internet services
- Pricing policy evolution amidst uncertainty:
  - (Pre-deregulation) NITEL's rate-of-returns pricing structure
  - (2010) The NCC introduced price cap regime in the telecom sector
  - (2013) Initiation of the cost-based pricing model and wholesale price cap regulation by the NCC
  - (2015) NCC proposes, then withdraws the proposed floor price regime on mobile data services
- (2013) Competition assessment (Telco dominance)⟶ Removal of on-net/off-net disparity ⟶ Introduction of price floor for calls
- (2017) Continuous consumer shift from traditional GSM services to data bundles that incorporate cheaper over-the-top (OTT) services⟶ (led to) intense price competition among telecom operators in voice and Internet data

**5.1.3.1.3 Trace Outcomes**

- (2000) Opening up of competition for mobile and fixed telephony and Internet services⟶ (led to) Increased network capacity and coverage:
  - Increase in private investments in the telecoms market in Nigeria
  - Increase in aggregated number of connected lines and teledensity in Nigeria
  - Growth in Internet users and broadband penetration in Nigeria
    - From the period upward 1999, Nigeria subscriber statistics showed a dramatic increase from a total fixed telephone lines record of just under 400,000 to a whopping 9,174,209 connected mobile lines in 2004 and a geometric increase to 242,925,907 in 2018 with a comprehensive active mobile line record of 162,524,912 (Figure 6), with teledensity scaled from a paltry 0.04 in 1999 to 96.76 in 2019 (Figure 7). Correspondingly, the Internet user numbers significantly shifted from less than 200,000 in 1999 to a massive 97 million total Internet connections by 2017, with a current broadband penetration of over 30%. Likewise, private investments in Nigeria's telecom sector grew from about US$50 million in 1999 to over US$32 billion as of 2017.

- (2010) OTT emergence intensified competition ⟶ leading up to the sale of parts of network infrastructure by Telcos

- (2013) NCC cost-based tariff structure ⟶ Data services became expensive, especially in the wholesale segment
- (2015) NCC withdrawal of floor price regime on mobile data services ⟶ drastic downward revision of data subscription plans (in reference to prices) by MNOs.
- (Pre-deregulation to 2015) The net effect of an uncertain regulatory environment [pricing ⟶ policy] Stalled growth in Nigeria's telecommunication sector (Q2 – Q3 2017, see Figure 8); delays/deferrals of network expansion and upgrades
- (2017) Intense price competition among telecom operators in voice and Internet data as a consequence of consumer shift towards OTT services ⟶ Market dominance amplification

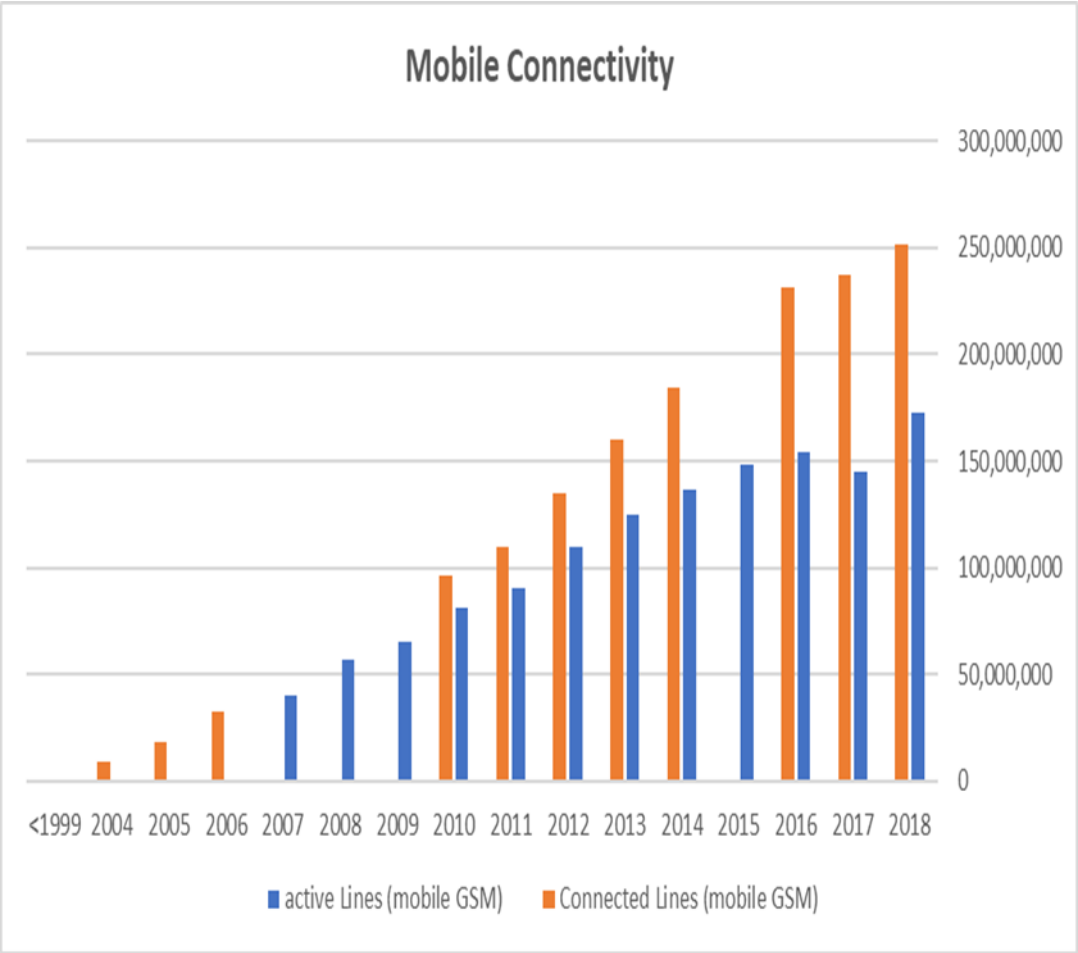


**Figure 6: Mobile connectivity trend in Nigeria Pre-1999 – 2018. Source: NCC Database**

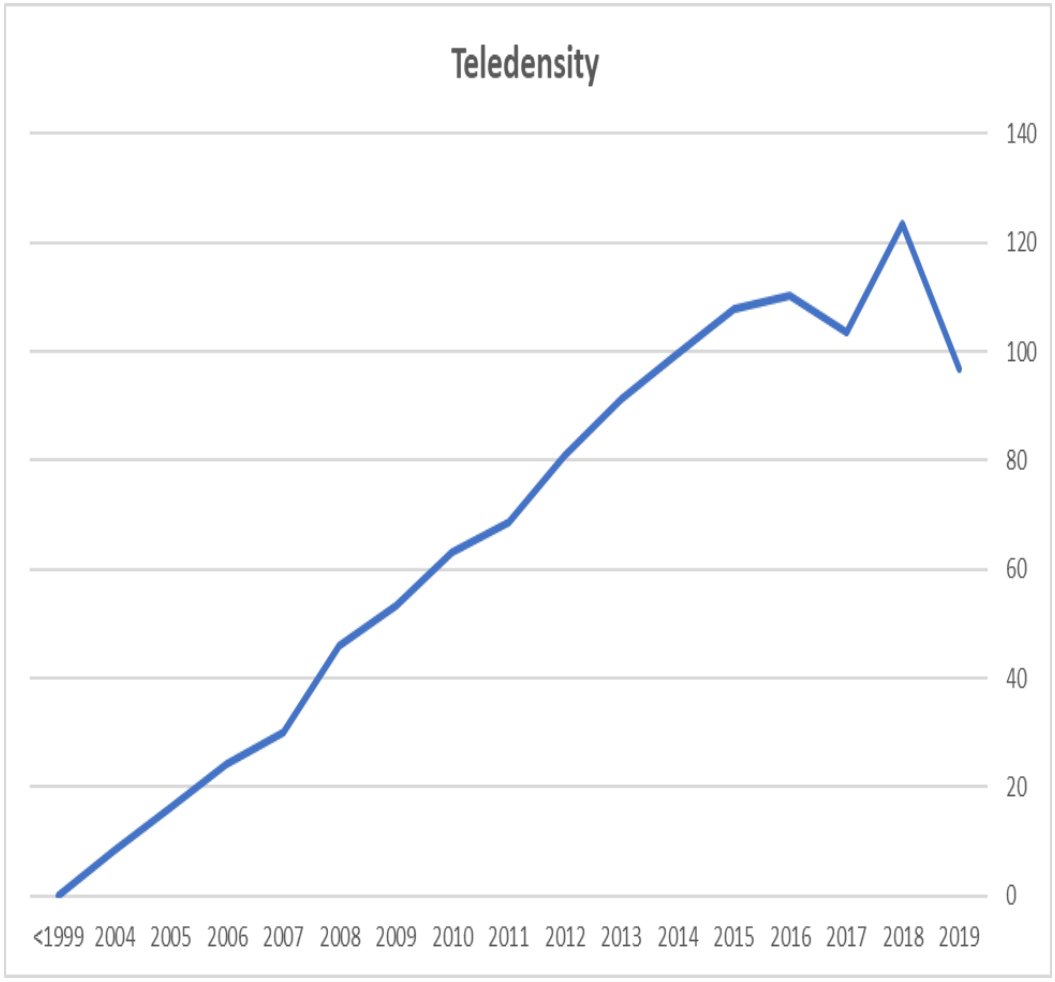


**Figure 7: Teledensity trend in Nigeria Pre-1999 – 2019. Source: NCC Database**

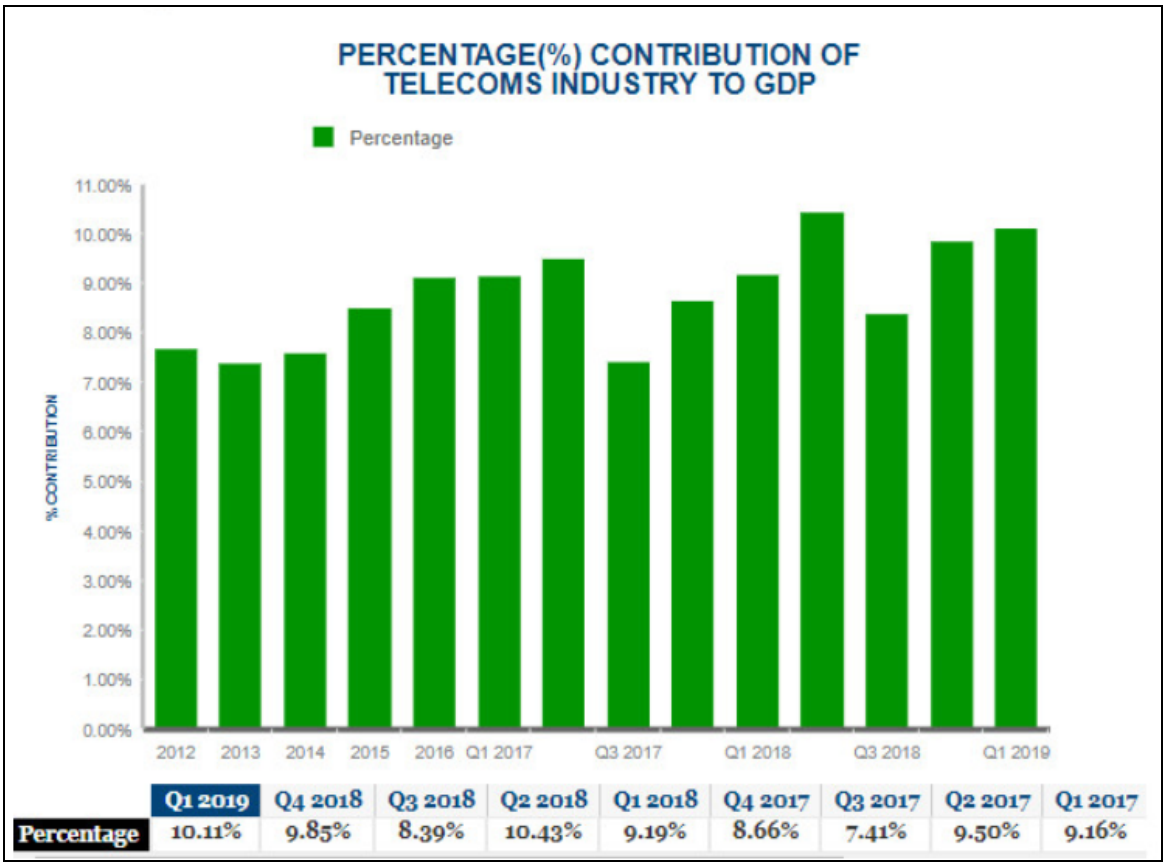


**Figure 8: Growth trend of Nigeria's telecommunications sector (2012 – 2019). Source: NCC Database**

### 5.1.3.2 Cost-Benefit Analysis of Policy Actions and Outcomes

This sub-section analyses the economic efficiency implications of policy actions and their outcomes within the Nigerian telecommunications industry, particularly their static and dynamic efficiency effects, as well as the redistributional equity for social welfare as the market evolves sustainably in the long term.

#### 5.1.3.2.1 Foreground

The partial liberalization of the state-run NITEL in 1992 resulted in network upgrades, modernization of its telecommunications services, and increased profitability (Jerome, 2002).

Nevertheless, this traction was not sustained as the telecommunications industry remained under-invested with great unmet demands, leading to full liberalization and privatization in 1999. With respect to pricing, after the privatization of NITEL, there was a continued upward review of service tariffs, which had remained stagnant before the commercialization era. Within the full liberalization era, the enhanced competitive environment of the telecommunications market necessitated the current cost-based pricing regime to guarantee increased access and availability of new-generation networks.

In the context of OTT regulatory imperatives, while potentially driving increased demand for data services and, consequently, revenues, there have been calls by traditional telecommunications operators to regulate OTT services within the country's converging telecommunications market. This market challenge is even more imperative for the mobile segment, where substitution of traditional telecommunications services is rife in the predominantly pay-as-you-go markets of developing countries (Stork, Calandro, & Gillwald, 2013; Gerpott, Thomas, & Weichert, 2014). Therefore, arguments in favour of regulatory intervention have the potential to inhibit access growth in these regions, especially in underserved rural areas, leading to an increase in the digital divide (Ogbo, Brown, & Sicker, 2017). So, in resource-constrained environments — where affordable mobile connectivity is a critical access factor — there are counterarguments against regulatory intervention in this seemingly positive price discriminatory practice by the MNOs in response to OTT market entry (Gillwald, 2017).

In the Nigeria case, OTT competition has been identified by some scholars as the main factor for revenue losses in the telecommunications market and a significant factor for lower network infrastructure investments since 2017 (Adaramola, 2018; Fowora et al., 2018). This proposition has fuelled the arguments for regulating OTT services in Nigeria. However, some other experts argue that, on the converse, network operators across Africa (including Nigeria) have benefited from significant revenue growth as a result of OTT-induced mobile broadband adoption. This other proposition is based on the ramp-up in operator data revenues, which, according to them, fully compensates even beyond any losses experienced by them in both the voice and SMS market segments (Esselaar & Stork, 2018). In this regard, this latter school of thought proffers adopting flat access pricing structures that bundle in OTT services as a competitive path forward for network

operators. According to its proponents, this condition transforms the OTT-Telco relationship from a partially substitutable model to a complementary one (Jirakasem & Mitomo, 2019).

Nevertheless, there are counterarguments against this proposition. According to Steingröver, Larrea, and Zhelev (2019:241), "*This model is the kiss of death for traditional Telco services for which the consumer has to pay on a per-use basis, but which offer no apparent advantages over their free alternative*." Instead, the scholars propose a supply-demand model that balances prices with volume usage to equalize OTT competition effects and ensure that incentives for infrastructure investment are supported. The author posits that regulatory impediments and norms (such as net neutrality) to having these competition conditions, as highlighted above, should be analysed in the context of changing market environments, considering consumers' willingness to pay. As currently obtained in the Nigerian market, the NCC continues to maintain a neutral regulatory position in favour of the OTTs, basing their position on consumer welfare sentiments within a competitive capitalist market.

#### 5.1.3.2.1.1 Economic Efficiency (static and dynamic): Net Surplus of Resource Allocation with a focus on Investment and Innovation

Nigeria is undergoing significant socio-economic development due to the convergence (entailing both innovation and infrastructure investments) between traditional mobile telecommunications and more recent broadband-driven OTT communication services — the latter a key driver for increased Internet adoption and usage. With relatively inexpensive data pricing in Africa (although still not affordable for a large segment of the population), Internet access has been enabled via mostly free OTT substitutes for the more expensive voice and text mobile services offered by the telco operators. However, the affordability problem reinforces the digital inequality paradox between those with access and the means to use these substitute services and those who are marginalized from accessing them, as broadband services with appreciable quality of service remain clustered around major city centres that are considered commercially viable.

According to Gillwald (2017), this high cost of access is due to policy-induced impediments[54] that constrain effective regulation of the telco operators and the OTTs, producing sub-optimal

[54] Mostly due to problematic institutional arrangements, lack of capacity and market structuring.

competitive outcomes (see also Levy & Spiller, 1997). Therefore, for the Nigerian telecommunication ecosystem to maximize the positive externalities associated with broadband infrastructure investments, this access constraint needs to be bridged beyond the technical network measurements to encompass more broadly the ecosystem components of services, applications, and the devices that carry these concerning the users. Even with the drastic reduction of international bandwidth prices with the increasing competition intensity in the wholesale market, this benefit has still not trickled down to the consumers at the retail end of the market as a result of high-cost domestic IP transit as operators shift their legacy network infrastructure to all-IP digital platforms (Gillwald & Calandro, 2013).

In resolving the policy challenge of access as highlighted above, while pricing and the correlated consumption levels are categorized economically as static efficiency factors, the complementary factors of innovation and investment are dynamic and more complex to redress. A plausible policy pathway (efficiency trade-off) for the Nigerian ecosystem will be adopting an open-access competition regime from data to network infrastructure (within a structurally separated governance arrangement) to enable investment and innovation on both market sides — telecom operators and OTTs, respectively.[55] The rationale for this position is that the critical supply-side adjustment will ultimately impact positively on the demand side, as intensified competition will drive down pricing with consequent affordability and consumption implications (see Smith, Elder, & Emdon, 2011; Gillwald et al., 2016).

#### 5.1.3.2.2 Redistributional Equity: Capacity for Inclusive Access with a Focus on the Demand-Side Value in the Allocation of Resources

The provisioning of next-generation network access infrastructures will require an optimal balancing of broadband supply and demand. With the apparent overburdening of MNO network

[55] This will entail non-discriminatory access to bottleneck upstream and downstream communication resources (considered as common-pool resources in this context) across the multi layers of the converging digital ecosystem (including essential network infrastructure and critical digital resources such as data) within a regulatory arrangement that balances both dynamic and static efficiencies in relation to innovation, investments and ultimately social welfare via an optimal pricing structure (see Laffont & Tirole, 1994; Spintrack, 2005; Bauer & Bohlin, 2008; Klumpp & Su, 2010; 2015; ESCAP, 2021). However, this end-to-end access mechanism will be regulated within a structurally separated governance arrangement with regard to market segments definition with appropriate ex-ante regulatory or ex-post competition law (see De Bijl, 2005; Teppayayon & Bohlin, 2010; OECD, 2013b; Schnurr, 2016).

infrastructure by increasing OTT data traffic reaching capacity limits[56], an economically cost-efficient option for the MNOs to upgrade their network quality of service (QoS) will be to densify their network by adding more cell sites to their macro network layers for higher spectrum re-use. However, to enable their coverage capacity for more inclusive access to underserved and unserved areas countries[57], they will need to expand their spectrum availability by leveraging the 3.5 GHz band that is currently only conditionally accessible (with universal access obligations) as well as the 5 GHz band that is within the unlicensed category.

#### 5.1.3.2.3 Sustainability: Future Change Responsiveness and Adaptability

To address the fundamental issue of ubiquitous broadband access and usage within the converging telecommunications market in Nigeria, there is a need to ensure the long-term sustainability of the critical data market segment. A key policy pathway in the realization of this objective is the reinstatement of the data price floor. This proposition will safeguard and grow new generation access network infrastructure in alignment with increasing data traffic and lessen market value erosion for network operators who, due to intensifying OTT-induced competition, have priced data often below cost[58], thereby constraining their capacities to reinvest in network expansion. This process will be imperative to address the poor quality of service and experience for users, especially in underserved market segments.

Another critical policy pathway to ensure the sustainability of Nigeria's converged telecommunications market is to enable a regulatory framework that will optimize the harmonious co-existence of both MNO network infrastructures and the OTT services that run on them, as one side of the market cannot survive without the other in maximizing user welfare. The author propositions that this pathway can be realized via a functionally equivalent and technology-neutral regulatory regime that prioritizes the structural separation of both sides of the market, with the option for MNOs to sell network capacity on a wholesale basis to OTTs within a regulated pricing

[56] Especially in the densely populated commercial centres across Nigeria.

[57] Nigeria's household rural-urban penetration gap for Internet services is put at 15.6%; this is higher than the average for Global South countries. See Alliance for Affordable Internet (A4AI) Report. 2020. Rural Broadband Policy Framework: Connecting the Unconnected. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/07/Rural-Broadband-Policy-Framework-Report_A4AI.pdf

[58] Why NCC wants upward price review for data services in Nigeria. Accessed July 12, 2021: https://guardian.ng/news/why-ncc-wants-upward-price-review-for-data-services-in-nigeria/

regime. This policy option leans more towards providing some harmonization to the already complex telecommunications ecosystem, as asymmetric regulation, especially concerning licensing regimes, according to ITU (1999: 48), "*may impede the growth and implementation of global services, and make more complex the transition to new generation regulatory frameworks that will be required for the age of cyber networks."* Furthermore, a consequence of structural separation will also catalyse competition on the network infrastructure side of the market for maximizing production efficiencies in providing broadband access to unserved and underserved segments at more affordable prices. The author further refines the above policy propositions based on the institutional analysis carried out by triangulating them with the primary interview data as analysed in Section 5.2.

## 5.2 Thematic Interview Findings and Discussions

This section analyses the interview data along the critical thematic dimensions — Market Segmentation, OTT-MNO Market Disruption, Regulatory Structures, Investment and Innovation Imperatives, and Social Welfare Imperatives.

### 5.2.1 Market Segmentation

Assessing regulatory policy for OTT-Telco competition in the Nigerian telecommunications market requires a prior market definition. Globally, within the converged telecommunications and Internet value chain, there are four distinct layers (see Fransman, 2000; Maitland, Bauer & Westerveld, 2002; Stork et al., 2020):

i. *Physical/Equipment Layer*: comprises communication equipment such as network transmission systems, BTS towers, network switches, routers, servers, etc.
ii. *Network Infrastructure Layer*: consisting of network elements as provided by network operators (mobile and fixed), Internet service providers (ISPs), Internet access providers (IAPs), and virtual network operators (mobile connectivity providers, intermediaries and resellers, and content distribution networks (CDNs)).
iii. *Content/Applications and Services Layer*: consists of network services (including the classic voice services and SMS services) provided by mobile network operators (MNOs), Internet service operators (ISPs), over-the-top services (OTTs) as provided by Content Application Providers, and value-added services (VAS).

iv. *Consumer Interface Layer*: this comprises consumer access devices (such as mobile phones and computers), operating systems and software, application users, and customers.

According to Interviewee 1, these separate layers of the converged value chain are regulated distinctly, considering the unique characteristics of the specified digital market segment. However, with the competitive conditions created by convergence, market players do not focus on a particular value chain segment but try to exert market power across the entire ecosystem value chain. In reflection, according to Interviewee 2, this constant reconfiguration of the value network creates boundary uncertainties in precisely defining the markets within the converged ecosystem, with complementarities and substitutability between the value chain segments. This complex situation becomes even more significant in the predominantly prepaid markets of developing countries such as Nigeria[59] where the substitutive power of OTTs for traditional voice calls is of more significant effect due to affordability constraints.

In addition, Interviewee 1 opined that the Nigerian telecommunications regulator — the Nigerian Communications Commission (NCC) — does not have regulatory oversight over OTTs, as their legal jurisdiction does not extend beyond the connectivity layer of the converged telecommunications ecosystem.

#### 5.2.1.1 Discussion – Market Segmentation

Technology convergence has dramatically changed the market structure in telecommunications markets, altering the competitive dynamics between traditional telecommunication operators and emergent over-the-top players (Krämer & Wohlfarth, 2018). In this regard, to explicate a systematic regulatory framework that accounts for the specificities of the layer-separate digital markets, the product/service, spatial, and temporary dimensions must be considered. Considering the asymmetric reconfiguration of the value boundaries across layers[60], this convergent approach to a market definition by scholars is based on the substitutive economic effect of products and services rather

[59] As of December 2019, information from the NCC database indicated that 97.1% of mobile subscribers in Nigeria are prepaid subscribers, while only about 2.8% are postpaid subscribers. See https://www.ncc.gov.ng/accessible/documents/915-2019-year-end-subscriber-network-data-report/file

[60] Where vertical and horizontal integration is rife (see Peitz, Schweitzer & Valletti, 2014).

than the comparability of business models[61] (See Van Cuilenburg & McQuail, 2003; Krämer & Wohlfarth, 2018). Under such circumstances, communication services provided by OTTs are appraised as strong substitutes for similar services offered by traditional telecommunication companies (Peitz et al., 2014).

Nevertheless, on the contrary, *Nigeria's National ICT Policy (2012)*[62] proposed a regulatory framework that is based on the traditional vertical conception of telecommunications services within the digital markets[63], with the contents and application layer largely unregulated — which leads to unintended competition consequences (see Bauer, 2007; Adesanya, 2020). For this challenge to be ameliorated, there is a requirement for an update to the extant regulatory framework for the telecommunications sector in Nigeria. Nevertheless, this process must consider the country's relatively lower maturity in relation to telecommunications convergence, which is still largely voice-centric with lower levels of product innovation.

### 5.2.2 OTT-MNO Market Disruption

According to Interviewee 1, a strong impact of the emergent OTT-MNO market competition is the rapid growth of network traffic and incidental interconnect and site costs. According to the respondent, this is mainly due to increased data demand and, in some cases, voice traffic by new and existing mobile subscribers (as supported by Interviewee 6). Congruently, according to Interviewee 16, "*The market situation is becoming worrisome, as operator revenues are continuously being depleted by the impact of unlicensed over-the-top telecoms services, who make no significant contributions to the socio-economic development of the country; companies like Viber and WhatsApp are depleting the revenues of Nigeria's telecom operators*." However, according to Interviewee 1, "*the question of how they [OTTs] have impacted revenue streams of MNOs is a complex one because it depends on how much the specific MNO has embraced a data-centric strategy*." Within that purview, according to Interviewee 10, "*zero-rating popular OTT services like WhatsApp and Facebook [as a data-centric strategy] is [according to the respondent] a critical mechanism of our [the operator's]*

[61] I.e. whether the product and/or service is provided via a two-sided business model (on a 'free-of-charge' basis), or via the traditional one-sided business model (that is primarily fee-based).

[62] National Information Communication Technology (ICT) Policy. The Ministerial ICT Committee on ICT Policy Harmonization. January 2012. Accessed December 9, 2021:
https://www.researchictafrica.net/countries/nigeria/Nigeria_National_ICT_Policy_(draft)_2012.pdf

[63] Rather than the layered regulatory model (see ACMA, 2011).

*customer acquisition strategy in driving enhanced customer stickiness for longer-term revenue sustainability*." Concerning this mechanism, according to Interviewee 13, "*We [another mobile operator] expect a continued intensification of competition, especially in the data segment, even though this will continue to drive down realizable data revenue margins. However, we will continue to push our bundling propositions to drive market value effectively. In this regard, we expect smaller operators and possible new entrants to keep pushing for a data floor pricing regime. However, MTN Nigeria believes these emerging market dynamics should be primarily driven by strategic partnerships rather than regulatory intervention*."

Whereas OTTs may be the strongest traffic driver on MNO networks — an issue which is often identified as a market problem by MNOs — according to Interviewee 1, *"there is a not sufficiently acknowledged 'virtuous circle' between OTTs and MNO networks*." This notion is mainly about the increase in data revenues for the MNOs as a consequence of OTT operations (a position also supported by Interviewees 7 and 15). The impact of this positive externality on the performance of the MNOs is corroborated by Interviewee 23. In this regard, according to the respondent, "…*It didn't surprise me that we were oversubscribed [with respect to MTN's Initial Public Offering in Nigeria], to be honest. Because I think if you calmly look through the investment case and our cash flow generation and market position, you conclude that it's the best buy over a long-term basis.*"

However, according to Interviewee 4 (supported by Interviewees 5, 11, and 12), this positive externality is insufficient to compensate for its impact on the total revenue stream of MNOs. This position is in contrast to the submission of Interviewee 8 that "*OTT-induced increases in the demand for data and its consequent uptick impact on data revenues surpasses possible declines in voice and SMS revenues*." This position was evidenced by the respondent in reference to the data revenue of the only publicly listed MNO in Nigeria (MTN), at just about 19 percent of total revenue for 2019[64], which, according to the interviewee, had not grown significantly from about 11 percent in the last five years. This situation means that although voice still constituted about 70 percent of their total revenue[65], the traffic and the demand pressure for data services is putting a disproportionate capacity strain on

[64] MTN Nigeria Communications Plc Unaudited Condensed Consolidated Interim Financial Statements For the nine months and three months ended 30 September 2019. https://mtnonline.com/wp-content/uploads/2020/quarterly/MTN-Nigeria-Unaudited-Financial-Statements-September-2019.pdf

[65] With data revenue being only relatively marginal

their network, even more than for traditional voice or SMS services. This challenge is critically imperative in the Nigerian case, where about 50 percent of their sites were still 2G based, with newer generation broadband networks (3G and now 4G) available only in select urban centres to the exclusion of the unserved or underserved rural communities.

So, given these capacity constraints, the OTTs are leveraging the opportunity to disruptively disintermediate the MNOs as infrastructure providers, especially in the middle mile concerning network backbone transmission and metro backhaul), primarily via fibre, which is a less regulated segment (this position was supported by Interviewees 13 and 14). According to Interviewee 5, this segment is considered a corollary infrastructure domain concerning the regulatory imbalances in the Nigerian telecommunications sector in relation to MNO-OTT competition. More so, within the last mile, according to Interviewee 9, the upswing in the adoption of OTT services negatively impacts incoming international traffic at substantial cost implications to Telcos while generating significant revenues for OTTs, "*without any contractual obligation with incumbent telecommunication infrastructure providers with respect to interconnection services*." Furthermore, beyond the traditional voice and SMS value segments, Interviewee 10 opined that the OTTs are also disintermediating the MNOs in the value-added services, a value segment that the MNOs "*could potentially layer on their service as traditional services go away*."

#### 5.2.2.1 Discussion - OTT-MNO Market Disruption

Within the OTT-MNO competition debate, a complementary dynamic between both market segments currently subsists. On one end, MNO's last-mile infrastructure delivers OTT content via the Internet to consumers. Conversely, OTT services and content increase Internet data demand and adoption provided by MNOs. While this complementary effect increases the attractiveness of the network access to consumers, the value accruable in relation to investments required to sustain the business model is disproportionately in favour of OTTs because of a mismatch in cost structures (lower sunk costs and economies of scale) as well as profit scope (higher) in comparison to the traditional telecommunication operators (Bauer, 2005b). This situation has ultimately led to a significant squeeze in the ability of the telecommunications operators to survive in the market in the long term and an increase in market entry barriers in the short term, especially for smaller-sized market players. This problem becomes even more imperative considering the disintermediation strategy of the OTTs concerning the middle-mile backbone and metro backhaul infrastructure.

Although the economic pressure to reduce costs is probably market-acceptable, a total disruption could backfire on OTTs, as they need the complementary infrastructure and access services the telecommunication operators provide.

However, to deal with the impact of this competition dynamic and further reduce capital expenditure and attendant costs, telecom operators began selling off parts of their network infrastructure to third parties beyond industry-wide passive network-sharing relationships.[66] This process started with the smaller ISPs before culminating with the more dominant MNOs within the telecommunication ecosystem. In 2010, Starcomms (now defunct) sold its towers to SWAP, Visafone Nigeria sold to IHS[67], and Multilinks sold to HTN Towers. Then, in 2014, Etisalat Nigeria (now 9Mobile[68]) sold some of its towers to IHS; MTN Nigeria divested 49 percent of its tower shares to the same IHS, while Airtel Nigeria sold all of its tower infrastructure to American Towers.[69] Etisalat Nigeria sold the remainder of its towers to IHS in 2015.

While selling these network towers helped free up some capital for the Telcos to reinvest in innovation capabilities required to survive the OTT onslaught, it also created the unintended consequence of network infrastructure consolidation, mainly in the hands of foreign-owned TowerCos. This situation could generate both sovereign and anti-competitive risks regarding their market dominance and escalate lease rates in the long term for Telcos, for which they will ultimately push on the increased operational costs to the end consumers. Furthermore, tower infrastructure sales have also impeded the ability of the Telcos to differentiate their network services, especially for VAS providers, in a way that creates endogenous market entry barriers for their competitiveness.

Another survival mechanism the MNOs employ against OTT competition within Nigeria's voice-centric market is bundling their services onto their traditional offerings. While this allows them to increase consumer willingness to pay for traditional services such as voice while also gaining from data revenues and cost savings from scale economies of increased consumer adoption, it creates increased market entry barriers for smaller players operating in fewer market segments — thus drowning their continued viability.

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[66] TowerXchange Africa Dossier 2019. https://www.towerxchange.com/wp-content/uploads/2019/08/TX_AfricaDossier_2019.pdf

[67] https://www.ihstowers.com/

[68] https://9mobile.com.ng/

[69] https://www.americantower.com/

In the final analysis concerning consumer welfare, while the increased competition intensity between MNOs and OTTs is driving down the price (commoditization) of offerings and services in both voice and Internet data segments in the short term, the consolidation effects within the industry constitute a long-term risk for optimal consumer pricing — with an ultimately negative impact on consumption capacities. More so, this economic inefficiency as a consequence of the pricing externality[70] weighs disproportionately on the side of the MNOs — as they are the ones that internalize a significant proportion of revenue losses due to decreased consumer access and adoption of traditional telecommunication products and services (Peitz & Valletti, 2015). From an institutional perspective, the above dynamics are imperative in the Nigerian case, as price mechanisms concerning competition exact their most significant impact at the emergence of markets, especially when there is not yet an established conception of structural control, which has significance for the survival of incumbent firms (see Stinchcombe, 2000; Fligstein, 2001).

In empirically evaluating these market disruption effects, the author considered the published financial data of two of the biggest mobile network operators (MNOs) in the Nigerian telecommunications market — MTN Nigeria and Airtel Nigeria. While it is impossible to fully disaggregate the impact of OTT adoption on MNO revenues due to their bundling effect, the author assesses this effect in proxy as the ratio of data (digital) revenues as a percentage of voice and SMS revenues. The data tables (Figures 9 - 11) capture the financial performance figures from the base year of 2015 to the year 2021 for Nigeria, in comparison to similar markets of operation for MTN in South Africa and Ghana for the same period.

[70] With respect to internalizing revenue losses due to lowered market consumption)

| Nigeria MTN Currency: ZAR million | | Period | Subscribers in 1,000 | Revenue Total | Revenue Voice & SMS | Revenue Digital | Share of Digital Revenues | EBITDA Margin |
|---|---|---|---|---|---|---|---|---|
| | Current | 2021 | 68,471 | 60,050 | 37,017 | 23,033 | 38% | 53% |
| | Base | 2015 | 61,252 | 51,942 | 41,685 | 10,257 | 20% | 53% |
| | | % of Base | 112% | 116% | 89% | 225% | | |
| Nigeria Airtel Currency: USD million | | Period | Subscribers in 1,000 | Revenue Total | Revenue Voice & SMS | Revenue Digital | Share of Digital Revenues | EBITDA Margin |
| | Current | 2022 | 44,400 | 1,878 | 1,144 | 734 | 39% | 55% |
| | Base | 2019 | 37,468 | 1,106 | 740 | 366 | 33% | 50% |
| | | % of Base | 119% | 170% | 155% | 201% | | |

**Figure 9: Revenue Performance (2015 – 2021) for MTN Nigeria and Airtel Nigeria. Source: data from researchictsolutions.com**

| South Africa MTN Currency: ZAR million | | Period | Subscribers in 1,000 | Revenue Total | Revenue Voice & SMS | Revenue Digital | Share of Digital Revenues | EBITDA Margin |
|---|---|---|---|---|---|---|---|---|
| | Current | 2021 | 34,995 | 48,716 | 15,369 | 33,347 | 68% | 39% |
| | Base | 2015 | 30,588 | 40,038 | 20,661 | 19,377 | 48% | 33% |
| | | % of Base | 114% | 122% | 74% | 172% | | |

**Figure 10: Revenue Performance (2015 – 2021) for MTN South Africa. Source: data from researchictsolutions.com.**

| Ghana MTN Currency: ZAR million | | Period | Subscribers in 1,000 | Revenue Total | Revenue Voice & SMS | Revenue Digital | Share of Digital Revenues | EBITDA Margin |
|---|---|---|---|---|---|---|---|---|
| | Current | 2021 | 25,350 | 19,187 | 6,732 | 12,455 | 65% | 55% |
| | Base | 2015 | 16,255 | 7,903 | 5,414 | 2,489 | 31% | 41% |
| | | % of Base | 156% | 243% | 124% | 500% | | |

**Figure 11: Revenue Performance (2015 – 2021) for MTN Ghana.**
**Source: data from researchictsolutions.com.**

Within the African telecommunications market, zero-rating is a crucial data strategy adopted by MNOs as in other emerging markets dealing with OTT disruption while increasing market share by leveraging network effect externalities (see Eisenach, 2015; Galpaya, 2017). From Figure 9, Airtel Nigeria achieved an increase of 119 percent in their number of subscriptions in comparison to MTN Nigeria at a lower 112 percent from the base year of 2015 to 2021, even though MTN Nigeria is the more dominant operator at about 38 percent market share in comparison to Airtel Nigeria at about 26 percent. More so, as a derivative of zero-rating, which MNOs adopt in the short term to initially attract non-paying data subscribers to gradually increase their willingness to pay in the longer term for complementary services to cover the cost of OTT service provisioning, Airtel Nigeria also

achieved an increase in total revenues of 170 percent in comparison to MTN Nigeria at a lower 116 percent (Figure 9).

Bundling is another critical data strategy implemented by MNOs in dealing with the effects of OTT market disruptions in emerging markets and across the African telecommunications ecosystem (see Gillwald, Chair & Esselaar, 2015; Galpaya, 2017; Liu & Huang, 2017; Kwizera et al., 2018). Within this market mechanism, operators combine traditional voice and SMS services with OTT services as a single discounted product (see García-Mariñoso, Martínez Giralt & Olivella, 2008; Joshi et al., 2016). This data strategy helps increase total revenues even if ARPU (Average Revenue Per User) decreases by stimulating at-rate pricing for unlimited traditional telecommunications services — voice and SMS (Stork et al., 2016) — within an adjusted rate-of-return pricing mechanism. In comparison on a country basis, Nigeria ranks 19th out of 25 countries on the RIA Value for Money Index (VMI)[71] (see Gillwald, Mothobi & Rademan, 2018), indicating a lower level of product innovation in relation to the market competition when compared to say South Africa (with a ranking of 9th). This position is further buttressed and reflected in the data revenue performances of MTN Nigeria in comparison to MTN South Africa and MTN Ghana (Figures 10 & 11), with traditional voice and SMS revenues still very much dominant (see Gillwald et al., 2016).

Overall, though, the results from Figure 4 (in concurrence with the statements from Interviewee 23 on MTN's long-term revenue sustainability) discountenances the argument from some of the MNOs that their revenues were being depleted by the impact of OTT services. Nevertheless, while MTN Nigeria has championed the call for regulatory intervention concerning the effects of OTT services in the Nigerian market, Airtel Nigeria, on the other hand, has focused on operationalizing a more robust data strategy in mitigating the impacts of OTT market disruption. For example, Free Basics OTT service by Facebook, which is widely pervasive across operational telecommunications markets in Africa (including Nigeria), has Airtel as its first and still largest MNO partner on the continent (see Gillwald, Odufuwa & Futter, 2016). In contrast, MTN Nigeria is still "milking" its relatively ubiquitous lower-generation network infrastructure. It is still more heavily reliant on revenues from voice and SMS as its traditional line of enterprise profitability (Figure 9). The author explains this

[71] Research ICT Africa. https://www.researchictafrica.net/ramp/ramp_vmi_country.php?c=

disincentive of MTN Nigeria to invest in new-generation networks within the country as a business strategy to limit the cannibalization of economic profits from its legacy network infrastructure. This market positioning is mainly because its traditional telecommunications services (voice and SMS) still have dominant consumer adoption (see Briglauer, Cambini & Grajek, 2015).

### 5.2.3 Regulatory Structures

Based on the prior arguments in the market segmentation sub-section (5.1.1), while network operators are subject to national sector regulation, OTT service providers are not because, according to Interviewee 1, "*they do not compete for limited resources, such as spectrum, rights of way, numbering range, et cetera."* (self-referencing Stork et al., 2020). According to the interviewee, these resources belong to the domain of nation-states, in contrast to the Internet-based content and applications layer, which is more globally domiciled. In response, Interviewee 3 affirmed the regulatory authority of the NCC to introduce new guidelines or regulations across all the layers of Nigeria's telecommunication ecosystem, even for an emergent market. According to him:

> *"…even if it is a new market, what are we going to do? For instance, when telecommunications infrastructure services were introduced, the complementary regulatory policy was not there as of 2008 or so. It was in 2009 that the infrastructure was introduced. We have now brought in a new regulation for infrastructure sharing. We issued an undertaking saying to investors: 'This is another opportunity for you; you can invest in this package' and many of them came and applied for the license. We issued them the license, which has now eased the pressure on the operators because they saw the opportunity, and now it is a market for them."*

However, while the traditional telcos are regulated largely ex-ante via sector-specific frameworks, the OTTs are mostly subjected to ex-post regulation regarding competition laws. Therefore, the regulatory challenge becomes one of converging both paradigms in an optimal manner that is ecosystem agreeable. Within this purview, according to Interviewee 1, the lower level of data-centric convergence with respect to market competition for the Nigerian telecommunications market in contrast to the South African or Ghanaian markets (see Figures 9-11) is "*primarily because of the poor state of competition in Nigeria, as data-centric innovation has basically been driven by technological convergence from the activities of market players across the value chains of the industry, with little or no complimentary regulatory convergence…the NCC, NBC, and the Ministry of Communications et cetera have had no real contributions to this*

*evolution*." Corroborating this position was Interviewee 1, who stated that "*some types of OTT would emerge to be regulated ex-ante, while others will continue to be regulated ex-post.*" In this respect, Interviewee 23 stated that "*the policies that affect us [operators] the most are policies which define the competitive space in the industry, and as long as people are allowed to compete on an equal basis, and make the best business decisions, then it would continue to be a very, very good environment for anyone to invest in.*" In particular reference to pricing, Interviewee 9 proposed re-introducing a data price floor "*to incorporate some level of guarantee in ensuring that telecommunication operators profitably price data, regardless of changing customer behaviours due to cheaper OTT data offerings."*

#### 5.2.3.1 Discussion - Regulatory Structures

Traditionally, for any form of regulatory intervention to be introduced, an assessment of market power has to be undertaken based on the definition of relevant markets (Krämer & Wohlfarth, 2018). However, within the converged telecommunications industry, market definition in relation to substitutive effects is mostly asymmetric and depends on the unique product or service. Concerning pricing, the traditional approaches to market definition assume that pricing is set significantly higher than marginal costs. This mechanism is distorted within the converged digital market where marginal costs are almost zero, and prices can be zero for some sides of the multi-sided market — implying above marginal cost for the complementary sides (Hüschelrath, 2009; Elzinga & Mills, 2011; Krämer & Wohlfarth, 2018). More so, bundled products' prevalence accentuates the complexity of implementing traditional market definition approaches (Pereira & Vareda, 2013). These asymmetries complicate the market definition for the converged telecommunications industry as pricing becomes an insufficient reference parameter (with the possibility that markets may be defined too broadly or narrowly in relation to distorted consumer demand), and therefore, accurate identification of market power is unlikely.

Therefore, considering these dynamic complexities, the plausibility of ex-post competition law is doubtful for OTT-MNO regulation in most cases (Monopolkommission, 2015; Krämer & Wohlfarth, 2018). Nevertheless, even an ex-ante regulatory regime must take into consideration the specificities of the layer-separate digital markets, as well as their spatial (concerning products and services) and temporary (jurisdictional) dimensions (Whitt, 2003). A converged regulatory

framework does not necessarily mean that all the digital markets can be lumped together as one, even though a strict market distinction is impossible (see Latzer, 2009).

However, considering the low maturity of the Nigerian telecommunications industry with respect to broadband infrastructure, the primary objective of regulatory intervention has to be to facilitate market penetration in relation to access and use on the demand side, as well as infrastructure investments on the supply side. In particular, concerning pricing the complementary and substitutive products and services offered by the OTTs and the MNOs, pricing inefficiency externalities are bound to emerge (Peitz & Valletti, 2015). This pricing inefficiency is a fundamental economic rationale for regulatory intervention (Economics Frontiers, 2005). Within this purview, the NCC may need to evolve the current cost-based pricing structure beyond the requirements for a price floor, especially with respect to the retail mass market segment — where affordability and price sensitivity are critical factors influencing access and adoption (see Gillwald, Odufuwa, & Futter, 2016). This proposition will likely necessitate a subsidy provision to cover network costs for these services (Armstrong, 2002). The author proposes that this market deficit should be financed by the OTTs, who benefit the most from the inefficiencies induced by the network externalities due to increased consumer adoption. The funding mechanism, the author indicates, can be structured as a termination charge requirement for OTTs[72], balanced out by open access to bottleneck infrastructure provided by the MNOs within the liberalized Nigerian market (see Maegli, Jaag, Koller & Trinkner, 2010; ITU, 2019). This regulatory framework for pricing can be applied ex-ante but should also structure in ex-post competition law for dispute resolution between MNOs and OTTs on a case-by-case basis (see Ismail, 2003).

[72] The European Telecommunications Network Operators' (ETNO) made a similar proposal in 2012 for termination charges of OTT traffic in alignment with the position of European Network Operators — who were willing to provide commensurate levels of service quality to OTT providers willing to pay for such charges (see OECD, 2013a). Such termination charges, according to Armstrong (2002), falls within a one-way interconnection typology for managing Internet-based communication termination to the consumer on a traffic usage-based cost share principle (see also Jayakar & Park, 2014). In furtherance, Armstrong (2002) posits that even when there is effective competition between network operators and content providers, it does not justify a *laissez-faire* policy towards interconnection arrangements by the regulatory authority. In particular, such interconnection arrangements are applicable to OTTs such as Skype Out which can terminate on both Public Switched Telephone Network (PSTN), especially when via local loops, and mobile networks (see Blythe, 2005; Stork, Nwana, Esselaar, & Koyabe, 2020)

Concerning licensing, the *2017 NCC License Framework for the Establishment of Mobile Virtual Network Operators in Nigeria*[73] proposed a service-based MVNO license for OTTs as a potential differentiated market segment on a bulk purchasing basis. This provision was in tandem with the NCC's legal mandate within the ambits of the *Nigerian Communications Act 2003*[74] to issue licenses for providing communication services within Nigeria's telecommunications industry. In a complementary pattern, the Federal Ministry of Information and Communication, in June 2021, directed the National Broadcasting Commission (NBC) to commence the process of broadcast licensing all OTTs operating within the country.[75] However, while the potential implications of this regulatory mechanism concerning OTT licensing are still far from straightforward for the Nigerian context, it raises several unintended policy consequences for promoting cross-border provisioning of digital services within the converged telecommunications ecosystem. One significant policy outcome might be that some OTTs may restrict cross-border access of digital content and applications to consumers by geo-blocking the Nigerian market. More so, due to the international nature of the Internet with respect to IP-based digital services, there are bound to be jurisdictional complications for regulatory compliance and enforcement within a national regulatory framework for OTTs.

Concerning these dynamics, in assessing data-centric convergence in relation to market competition for the Nigerian telecommunications market, contrary to the view of Interviewee 1 that the ecosystem's digital maturity is primarily because of the poor state of competition in the market, the author asserts that the market has been relatively competitive, but the fundamental limitation has been a weak complementary regulatory convergence. Following the deregulation and liberalization market transition, the NCC has facilitated market entry through transparent licensing rounds and enabled a more competitive environment within Nigeria's telecommunications industry (see Oyedijo, 2012; Gillwald et al., 2018; Ifediora, 2022). However, even with the shift towards a data-centric telecommunications ecosystem driven by OTT services within a converging market, the traditional voice and SMS segment remains dominant, as evidenced in Figure 4. The NCC has not been able to provide the requisite enabling environment to incentivize significant investments in new-generation access networks. The regulator has not pursued a services-based competition

[73] Accessed March 09, 2021: https://www.ncc.gov.ng/documents/941-draft-mvno-licence-framework/file

[74] https://www.ncc.gov.ng/accessible/documents/128-nigerian-communications-act-2003/file

[75] Accessed June 14, 2021: https://twitter.com/FMICNigeria/status/1400843069583396875?s=03

regime[76] nor, more fundamentally, effective price regulation of the wholesale segment of the telecommunications market — critical for network investment incentivization[77] and competition intensification within a converging market (see De Bijl & Peitz, 2008; Blackman & Srivastava, 2011; Koboldt, 2012; Bergqvist & Townsend, 2015; Onyeajuwa, 2017; Ahokangas et al., 2021; Ate & Mohamed, 2021). A key ex-ante mechanism for implementing the aforementioned pricing regulation is the institution of a price floor at the retail segment with a direct reference to the wholesale segment, which the NCC had tried to introduce earlier but could not effectively implement and had to withdraw (see Gillwald et al., 2018).

As noted by Interviewee 1, while data-centric innovation has been driven by technological convergence from the activities of market players across the value chains of the industry, the Nigerian Communications Commission (NCC) had also, in response, adopted a unified access licensing scheme regime effective since 2006.[78] It further issued Guidelines on International Gateway Access and Voice over Internet Protocol (VoIP) for the Nigerian Telecommunications Industry[79] in 2016[80], even though this licensing does not cover the regulation of OTT services in the market (see Osundolire, 2018).

Ultimately, the shift from a vertical to horizontal regulation of the converging digital ecosystem has not been realized as specified in the National ICT Policy of 2012, primarily due to political reasons, as opined by Interviewee 14 (see also Onyechi, 2020). The NCC has since maintained a "no regulation" stance concerning OTT services in the Nigerian telecommunications industry. While this position aligns with the jurisdictional capacity of NCC concerning both the connectivity and network layers of the converging digital value chain, the regulator will need to assess the competitive effects of data-centric innovations such as bundling and zero-rating on a case-by-case basis and

[76] Given that local loop unbundling under an infrastructure-based regime may not be viably replicable as the market transits towards new generation network infrastructure)

[77] With respect to infrastructure cost recovery

[78] Nigerian Communications Commission, "Licensing Framework for Unified Access Service in Nigeria" (2006). Accessed December 20, 2022: https://www.ncc.gov.ng/docman-main/licensing-documents/licensing-frameworks/434-licensing-framework-for-unified-access-service/file

[79] https://www.ncc.gov.ng/docman-main/legal-regulatory/guidelines/63-guidelines-for-international-access-and-voice-over-internet-protocol-voip/file

[80]Specifically for network licensees to automatically transmit voice, data and video signals under the Full Gateway and International Data Access License, not tied to any specific transmission medium

collectively with regard to the content and applications layer. This assessment is imperative for the Nigerian market — still dominated by few players — to ascertain predatory pricing, margin squeezes, or non-price effects of market power in relation to barriers to market entry (see ACCC, 2003; Competition, 2005; Kobayashi, 2005; Mariñoso, Martínez-Giralt & Olivella, 2008; Weller & Woodcock, 2013; Stork et al., 2020). This mechanism will align institutionally, even at the regional level, with the requirements of the ECOWAS ICT African Regulatory Watch Initiative on Licensing Regimes, OTTs, and International Gateway Liberalization (2019).[81]

### 5.2.4 Investment and Innovation Imperatives

According to Interviewee 3, due to a large population of about 200 million and a substantial youth segment, Nigeria is a critical telecommunications market, especially concerning the demand for data and non-data services and products from mobile operators and OTTs. This situation creates significant imperatives for network infrastructure investment. Within the purview of the evolving telecommunications market disruption, global OTT platforms are increasingly co-investing with MNOs in network infrastructure to "coopetitively" complement the build-out of new generation connectivity. However, in some longer-term considerations, the OTTs may move to completely disintermediate the MNOs from the connectivity layer of the converged telecommunications industry (corroborated by Interviewees 1, 4, 10, and 11).

In Nigeria, according to Interviewee 8 (supported by Interviewee 11), MainOne[82] — a connectivity service provider — is building a 750-kilometre open-access fibre infrastructure in Nigeria with co-investment from Facebook and support from local state authorities in Ogun and Edo States. This network infrastructure will allow for the connection of MNO base stations and ISP points of presence (PoPs) at an affordable rate, providing metro last-mile broadband connectivity access to a consumer base of about one million people (Interviewee 13). More so, on the continent, Facebook

[81] ECOWAS ICT African Regulatory Watch Initiative on Licensing Regimes, OTTs and International Gateway Liberalization. (2019). Digital Development Partnership Report. Accessed December 22, 2022: https://documents1.worldbank.org/curated/en/303601616414309025/pdf/ECOWAS-ICT-African-Regulatory-Watch-Initiative-on-Licensing-Regimes-OTTs-and-International-Gateway-Liberalization-Executive-Summary-and-Full-Report.pdf

[82] www.mainone.net

is partnering with some leading African and global MNOs to build a 37,000 km subsea fibre-optic infrastructure (2Africa[83]) that will interconnect the region with Europe and the Middle East via twenty-one cable landings in 16 countries in Africa, including Nigeria. The primary objective of this significant investment is to enhance broadband capacity and access for hundreds of millions of people across the region.

#### 5.2.4.1 Discussion - Investment and Innovation Imperatives

The increasing network capacity demand in Nigeria's telecommunications industry due to OTT market penetration and adoption of products and services is increasing the imperative to invest (especially in data infrastructure) more efficiently. However, the regulatory lacuna concerning OTT competition is in part causing the MNOs to invest less in their data networks, as acknowledged by MTN Nigeria — the dominant MNO in the country — in its 2019 Q1 results.[84] In bridging this infrastructural deficit for next generation networks (NGN), the emerging co-investment dynamics between the OTTs and MNOs constitute a market-led solution within the Nigerian market. However, this developing solution in a highly concentrated market such as Nigeria's may create new competition bottlenecks with adverse market outcomes such as tacit collusion, especially in the retail segment, depending on the co-investment agreement terms and given the substitutability of services (see Bender, 2011; Bourreau, Cambini & Hoernig, 2013; Cambini & Silvestri, 2013; Krämer & Vogelsang, 2017; Gillwald et al., 2018). While complementary NGN infrastructure access regulations may help bridge this constraint on market competition, it might also have the contrary effect of reducing the still fledgling investment incentives within the market. A critical regulatory trade-off for the NCC will be to further facilitate faster and broader NGN infrastructure deployment, which is far more socially beneficial, rather than focusing on market competition intensification, via a light-touch ex-ante access regulation regime in balancing static and dynamic policy objectives (see Bender, 2011; Jaag & Trinkner, 2011; Parcu & Silvestri, 2014).

Nevertheless, according to Interviewee 5, regulatory considerations for OTT-Telco investment dynamics must still not stifle innovation, especially on the side of the OTTs, who are significant

[83] https://www.2africacable.com/

[84] https://www.mtn.com/wp-content/uploads/2019/05/MTNN-Q1-2019-local-analyst-presentation.pdf

contributors to expanding the innovation space in that regard. This proposition is imperative within Nigeria's telecommunications industry. Even with the global shift towards data products and services, the sector for the country remains a voice-centric market — reflecting a lower level of market innovation maturity (see Gillwald, Mothobi, & Rademan, 2018). This market situation reflects a slower regulatory adaptation for enabling the required business model innovation by the traditional telecommunications operators within the converging telecommunications ecosystem, with respect to expanding broadband investments, evolving integrated digital services, enhancing across-ecosystem information flows, as well as lowering their transaction costs, as we have seen in South Africa for example, where data revenues have for some years now exceeded voice revenues (see Gillwald, Mothobi, & Rademan, 2018; Moyo, Chinembiri, & Govan-Vassen, 2021).

### 5.2.5 Assessment of Social Welfare Imperatives

While acknowledging the complex particularities of infrastructure industry regulation, where natural monopoly elements need to initially keep prices as high as possible to meet investment requirements in network extension, consideration of other public interest objectives — such as universal access — precipitates the need for a more inclusive regulation. From a welfarist perspective, the ultimate aim of competition policy is maximizing consumer surplus (Qaqaya, 2008). In Nigeria's telecommunication industry, the increase in competition intensity due to OTT-MNO market dynamics enhances incentives for product differentiation and quality of service for maximizing social welfare. Considering the complex complementarities between network infrastructure and content services, the societal benefits of OTT-MNO competition cannot be assessed separately (Peitz, Schweitzer, & Valletti, 2014).

From a developing country perspective, the interface between competition regulation (supply-side focused) and social welfare (demand-side focused) needs to optimally balance the economic incentive and the bargaining power of the consumer (Qaqaya, 2008). This efficiency can only be optimized for both the short and long terms when assessed contextually based on the dynamic priorities of the market (whether directly or indirectly beneficial to the consumer) per time as consumer demand co-evolves with available products and services (Adesanya, 2020).

In line with the principles of the *United Nations Guidelines for Consumer Protection*[85], the priority for consumer welfare in relation to the competition regulation of OTT and MNO dynamics within the context of Nigeria's telecommunication industry as a contemporarily liberalized market is consumer access to essential products and services. While the heightened competition intensity due to OTT entrance into Nigeria's telecommunications industry has enabled consumer access to innovative products and services at competitive prices (Muhammed & Oyinwola, 2019), mobile Internet penetration is still below 50 percent, with high-speed connectivity delimited to major cities in the country. This situation creates a massive opportunity for next-generation network infrastructure development as the traditional MNOs transition from voice-centric to data-centric business models in the context of an increase in consumer willingness to pay for mobile Internet access (Ogidiaka & Ogwueleka, 2019). The evolving consumer preference may, therefore, necessitate regulatory forbearance on the side of the telecommunication operators to provide the required incentive for further infrastructure investment and expansion.

In Nigeria's case, the telecommunications sector's liberalization since the 2000s has significantly contributed to increased access and adoption of telecommunications services, especially mobile telephony across the country (Adediran et al., 2016). Nevertheless, as currently obtainable, without a competitive fixed line segment (at a current penetration of about 0.2 percent)[86], recent evidence indicates that mobile coverage gaps persist in unserved and underserved areas of the country (AfDB, 2013; Arakpogun, Wanjiru & Whalley, 2017). The GSM Association (GSMA)[87] reports a 2G coverage of 87 percent and a 3G coverage of 51 percent across the population — ranking 13 out of 51 countries in sub-Saharan Africa, behind regional leaders like South Africa, with 96 percent 3G coverage, and Mauritius, with 90 percent 3G coverage (GSMA, 2015). NCC's latest coverage maps indicate less than 10 percent coverage for 4G in the country (see Figures 7 - 9). More so, Research ICT Africa (RIA)'s After Access Survey indicates an internet penetration of about 30 percent for Nigeria, far less than the same index for South Africa in comparison (Gillwald, Mothobi, & Rademan, 2018; see also Figure 10).

[85] https://unctad.org/system/files/official-document/ditccplpmisc2016d1_en.pdf

[86] See Nigeria's National Broadband Plan (NNBP, 2020-2025). Accessed December 27, 2022: https://www.ncc.gov.ng/documents/880-nigerian-national-broadband-plan-2020-2025/file

[87] https://www.gsma.com/

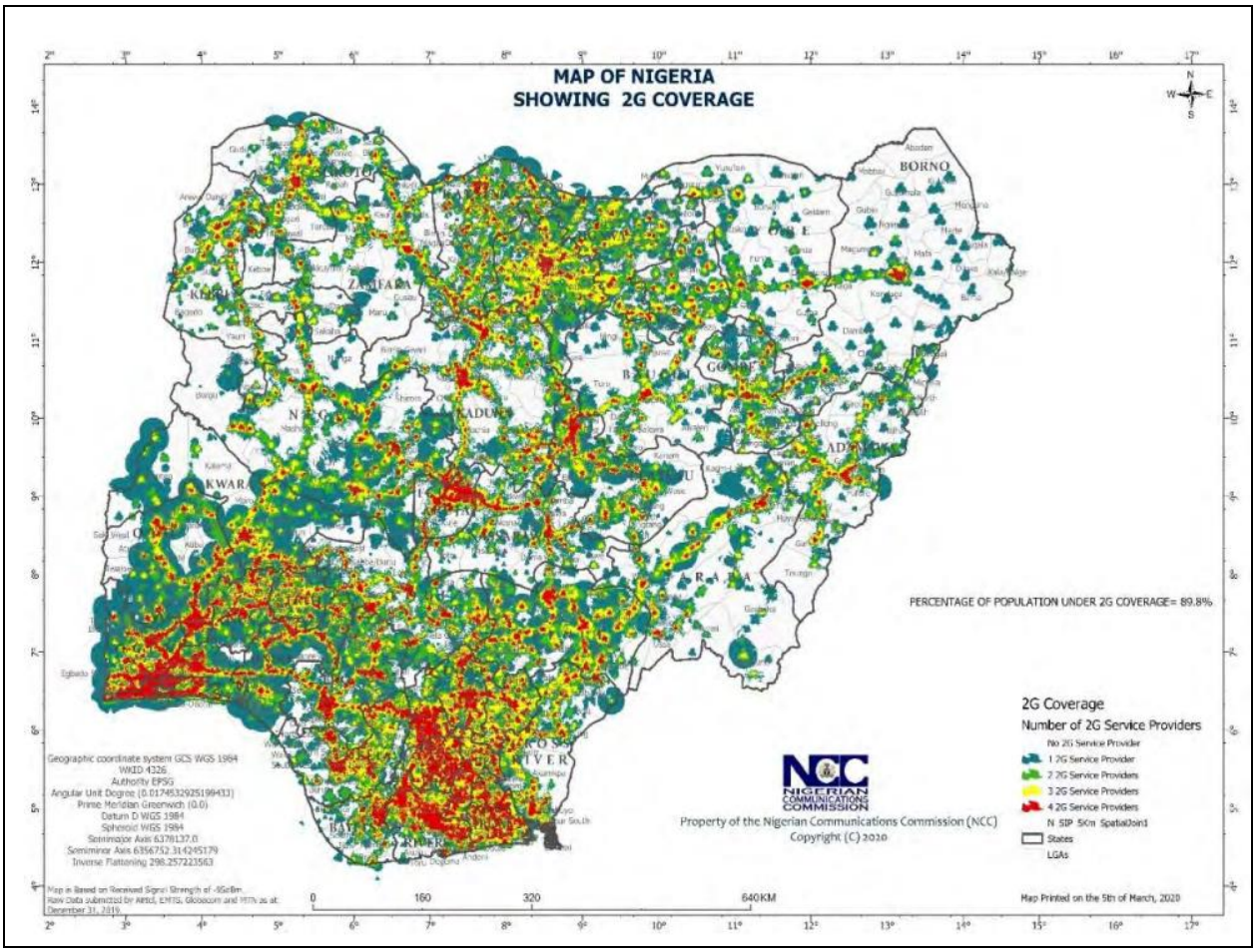


**Figure 12: Nigeria's 2G Coverage Map. Source: NCC**

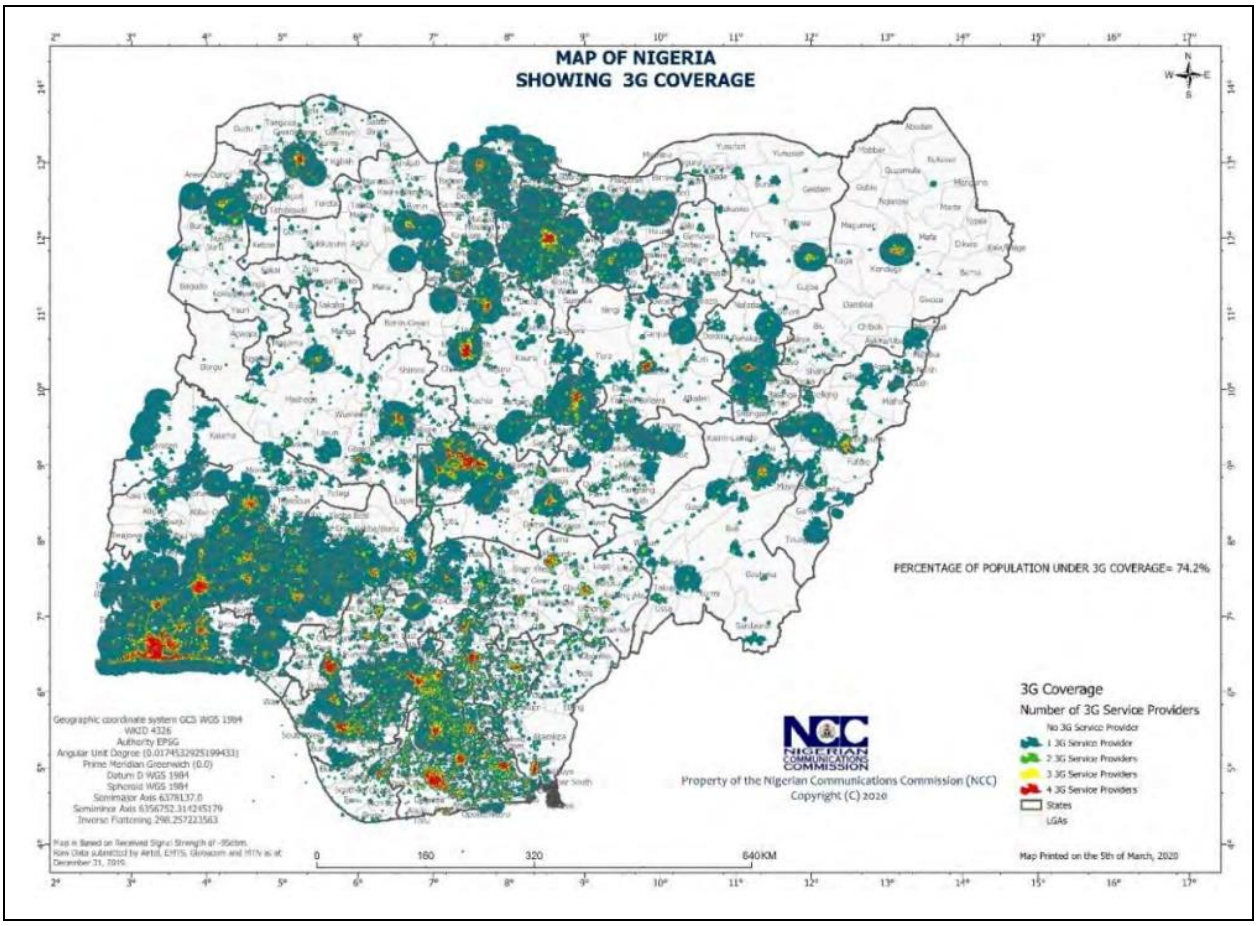


**Figure 13: Nigeria's 3G Coverage Map. Source: NCC**

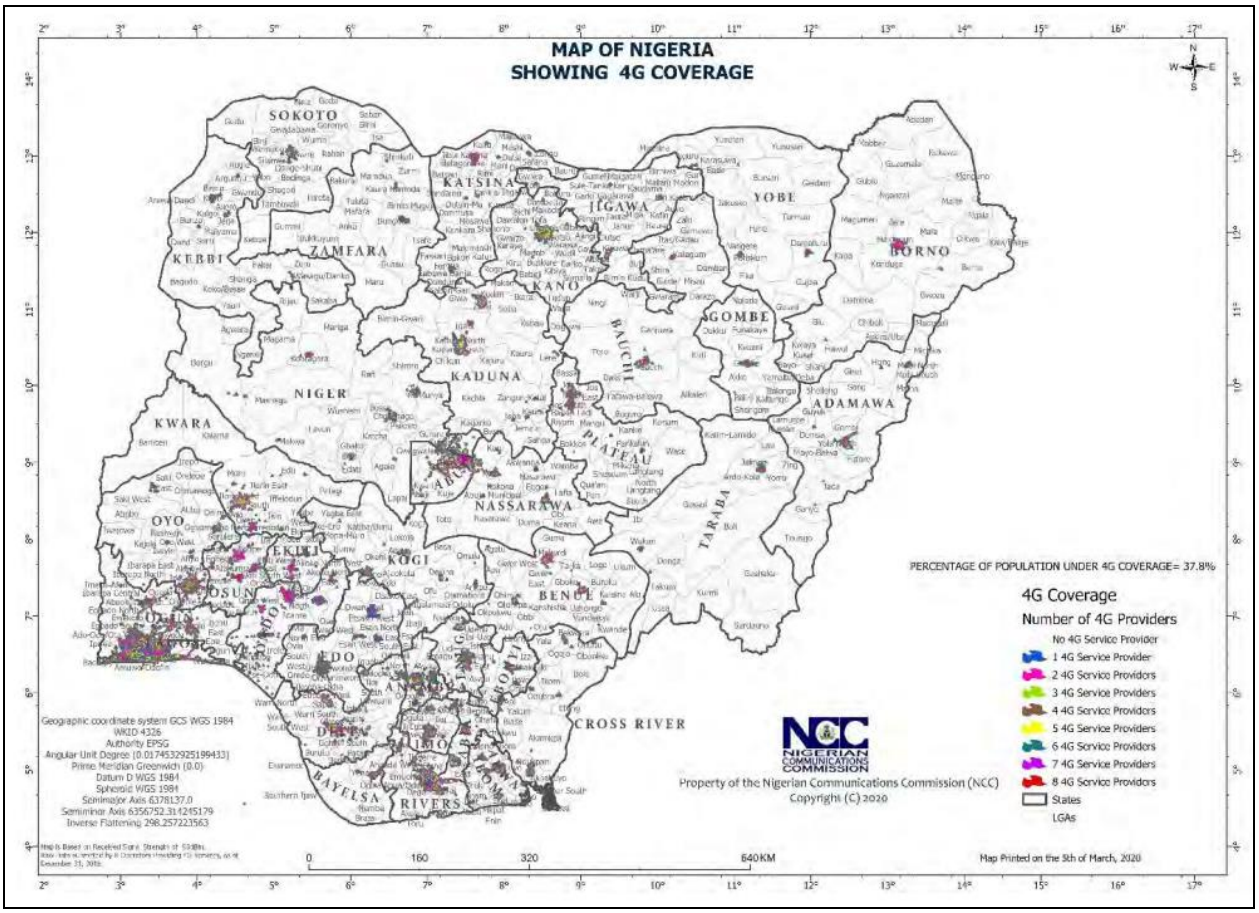


**Figure 14: Nigeria's 4G Coverage Map. Source: NCC**

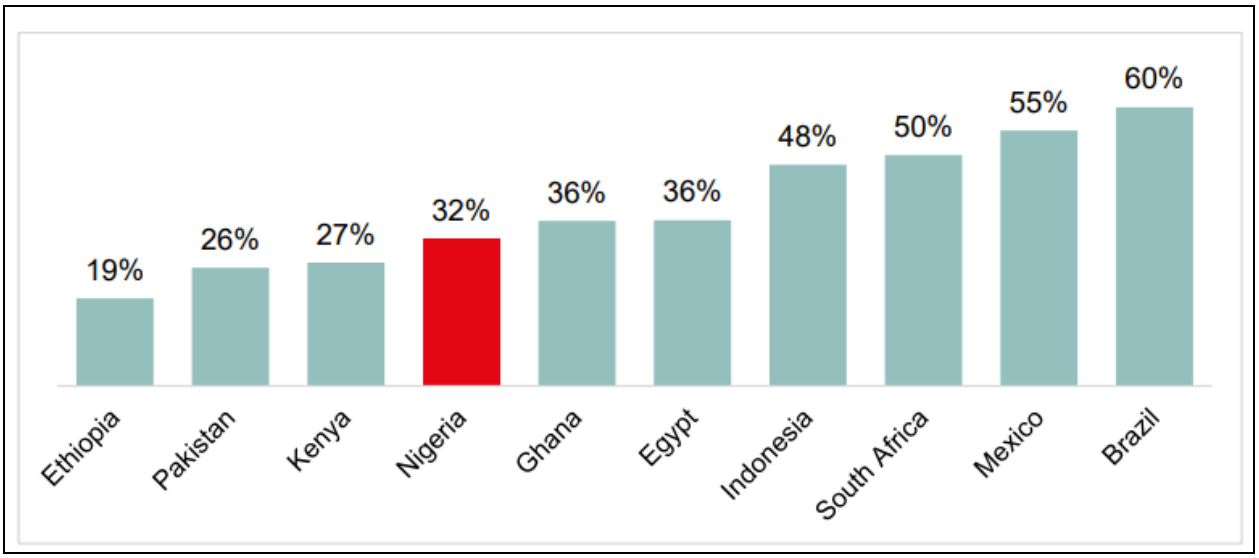


**Figure 15: Comparative of Nigeria's mobile internet penetration vs. selected countries. Source: GSMA Intelligence (2019).**

Corroborating the coverage situation in Nigeria, according to Interviewee 23,

> "*While we intend to hit 80 percent 4G population coverage at the end of this year [2022], I still get a shocking and surprising quantum of people that call me, telling me that they don't have coverage in one location or the other. So, I think there is still a massive opportunity out there in terms of people that we can bring in under the telecommunications umbrella in Nigeria. It is an opportunity that exists from a financial and social perspective, so there is room for economic opportunity for MTN Nigeria. It won't be 100 percent and will never be 100 percent. I don't see anywhere in the world with 100 percent. Still, I think there are many opportunities to bring these people into the telecommunication ecosystem and uplift them and everything about their lives."*

Within this context, to bridge these infrastructural deficits in an environment of constrained government spending, stakeholders within the country's telecommunications industry estimate a private sector investment requirement of about $140 billion to realize the broadband penetration target of 70 percent and 3G network coverage of 90 percent by 2025 (see (Adepetun, 2022), as indicated in the Nigerian National Broadband Plan (2020 – 2025).[88] So far, Nigeria's Universal Service Provision Fund (USPF),[89] set up by the NCC in 2007, has been ineffective and inefficient in realizing the ubiquitous coverage targets in the country (see Arakpogun et al., 2017; Osuagwu, 2021; Mgbeokwere, 2022). In optimizing the USPF in the context of Nigeria's converging telecommunications industry, a fundamental consideration is the market efficiency in relation to the regulation of emerging competition dynamics. This consideration is pivotal for market operations and its efficient expansion, especially in unserved and underserved areas (see Navas-Sabater, Dymond & Juntunen, 2002; Dymond & Oestmann, 2003; Muhammed & Oyinwola, 2019).

A World Bank empirical study led by Foster and Briceño-Garmendia (2011: 160) indicated that over 30 percent of the unserved population across Sub-Saharan Africa "will be provided with network coverage if fully effective competition is established." Therefore, a less complex and more cost-effective policy pathway for bridging the coverage gap in the Nigerian case is to ensure the optimality of market efficiency to incentivize private investments before considering USPF subsidization. This proposition is imperative contextually, given that the existing coverage gap in-country is historically attributed mainly to market inefficiencies rather than the non-commerciality of

[88] https://www.ncc.gov.ng/documents/880-nigerian-national-broadband-plan-2020-2025/file

[89] https://www.uspf.gov.ng/

uncovered areas (see Figure 16) and its very low sensitivity to higher costs of new generation network infrastructure (see Figure 17).[90]

[90] The empirical study by Foster and Briceño-Garmendia (2011: 167) indicates that "even the most extreme rise in infrastructure costs—six times higher than the baseline scenario—increases the coverage gap in Nigeria to only 1.4 percent of the population."

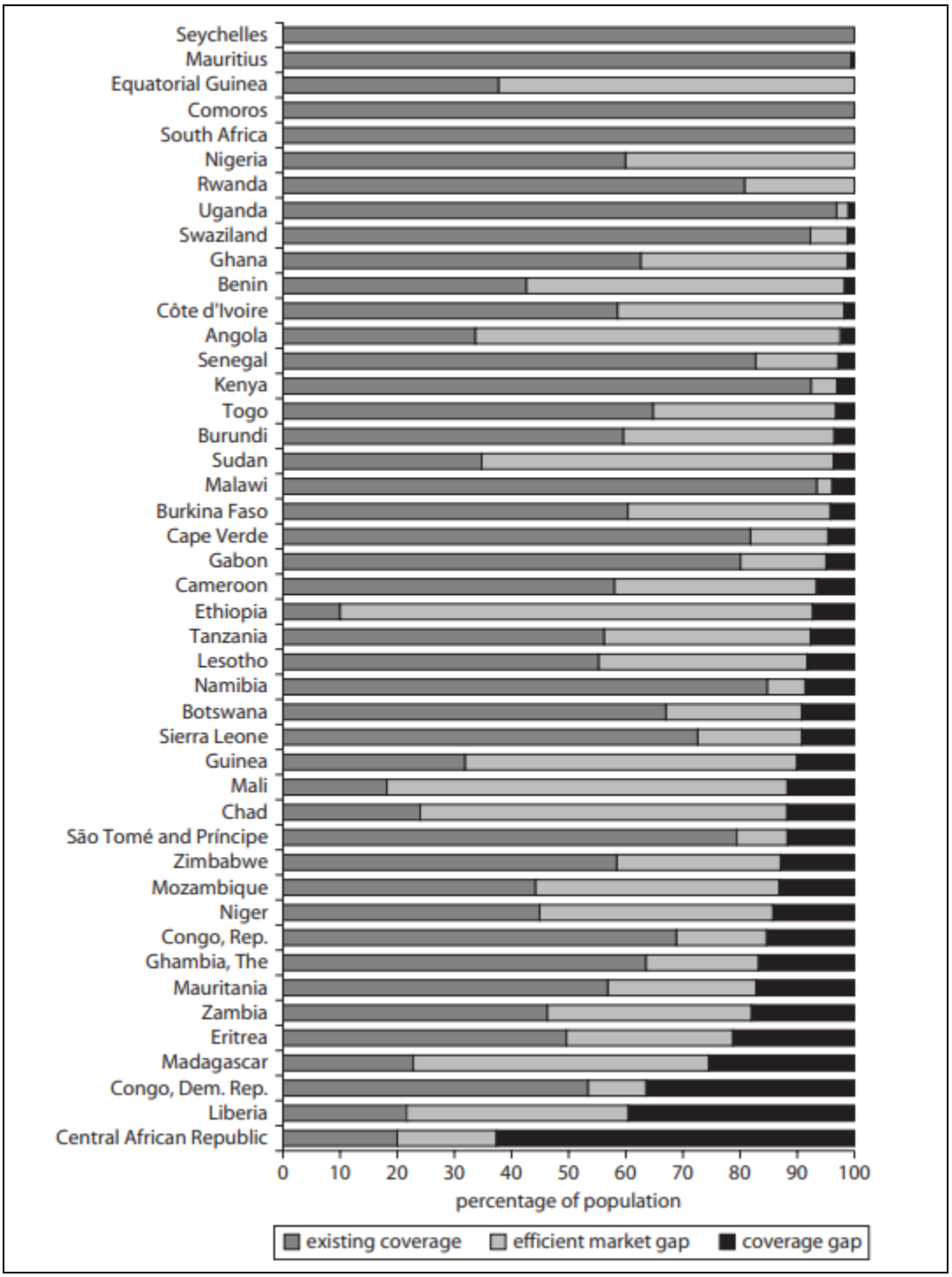


**Figure 16: Comparative Coverage Gap Analysis for 45 SSA Countries. Source: Mayer et al. (2009)**

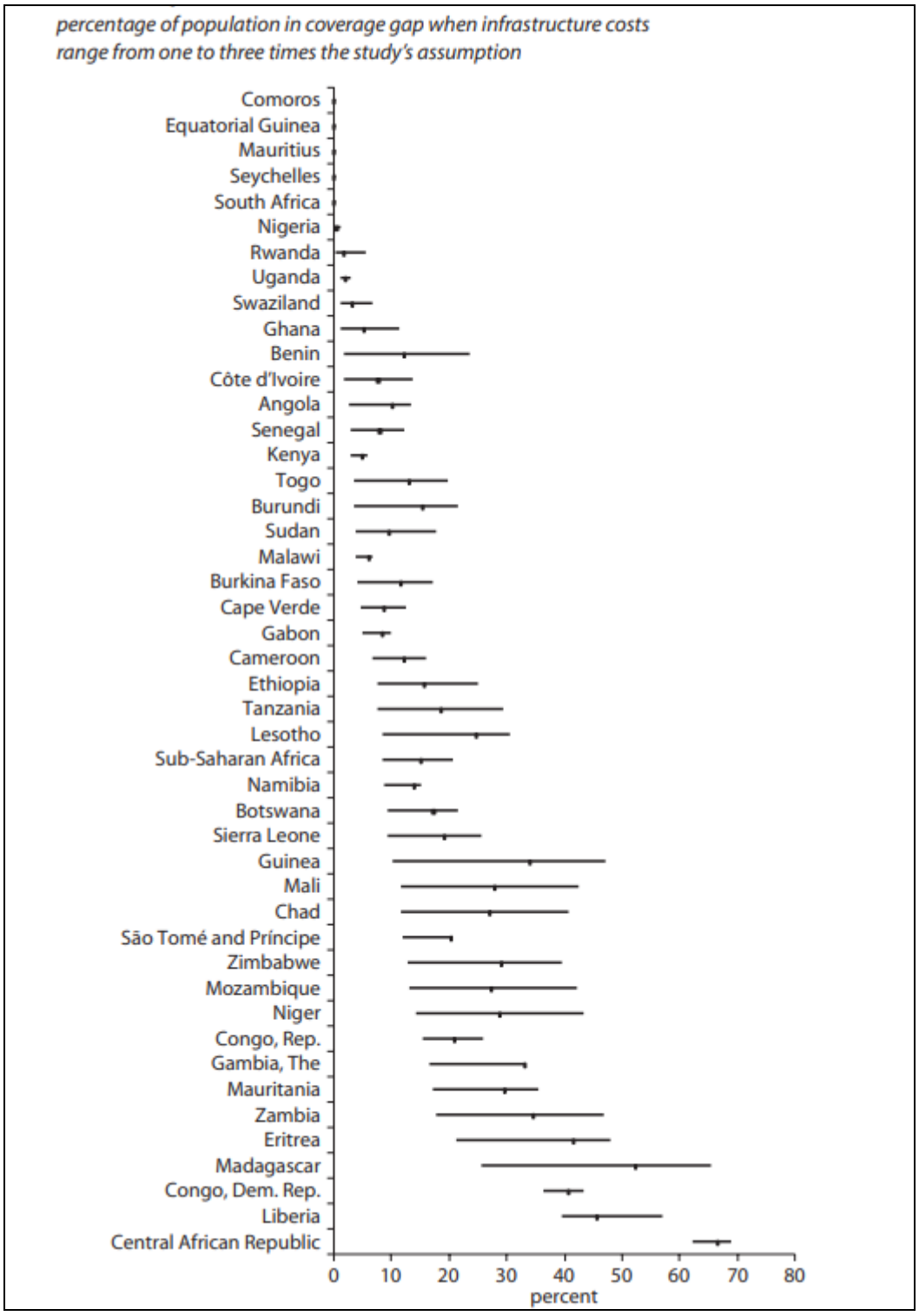


**Figure 1: Country-Level sensitivity of coverage gap to infrastructure cost changes.**

**Source: Mayer et al. (2009)**

In relation to these assessments, one of such critical regulatory reforms in addressing the efficiency gap in the Nigerian telecommunications market is an optimal pricing regime. In alignment with the position of Interviewee 9, a vital policy pathway in this regard is the re-introduction of a data price floor to incorporate some level of guarantee in ensuring that telecommunication operators profitably price data and voice services, regardless of changing customer behaviours as a result of OTT data offerings.[91] Bridging this pricing inefficiency is a fundamental economic rationale for regulatory intervention[92] before USPF subsidization in unserved and underserved areas. This proposition is imperative especially concerning the retail mass market segment, where affordability and price sensitivity are critical factors influencing access and adoption (see Armstrong, 2002; Dymond & Oestmann, 2003; Gillwald, Odufuwa, & Futter, 2016). This pricing strategy considers the impact of network externalities[93] from the side of the OTTs and will encourage more adoption of Internet services, raising the overall social welfare. This proposition contrasts with the current cost-based pricing structure proposed by Nigeria's National Telecommunications Policy and adopted by the NCC, which it justifies on the argument of idealistic competitive telecommunications markets. The reinstatement of the data price floor will safeguard and expand new generation access network infrastructure in alignment with increasing data traffic and lessen the erosion of market value for network operators who, due to intensifying OTT-induced competition, have priced data often below cost[94], thereby constraining their capacities to reinvest in network expansion. This process will be imperative to address the poor coverage, quality of service, and user experience, especially in unserved and underserved market segments — where the markets are commercially constrained to generate cross-subsidies that may allow for artificially below-cost pricing (see Dymond & Oestmann, 2003).

[91] In relation, data-centric innovations such as bundling by MNOs in response to OTT competition effects provides a viable mechanism for a more ubiquitous provision of an excludable public good such as internet-based telecommunications services (see Fang & Norman, 2003; Kobayashi, 2005).

[92] See Economics Frontiers (2005)

[93] In relation to network externalities, the aforementioned position is surmised on the perspective that while consumer citizens may realize direct benefits as a result of the economic activities of both the MNOs and OTTs, non-consuming citizens also benefit from the systemic, inter-relational effects of the converged digital ecosystem that improves societal socio-economic conditions (see Madden, 2010; Frischmann, 2012; Acharya, 2013).

[94] Why NCC wants upward price review for data services in Nigeria. Accessed July 12, 2021: https://guardian.ng/news/why-ncc-wants-upward-price-review-for-data-services-in-nigeria/

The aforementioned proposition is pertinent for the developing Nigerian market, given the increased infrastructural cost constraint imposed on the incumbent MNOs by the currently unregulated market entrant OTTs, which further limits the possibilities for cross-subsidization and cost averaging towards universal service provisioning (see Xavier & Ypsilanti, 2007). More so, compared to more developed markets, the Nigerian market's cost of universal service provisioning, according to Interviewee 1, "is extremely more significant — given the higher challenge of both affordability and coverage gaps, requiring a larger scale of universal service." Therefore, based on classical market economic theory, a laissez-faire regulatory approach, particularly concerning an optimal pricing regime, will ultimately not be positive for social welfare regarding universal service provisioning by incumbent MNOs in the wake of fierce international competition (see Melody, 1997).

In particular reference to pricing, the regulatory agency (NCC) may need to evolve the current cost-based pricing structure beyond the requirements for a price floor, especially with respect to the retail mass market segment where affordability and price sensitivity are critical factors influencing access and adoption. This pricing strategy will consider the impact of network externalities from the side of the OTTs and encourage more adoption of Internet services — raising the overall social welfare. This position contrasts with the current cost-based pricing structure proposed by Nigeria's National Telecommunications Policy and adopted by the NCC, which the regulatory authority justifies on the argument of idealistic competitive telecommunications markets. In relation to network externalities, the author surmises this position on the perspective that while consumer citizens may realize direct benefits as a result of the economic activities of both the MNOs and OTTs, citizens who are not consumers also benefit from the systemic, inter-relational effects of the converged digital ecosystem that improves societal socio-economic conditions (see Frischmann, 2012).

### 5.3 Overall Conceptual Analysis

In applying a complexity theory lens that emphasizes dynamic interactions among interdependent actors, the author conceptualizes the telecommunications industry in Nigeria within the broader digital ecosystem that encompasses the MNOs, OTTs, network infrastructures, processes, policies, applications, services, users, and other ecosystem stakeholders within the domain of study. This broader context allows the interrogation of specific regulatory and policy interventions across a

more comprehensive ecosystem framework. It highlights the critical inclusion of consumers or users — who, from a social policy endpoint, should be at the centre of the telecommunications ecosystem. Having the user at the core of the ecosystem allows more focus on the demand-side assessment of policy mechanisms and interventions, beyond the traditional supply-side focus in public resource assessment, allocation, and infrastructure development, in ensuring that the capabilities of the converging telecommunications market are realized at the ecosystem base. In addition, it allows for a better analysis of welfare effects[95], particularly in allocating public goods and delivering public services by the private sector.

Regarding the converging telecommunications and Internet value chain, complexity theory allows the author to conceptualize this sub-sect of the ecosystem as an organic network beyond just the traditional layered models used by scholars to analyse telecommunications systems (see Fransman, 2006). This more ecological approach helps comprehend the adaptive nature of the telecommunications infrastructure systems as they evolve from analogue to digital and Internet Protocol (IP) based domains, with intrinsic characteristics of scalability, self-organization, and sustainability (Smith, Elder, & Emdon, 2011).

At the infrastructure layer, assessing the development of the telecommunications ecosystem in Nigeria incorporates both the social-economic and technical dimensions, which then allows the interrogation of the dynamic complexities in its evolution. From a technical standpoint, we can assess its heterogeneous technological capacity; on the other hand, we can evaluate the interplay between the ecosystem stakeholders and the institutional mechanisms driving the ecosystem's growth from a social-economic dimension. From this analytical viewpoint, the author posits that while Nigeria's telecommunication industry's infrastructure system has expanded due to the opening up of competition for mobile and fixed telephony and Internet services, it has not led to the complementary development of institutional stakeholder capacity or capabilities of users. The author argues that a fundamental reason for this state is the traditional top-down process of policy development (passed down from market liberalization legacies), which creates significant regulatory

[95] If a traditional definition of consumer-producer surplus is employed.

asymmetry, neglecting the cultural context of infrastructure adoption and use within Nigeria's telecommunication industry.

More so, with the increasing reliance on the existing network infrastructure as a consequence of OTT services adoption by users[96], the optimal network capacity requirements were therefore unforeseen[97] and consequently unplanned in coping with the socio-technical demands for infrastructural flexibility and adaptability. This critical demand contradiction is fundamental in creating the current tension for infrastructure evolution within Nigeria's converged telecommunications industry[98], which is in itself a complex adaptive system — both constrained and enabled by its installed base (see Hanseth & Lyytinen, 2016).

A complexity perspective sensitizes the analysis to the fact that new generation network infrastructure additions to Nigeria's evolving telecommunications market are path-dependent and non-linear (making outcomes even more unpredictable). Therefore, they should be integrative to the current base from a horizontal and backward demand compatibility dimension — including user capacity and agency (see Star & Ruhleder, 1996; Edwards et al., 2007; Oughton et al., 2018). In particular, investing in technological capabilities from a user perspective can act as a system attractor for self-organization in addressing the "bootstrap problem" of infrastructure buildout. This effect will reduce the risk of foregone investments, increase the credibility and adoption of new-generation infrastructure, and likely further increase the installed capacity base (Hanseth & Lyytinen, 2016). Furthermore, to ensure the order requisite for maintaining ecosystem stability and resilience during the process of network infrastructure evolution within the Nigerian telecommunications market, deploying a modular approach to infrastructure development would be appropriate for the Nigerian context (see Bauer & Herder, 2009; Perrow, 2009). This proposition would imply that localizing the varied network requirements across the different parts of the country in a balanced manner — concerning simplicity, affordability, and user capacity — would create even more significant room for additional ecosystem innovation. This position aligns with the path-dependent historical ecosystem perspective as was adopted by NITEL during the pre-deregulation era in bridging

[96] Including complementary network effects

[97] By both operators and regulators

[98] More so, as regulatory controls shift from local to global contexts

network infrastructure deficits by leveraging a phased network expansion approach (see Obutte, 2014).

On the institutional dimension, regulation of these complex adaptive systems will require investment models that depend on evolving the institutional arrangements in relation to the regulatory capacity of agencies. This plausibility will enhance investors' confidence, especially within a more open infrastructure ecosystem, beyond the traditional considerations of static efficiency that have prevailed in the Nigerian telecommunications market. This condition is even more imperative considering the critical issue of ubiquitous and affordable access within the Nigerian ecosystem — where increased infrastructure investments are crucial for enhancing inclusive broadband adoption via demand stimulation and supply of OTT services (see Gillwald, 2017). Moreover, institutional arrangements that constrain the independence of the regulatory agencies will lead to failure in creating an environment of stability and certainty that will guarantee returns on infrastructure investments (see World Bank, 2014).

However, the aforementioned policy pathway critically depends on the relationship-building capacity of the regulatory authority within the evolving dynamics between states, the converging multi-sided telecommunications market, and ultimately, the society for co-constructing stakeholder-agreeable outcomes based on a public-good perspective (Black & Kingsford Smith, 2002; Bourgon, 2011). According to the conceptual analysis in Section 5.3, this critical imperative is traditionally lacking within the Nigerian telecommunications industry. This requirement is imperative when considered within an adaptive mechanism for institutional change concerning the evolving complexities earlier highlighted. Maintaining the institutional status quo portends a source of institutional instability for stakeholder-agreeable outcomes (see Haveman & Rao, 1997; Scharpf, 1997; Rinas, 2021). The resultant effect of this condition is the dis-incentivization of both investments and innovation, which might ultimately lead to institutional exhaustion (see Fligstein, 2001).

## 5.4 Historical Policy Evolution Assessment from More Mature Telecommunications Markets

As outlined in Section 5.3, the institutional considerations highlight the regulatory policy challenges and deficits that ecosystem stakeholders need to bridge for a converging telecommunications market like Nigeria's. However, as the challenges that have crystallized from the exploration of the thesis' research questions are not unique to Nigeria[99], this section draws selected insights from the early historical steps of regulatory reform and policy evolution processes of more developed telecommunications markets, which could be congruent for the Nigerian situation. The telecommunications policy discourse in the more developed digital markets is currently moving from the past regulatory regime, mainly focused on the introduction of competition into the telecommunication market, to a next-generation framework of regulating the digital economy (e.g., Furman et al. 2019; Crémer et al., 2019; Morton et al., 2019). Some contemporary steps in this direction include passing relevant European legislation, such as the Digital Markets Act (DMA) in 2022 and the Digital Services Act (DAS) in 2020. These current reforms are interesting policy initiatives from which ecosystem stakeholders might eventually draw lessons and insights for the Nigerian evolution. Because the contextual telecommunications market is at an early stage of convergence development, this section briefly focuses on lessons from the prior institutional and regulatory developments in select, more mature telecommunications markets.

### 5.4.1 United Kingdom

Mainly as a consequence of colonial history, Nigeria's telecommunications regulatory framework is modelled after that of the United Kingdom, with contextual applicabilities and minimum transplantation issues between the policy frameworks developed by The Office of Communications (Ofcom)[100] and those of the NCC (see Adesanya, 2020). From the primary perspective of convergence, The Communications Act 2003[101] was the basis for regulatory policy reform, as implemented by Ofcom within the British telecommunications industry (see Doyle & Vick, 2005). A product of the newly elected Labour Government in 1997, several options were open to the Tony Blair-led government in dealing with the emerging dynamics of convergence in the British

[99] With adjacent implications for similar developing countries in general

[100] https://www.ofcom.org.uk/home

[101] https://www.legislation.gov.uk/ukpga/2003/21/contents

telecommunications market. At one end of the various policy pathways was to maintain the regulatory status quo and simply enhance coordination between the several distinct regulatory institutions within the telecommunications industry; at the other end was the establishment of a converged regulator, and in between the two options, was the creation of two separate regulators — one to superintend telecommunications infrastructure, and the other, as a digital content regulator. After several consultative engagements, the British Government abandoned its initial evolutionary regulatory approach towards a more revolutionary process with the publication of the Department of Trade and Industry (DTI) White Paper — A New Future for Communications[102] in 2000. The White Paper dismissed the extant regulatory structure in the UK telecommunications industry and set out modalities for establishing a new converged communications regulator that will be responsible for the combined regulation of electronic communication networks and services, digital content, and broadcasting services, Ofcom, in 2003.

The main objective of this policy pathway was universal access within a dynamic and competitive communications market, combining light-touch regulation with significant social welfare considerations (see Michalis, 2014). Nevertheless, while conventional wisdom indicates a non-interventionist role for a neo-liberal State, the British National Government continues to play a significant part in shaping the policy evolution process of its telecommunication market (see Wang & Sun, 2021). A key policy pathway in this regard, especially concerning universal access, is the enforcement of its "competition-for-the-market" model to incentivize private investment in areas in which commercial investment projects are not feasible, enabled by an open access regime at the wholesale infrastructure layer (see DDCMS, 2018). It has also implemented a risk-adjusted retail pricing regime that guarantees operators a fair return on infrastructure investments and regulatory forbearance to support commercial agreements between operators for new-generation infrastructure sharing.

### 5.4.2 The European Union (EU)

The EU telecommunications framework is normatively based on a neo-liberal policy perspective (see Simpson, 2009). Significant policy reforms in the EU began around the late 1990s, with systematic

[102] https://www.key4biz.it/files/000038/00003816.pdf

changes to regulatory approaches concerning market competition. The regulatory policy evolution started with the issuance of the EU Green Paper on the convergence of telecoms, media, and IT technologies[103] in 1997 and culminated with the enactment of the European Electronic Communications Code (EECC)[104] in September 2016 for the governance of the EU telecommunications market (see Latzer, 2014; European Commission, 2016; Briglauer et al., 2017; European Parliament and Council, 2018; Savin, 2018b; 2018c). The main goals of the EECC were three-pronged: incentivizing investments in new-generation access networks, facilitating infrastructure co-investments, and enhancing access regulations (see Briglauer & Vogelsang, 2017). With respect to the disruptive emergence of OTTs and the convergence of networks, the regulatory objective of the EECC in driving up investments in new generation access (NGA) networks was underpinned by a policy pathway of less market regulation, especially concerning wholesale access[105] in conflict with the contrasting objective of universal service provisioning in relation to high-capacity connectivity requirements (see Briglauer, Cambini & Grajek, 2015; Briglauer et al., 2017; Vogelsang, 2019). As an outcome, the EU fell behind other developed regions in ubiquitous NGA deployment.[106] In hindsight, high-capacity connectivity required less emphasis on static competition and consumer welfare imperatives, which meant that high enough prices in relation to capacity requirements were critical for incumbent operator profitability (see Waverman, 2007; Bourreau, Cambini & Doğan, 2012).

### 5.4.3 United States of America (USA)

The contemporary telecommunications policy framework in the United States (US) is historically underpinned by the supposition of a two-sided market structure and the principal conception of network neutrality for an open Internet. The critical focus is furthering the objectives of market

[103] https://op.europa.eu/en/publication-detail/-/publication/3967c098-852d-4774-af8b-691e70b40395

[104] https://d-nb.info/1193584868/34#:~:text=In%20September%202016%2C%20the%20European,into%20high%2Dspeed%20communication%20networks.

[105] This policy mechanism contrasts slightly with that of the UK (Ofcom) where wholesale access is regulated in relation to the competition intensity at the local exchange level (see Larouche, 2007).

[106] For example: Fibre to the home (FTTH) adoption was above 70 percent in South Korea and Japan but less than 10 percent in the EU as of early 2017, while 4G/LTE deployment in the United States was more than 65 percent as of 2016, in comparison with the same figure for the EU at around 30 per cent (Savin, 2018c: 33; Humphreys & Simpson, 2018; Milon, Nur-Al-Ahad & Monjurul Alam, 2018).

competition, new generation access network expansion, and universal service (see Smith, 1968; FCC, 1996; 1998; 2001; 2002a&b; 2005; 2009; Oxman, 1999; Liebenau, Elaluf-Calderwood & Karrberg, 2012). Similar to the neo-liberal policy of the EU, in realizing the above policy objectives, the Federal Communications Commission (FCC) pursues reduced regulation to promote market competition (see Bar & Sandvig, 2008; Flew & Su, 2021). In particular, concerning the emergence of convergence in the telecommunications industry, the FCC's perspectives are significantly shaped historically by the 1972-86 Computer Inquiries Resolutions. This adoption was in congruence with a major shift from the traditional structural separation in regulating the telecommunications and broadcast industries, in alignment with the emerging Chicago School position of promoting efficiency and innovation through competition in public utility regulation (see FCC, 1972; Zarkin, 2003). However, the FCC maintained a market boundary between regulated communications and often substitutable, unregulated data processing services to enhance open competition and prevent cross-subsidization.

This policy mechanism created a classification dichotomy between basic and enhanced telecommunication services within a layered market model, eventually forming a vital component of the Telecommunications Act 1996 (see FCC, 1996; Oxman, 1999; Liebenau et al., 2012). In addition, to provide market safeguards within the ambits of structural separation, the FCC required that facilities-based telecommunications providers who desired to provide enhanced services must have to unbundle their basic offerings from the enhanced telecommunications service or provide the bundled service via an un-affiliated enhanced service provider (ESP) (see Cannon, 2002). More so, in contrast to the funding mechanism primarily derived from the 1 percent of the total revenue of mobile telecommunications operators in the case of Nigerian USPF, ubiquitous access as enabled by the FCC's universal service system was significantly, historically funded by a combination of implicit and explicit subsidies provided by the government in lieu of the cost requirement of telecommunications service provisioning by private players in non-commercial areas (see FCC, 1996; Oxman, 1999).

### 5.4.4 South Africa

Like the Nigerian case, telecommunications policy scholars still consider South Africa a maturing telecommunications ecosystem. This position is with respect to congruent market and regulatory challenges, including significant unsatisfied user demand for basic services, poor quality of service,

and high data prices, despite liberalization and consequent remarkable industry growth (see Fricke, 2004; Southwood, Nguo, Sagna & Lewis, 2006; Pau, 2011; Gillwald, Moyo & Stork, 2012; Mpwanya & Letsoalo, 2019; Shava, 2021a,b). With four licensed mobile network operators (MNOs) — MTN, Vodacom, Cell C, and 8ta (a subsidiary of Telkom) — the South African telecommunications industry is similarly as competitive with respect to market structure as the Nigerian case. However, a key distinction is the prevalence of a fixed line market penetration of almost 2.5 percent in contrast to the Nigerian case at a lowly 0.05 percent.[107] The continuous evolution of fixed-mobile convergence within the South African market had driven the embracing of OTTs by the dominant mobile network operators. This mechanism consequently enhanced infrastructure utilization as a consequence of increased levels of data utilization, leading to the situation where the South African market long became more digitally mature than Nigeria's, as data emerged as the dominant revenue for MNOs since 2012 (see Gillwald et al., 2012; Montpetit, 2016; Eido, 2017; Chen, 2019; Turk & Zeydan, 2020). Consequently, the South African telecommunications market has since rolled out extensive new-generation networks, with 4G and 3G at 80 and nearly 100 percent coverage, respectively, across the country (see Gillwald, Mothobi & Rademan, 2018; Robb & Paelo, 2020). Concerning regulatory convergence, following the establishment of the South Africa Telecommunication Regulatory Activity (SATRA) as an independent sector regulator in 1997, the Independent Communications Regulatory Authority of South Africa (ICASA) evolved with the merging of SATRA and the Independent Broadcasting Authority (IBA) in 2000 (Chanakira, 2013). This evolution was followed by the regulatory repealing of the Telecommunications Act of 1996 and the Independent Broadcasting Authority Act of 1993 in establishing The Electronic Communications Act (ECA) of 2005. This policy process ushered in services-based and horizontal competition and licensing regimes in alignment with the technological convergence of the country's digital ecosystem (see Cohen, 2007; Mothobi, 2018).

### 5.4.5 Contemporary Developments and Lessons Synthesis

In more recent times, given the significant market dominance effects in relation to competition by the global digital platforms within the converged telecommunications ecosystem, the current focus

[107] See https://www.ncc.gov.ng/stakeholder/statistics-reports/industry-overview; https://www.ceicdata.com/en/indicator/nigeria/number-of-subscriber-fixed-line; https://www.ceicdata.com/en/indicator/south-africa/number-of-subscriber-fixed-line

of regulatory reforms globally has shifted to the assessment of the contemporary power structures within the political economies of regional markets with the ultimate objective of consumer welfare protection (see Hoelck, 2016; Geradin, 2018; Morton et al., 2019). The critical consideration within these assessments is the market power implications of cross-sided network effects and its implications for realizing social public interest objectives as can be leveraged by regulatory reform (see Morton et al., 2019; Parcu, 2020). This policy drive has been championed globally by the European Union (EU) since the early 2000s with an antitrust regulation focus in relation to country-specific market definition within the dynamically emerging digital ecosystem (see Eisenach, 2012; Evans, 2013). However, with the unsolved challenges with regard to effective policy interventions[108], the reforms shifted towards a transnational approach in the development of specific overarching regulations, given the significant trans-jurisdictional attributes of the dominant global digital platforms (see Batura, van Gorp & Larouche, 2015; Ezrachi, 2018; Morton et al., 2019). Nevertheless, there are still notable disagreements within the telecommunications policy scholarship with regard to the unsolved regulatory challenges of the converging digital ecosystem in relation to which economic assessment tools will work best for pro-competition policy reforms (see Crémer, de Montjoye & Schweitzer, 2019; Furman et al., 2019; Morton et al., 2019).

Within the emerging market context, beyond the complementary supply-side infrastructure issues that persist in evolving the existing telecommunications markets within the converging digital ecosystem, the barriers to mass broadband access are predominantly underpinned by demand-side issues (primarily digital literacy capacities and affordability of digital products and services). These factors reflect deep structural inequalities within and between countries on the African continent that require addressing. For example, the ongoing problem of applying remote community access solutions where 60 to 80 percent unconnected coverage problems persist barely addresses the minimum 20 percent critical mass for broadband network effects to scale within the region. While acknowledging these underlying challenges from a policy perspective, ecosystem stakeholders must take priority measures to expand access within these constraints to not catalyze the compounding effects of digital inequality on existing inequalities. Existing state responses (more so in South Africa than Nigeria) to responding to increased demand for bandwidth via the allocation of additional

[108] As the classical economic market assessment tools failed in relation to the evolving two-sided markets within the telecommunications ecosystem (see Evans & Schmalensee, 2013).

spectrum to dominant market players (primarily used as buffer spectrum to test 5G) did not bring new people online but offered those already online higher quality bandwidths. So, alternative strategies to exclusive national licensing and expensive GSM business models, to enable more cost-effective technologies and reduce market entry barriers to facilitate multiple market players through effectively regulated wholesale access regulation, are the kind of essential policy experimentation needed within emerging markets telecommunications ecosystems evolution.

Within the thesis context, a critical lesson for Nigeria in evolving its converging telecommunications market is the level of active government involvement. For example, while the importance of broadband expansion had become common ground in both the European Union and the United States, their neo-liberal, non-interventionist position contrasts markedly in its development with a strong government interventionist approach of, say, South Korea — the global leader in broadband evolution on both the supply and demand sides (see Picot & Wernick, 2007). Within this approach, the South Korean government championed the establishment of new-generation, high-speed backbone network infrastructure and stimulated demand via public projects, emphasizing the public-good characteristics of broadband expansion and adoption beyond the market competition.[109] While the situation is quite ambiguous across the EU, with varying degrees of supporting measures[110], the supply and demand-side government initiatives were not as "hard" as obtainable in South Korea, with very proactive government involvement (see also European Commission, 2004; Frieden, 2018). Nevertheless, in practice, the regulatory authority must seek to balance government intervention and regulatory forbearance — a critical incentive in the evolution of next-generation network infrastructure development, as the ecosystem transits from voice-centric to data-centric business models in the context of an increase in consumer willingness to pay for mobile Internet access (see Ogidiaka & Ogwueleka, 2019).

One key area of application concerning this is the issue of a mandatory open infrastructure access regime. For South Africa, for example, even with the extensive rollout of new-generation networks across the country, leveraging its significant fixed line segment, the evolution of mandatory open

[109] As more emphasized, for example in the United States (in contrast to the entrenched "Chicago School" of competition policy) (see also Lessig, 1998; Popiel, 2020).

[110] Which Cava-Ferreruela and Alabau-Munoz (2006) describe as either soft (for example in the UK) or medium-level interventions (for example, across France, Italy, and Spain).

access regulation within the country's digital ecosystem based on fostering both competition for cost-effective last-mile network infrastructure investments, and innovation in telecoms service offerings, especially for new entrant OTTs, have not been successful. This policy outcome was because the infrastructure-level competition[111] was not viable, given the high sunk cost associated with new generation broadband roll-out. The market situation then required the State to establish a ubiquitous national fibre backbone that was made open to all service providers on a non-discriminatory basis and, instead, promote the market competition on a service basis to realize more dynamic efficiencies in market innovation (see Bauer & Bohlin, 2008; Gillwald et al., 2016; Gillwald, 2020). The implications of a services-based competition regime within the boundaries of the current net-neutral regulatory position of the NCC in favour of the OTTs are imperative for consumer welfare within a competitive capitalist market, especially with respect to zero-rated pricing models. This proposition could lead to traffic discrimination by network providers, considering the weak regulatory capacity of the NCC, and calls into question the effectiveness of net neutral regulation in a developing country market, such as Nigeria's converging telecommunications ecosystem (see Caf, 2015; Eisenach, 2015; Marsden, 2016).

## 5.5 Chapter Five Summary

This chapter establishes that assessing regulatory policy for OTT-Telco competition in the Nigerian telecommunications market requires a prior market definition. Therefore, based on the insights from the market segmentation theme, specifically, that technology convergence has dramatically changed the market structure in telecommunications markets, altering the competition dynamics between the traditional telecommunication operators and emergent over-the-top players, the thesis asserts that explicating a systematic regulatory framework that accounts for the specificities of the layer-separate digital markets must be taken into consideration.

While a complementary dynamic between both market segments currently subsists, increasing the attractiveness of the network access to consumers, the value accruable in relation to investments required to sustain the business model is disproportionately in favour of OTTs, because of a mismatch in cost structures (lower sunk costs and economies of scale) as well as a higher profit

[111] To achieve static efficiencies in price and consumer welfare

scope — in relation to the traditional telecommunication operators. Consumer effects such as price commoditization may portend adverse consolidation effects within the industry in the longer-term risk. In addition, the increasing network capacity demand in Nigeria's telecommunications industry due to OTT market penetration and adoption of products and services is increasing the imperative to invest, especially in data infrastructure, in a more efficient manner. However, the regulatory lacuna concerning OTT competition is partly causing the MNOs to invest less in their data networks.

From a welfarist perspective, the ultimate objective of competition policy is maximizing consumer surplus. Nevertheless, considering the complex complementarities between network infrastructure and content services, the author asserts that the societal benefits of OTT-MNO competition cannot be assessed separately. Therefore, considering these dynamic complexities, the plausibility of ex-post competition law was noted as doubtful for OTT-MNO regulation within the Nigerian telecommunications market. Nevertheless, even an ex-ante regulatory regime must consider the specificities of the layer-separate digital markets and their spatial (concerning products and services) and temporary (jurisdictional) dimensions.

Within that analytical context, an institutional analysis framing positions the users at the core of the converged telecommunications ecosystem for the realization of demand-side policy interventions, in addition to the more classical supply-side approach to telecommunications market developments. However, the analysis of the extant policy regime of the Nigerian telecommunications market crystallizes little about competition policy concerning two-sided telecommunications markets and, therefore, is inadequate for understanding the complex interrelationships between pricing, investment, and innovation as they affect social welfare. Considering the emerging market structure of the country's telecommunication industry, the thesis asserted the criticality of the requirement to review the extant price regulatory model in a manner that optimizes incentives to enhance competition in the multi-sided market so that the social welfare of users is maximized; un-influenced by market distortions that arise as a result of imperfect competition. In this regard, the institutional framework proposed policy pathways for a regulatory trade-off that optimizes both static and dynamic efficiency, with respect to the net surplus of resource allocation with a focus on investment and innovation; distributional equity for inclusive access with a focus on demand-side value,

complementary to the currently dominant supply-side valuation in the allocation of resources; and finally, a sustainable change responsiveness and adaptability in the short and long terms.

From a complex systems perspective, the thesis posited that while the infrastructure system of Nigeria's telecommunications market has expanded as a consequence of the opening up of competition for mobile and fixed telephony and Internet services, it has not led to the complementary development of institutional stakeholder capacity or capabilities of users. In this purview, a complexity perspective sensitizes the analysis to the fact that new generation network infrastructure additions to Nigeria's evolving telecommunications market are path-dependent and non-linear (making outcomes even more unpredictable). Therefore, they should be integrative unto the current base from horizontal and backward demand compatibility dimensions — including user capacity and agency. This position will require investment models that depend on evolving the institutional arrangements in relation to the regulatory capacity of agencies within the Nigerian telecommunications ecosystem. The author substantiates the policy implications of the above propositions in the ecosystem mapping that follows in Chapter Six.

# Chapter Six: An Initial Ecosystem Mapping of the Converging Nigerian Telecommunications Market

## 6.0 Introduction

In further integrating the conceptual and analytical discourse within the context of the thesis, it is important to re-emphasize that the rapid diffusion of Internet-based networks is altering the socio-technical communication system that enables the emerging digital ecosystem, including the institutional arrangements for national and global governance. Technically, as previously indicated, this transition is primarily driven by the convergence of the telecommunications ecosystem (Wu, 2004). Economically, however, the shift in the digital ecosystem is driven by the liberalization of markets that has spawned lower-cost technology innovation, ending natural monopoly elements of network infrastructure that provided the rationale for utility regulation and enabled competition in telecommunications infrastructure provisioning (see Mueller, 1999; Singh, 2016). These shifts in the digital ecosystem have significant implications for consumer access and use, competition, innovation, and investment, especially in developing countries — where the cost of new-generation infrastructure rollouts limits the speed of convergence.

In the domain of telecommunication policy analysis, a critical question arises as to whether challenges arising from such systemic changes as described assert any significance to contextual relationships in policy solution formulation in addressing market problems to minimize the previously stated unintended consequences. The complex causation patterns that arise because of the multifaceted, often non-linear, relations between these aforementioned factors raise new challenges for designing governance mechanisms to achieve socially desirable outcomes. For further emphasis, two main strands of research that tried to address this are inquiries into two- and multi-sided markets (e.g., Rochet & Tirole, 2006) and an emerging literature on complex adaptive systems and business ecosystems (e.g., Cherry, 2006; Parker et al., 2016). Although the jury is still out, traditional policy models no longer appear able to identify and balance market failures with the public interest and therefore are sub-optimal in unpacking the necessary and sufficient conditions for minimizing unintended policy outcomes (see Gillwald, 2009; Whitt & Schultze, 2009; Bauer & Tsai, 2014b; Bauer, 2015; Schultze & Whitt, 2016; Stocker et al., 2017; Bauer & Latzer, forthcoming).

Based on the above prelude, the thesis adopted a complementary synthesis of complexity theory and the Institutional Analysis and Design (IAD) framework to facilitate the assessment of efficient competition policy within optimal institutional arrangements that consider the increasingly complex convergence dynamics for investment, innovation, and social welfare. In particular, the IAD provides a guiding framework to analyse the static conditions of existing telecommunication policies and regulatory mechanisms in relation to dynamic situations where market interactions of both incumbents and new entrants create new dimensions that alter the incentives for investment and innovation on both sides of the market, with significant imperatives for long-term consumer welfare. As they relate to emerging market dynamics, these static assumptions form the basis of a comprehensive ecosystem mapping that elucidates a deeper vein of insights into the dynamic approaches to the governance of complex systems. The optimal conditions for designing an effective regulatory or policy intervention depend significantly on recognizing the most relevant intervention points within the ecosystem and coordinating the interventions to complement and support each other rather than counteract each other.

Within that purview, this Chapter provides an initial attempt at a comprehensive ecosystem mapping that can help inform dynamic approaches to the governance of advanced communications within the Nigerian context. It models the direct and indirect relationships between pricing, investment, and innovation within a coherent framework that encapsulates both the technical and socio-economic dimensions of the converging Nigerian telecommunications ecosystem.

## 6.1 Ecosystem Mapping Process

To develop the ecosystem mapping, the author assessed upstream causes and downstream effects to understand the critical forces driving the ecosystem evolution for the Nigerian telecommunications industry, aligning with the prior-stated thematic areas that the author identified from the institutional analysis in Section 5.1 and the analysis of the stakeholder interviews in Section 5.2. As the cause-effect relationships do not occur in isolation as with every complex system, the author looped the inter-relationships to feed into each other, capturing the dynamic patterns that drive the ecosystem evolution. The resultant dynamic loops, therefore, became the critical building blocks for the ecosystem mapping.

Within this purview, the author assessed the ecosystem interrelationships metaphorically and not explicitly based on any formal mathematical model to determine the direction and strengths of the ecosystem interactions (and therefore, the differences in the thickness of the lines are just for graphical illustration purposes, and to indicate stronger or weaker interrelationship effects). The author details the limitations of this qualitative approach in Section 7.3. Of note, however, is that this is a first effort to map these relevant interrelationships in relation to the converging Nigerian telecommunications market that would need to be refined and verified with additional data, as further explained in Section 7.3. Innovatively, the map blends economic concepts (e.g., investment, pricing mechanisms, cost), technical concepts (e.g., network traffic), regulatory concepts (e.g., deregulation), aspects of the legal and regulatory framework (e.g., ex-ante regulatory framework), and policy outcome concepts (e.g., market growth, consumer adoption, digital inequality) within the contextual Nigerian market. While some of the ecosystem linkages are preliminary as a first attempt, the author acknowledges that this is not yet a complete model but a starting point that will require further refinement leveraging more qualitative and quantitative data as the ecosystem matures, providing significant ambit for further, future research as the author states more explicitly in Section 7.3.

The author carried out the ecosystem mapping using the KUMU.IO online mapping software, which leverages systems theory and stakeholder mapping in developing an ecosystem map. The output of the ecosystem mapping (Figure 18) is available for full interactive visualization at the URL: https://kumu.io/JesoRay/phd-ecosystem-mapping#untitled-map-copy-copy2 . Due to page display constraints, which may confuse map interpretation in relation to the proximity of map elements, the author further clarifies that the + and - symbols signal the direction of the relationship. A '+' means that the construct increases within the ecosystem, and its influence could be in the same direction as another interrelating ecosystem construct, which is also '+' (e.g., higher prices, other things being equal, contribute to higher revenues); a '-' means that the ecosystem element decreases. In the instance when two interrelating ecosystem elements move in opposite directions (e.g., higher prices (+), other things being equal, are associated with lower consumption (-), this relationship is symbolized by an 'opposite' feedback indicated by the dotted line representation). However, because most of the ecosystem constructs are connected via more than one loop, the net effects are typically contingent on how strong the component effects are and their directions. Thus, higher prices

increase revenues (other things being equal) and reduce consumption (other things being equal). The latter, in turn, reduces revenues. So, the net effect of a price increase, for example, is influenced by these three counteracting effects. Policy scholars have extensively studied these ecosystem effects for simple market types, such as monopoly markets, where the net effect of a price increase on revenue is positive if the price elasticity of demand is <1 and negative if it is >1.

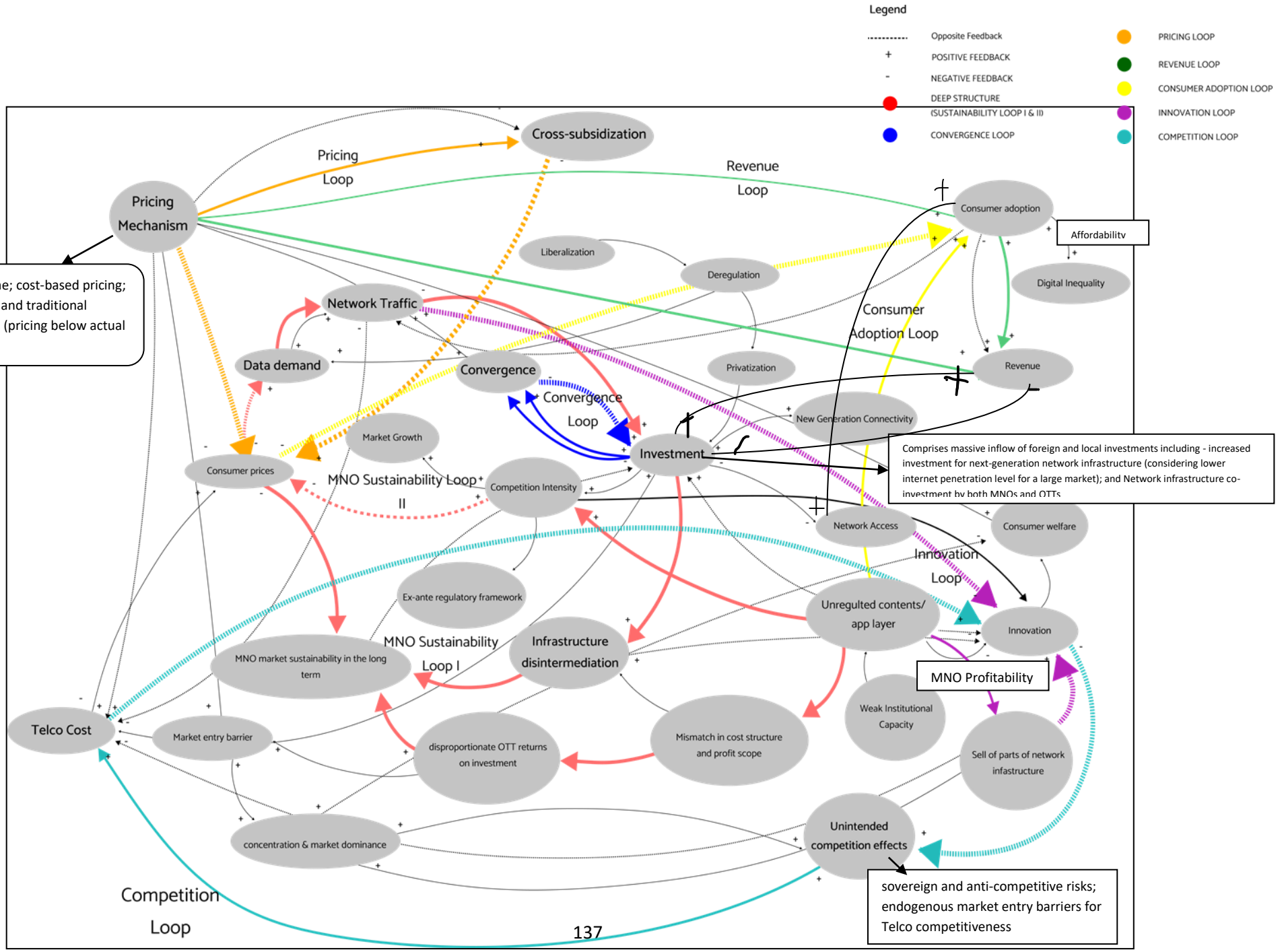


Figure 18: Ecosystem Mapping of Nigeria's Telecommunications Market

## 6.2 Ecosystem Mapping Results

The results of the ecosystem mapping reveal a contrasting perspective from the propositions of the theoretical analysis as expatiated in Section 5.3 which domiciles the consumer or the users as the central component of the telecommunications ecosystem. In contrast however, the ecosystem mapping of Nigeria's telecommunications ecosystem crystallizes the incumbent Mobile Network Operators (MNOs), particularly their long-term sustainability, as the most central component (i.e., the Deep Structure) of Nigeria's telecommunications market, concerning optimizing competition and consumer welfare outcomes. The imperatives of this centrality are assessed in the analysis of MNO Sustainability Loops 1 and 2 below, followed by a description of the other critical loops driving the ecosystem's dynamic evolution.

### 6.2.1 MNO Sustainability Loop 1

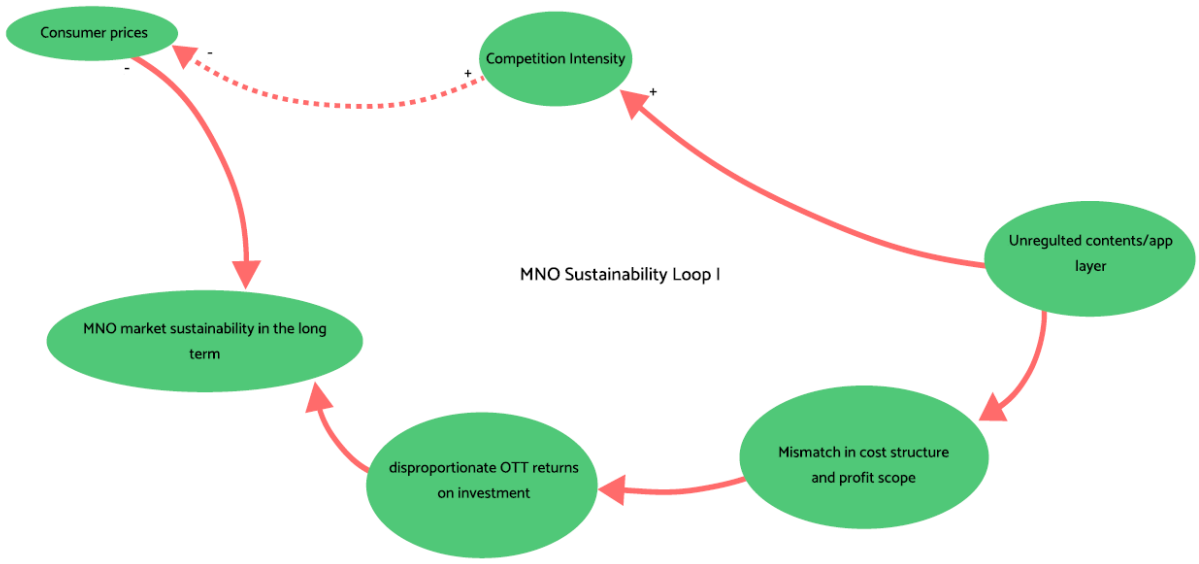


**Figure 19: MNO Sustainability Loop 1**

Figure 19 depicts a vicious[112] MNO Sustainability Loop 1.[113] Within Nigeria's evolving telecommunications market, as currently obtained within the ecosystem, the contents/app layer

[112] System feedback mechanism leads to an emergent worsening outcome

remains unregulated. While this regulatory posture, on the one hand, increases the competition intensity within the market (see also Bauer, 2007; Adesanya, 2020; Gillwald, 2020), which in turn reduces consumer prices in the short term; on the contrary, it reinforces the mismatch in cost structure and profit scope between the OTTs and the MNOs. This mechanism leads to disproportionate OTT returns on investment. Further, it constrains the MNOs' capacity to recover the increased cost of providing new-generation data services, ultimately hampering their long-term sustainability. The dynamic model reveals a potential effect contrary to the theoretical postulation in Section 3.3 that a more stringent competition policy, especially at the early stages of telecommunication maturity, will engender recombinant innovation but increase investment uncertainty — requiring a hybrid solution. Therefore, for optimizing competition and consumer welfare outcomes in Nigeria's evolving telecommunications market, regulation of the contents/app layer is requisite, even though this might not be OTT-specific if the hypothetical hybrid model is empirically proven to be correct.

[113] While there are additional interactions with other ecosystem constructs as depicted in Figure 18, the author isolates the links for this ecosystem loop as well as the other sub-lops that follow for analytic purposes in a simplifying way that these other connections do not change (ceteris paribus). The colouration across the sub-loops is also for graphical illustration and does not indicate any specialized meaning.

### 6.2.2 MNO Sustainability Loop 2

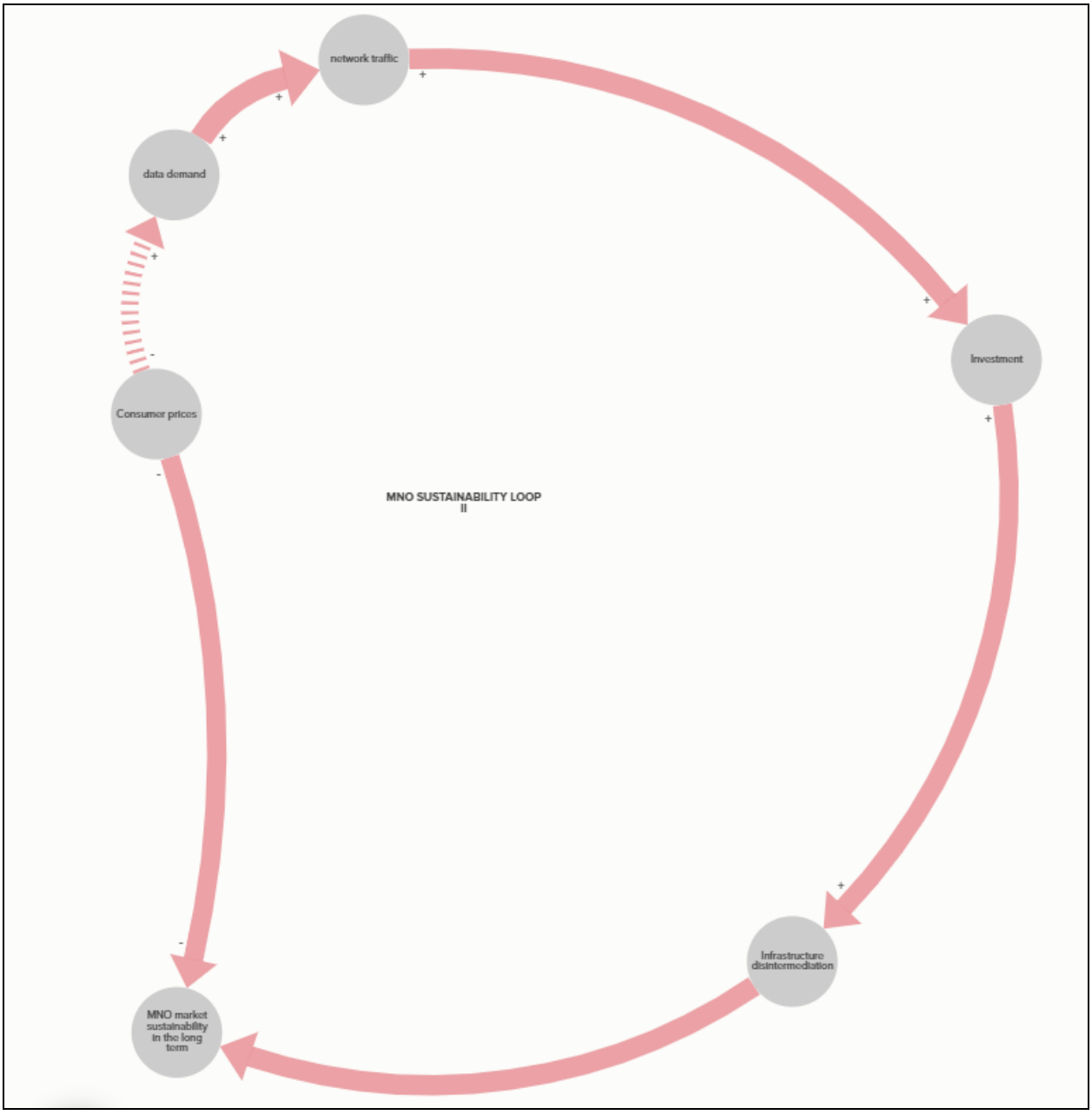


**Figure 20: MNO Sustainability Loop 2; thickness of the loop here stretched for clarity**

Figure 20 — MNO Sustainability Loop 2 depicts a vicious dynamic as well. In concurrence with the imperatives of Sustainability Loop I, lower consumer prices in the short term will continue to drive

more consumer data usage, scaling up extant network traffic and requiring increased investment to expand data networks. However, the increasing investment incentive for data networks will partly be driven by co-investment arrangements between MNOs and OTTs. This proposition portends an increased risk of MNO middle mile infrastructure disintermediation by the OTTs, and possibly even a complete infrastructure disintermediation[114] of MNOs in the fully converged telecommunications market in the long term[115], especially if MNOs do not provide them [the OTTs] with the requisite access to end-user last mile. Moreover, under the extant regulatory conditions explained in Sustainability Loop I, the inability of MNOs to recover the cost of providing data services due to below-actual cost pricing will also impede their long-term market sustainability. This outcome is in congruence with the theoretical postulations of Rochet and Tirole (2003), as expounded in Section 3.3 — that the extent of the interdependence between innovation and investment in the two-sided market within unique institutional arrangements determines the social welfare effects, whether contradictory or complementary, and have significant imperatives on demand-side value appropriation in relation to consumers' willingness to pay and access quality.

### 6.2.3 Consumer Adoption Loop

[114] Particularly at the connectivity layer

[115] Beyond current investments in backbone and metro backhaul

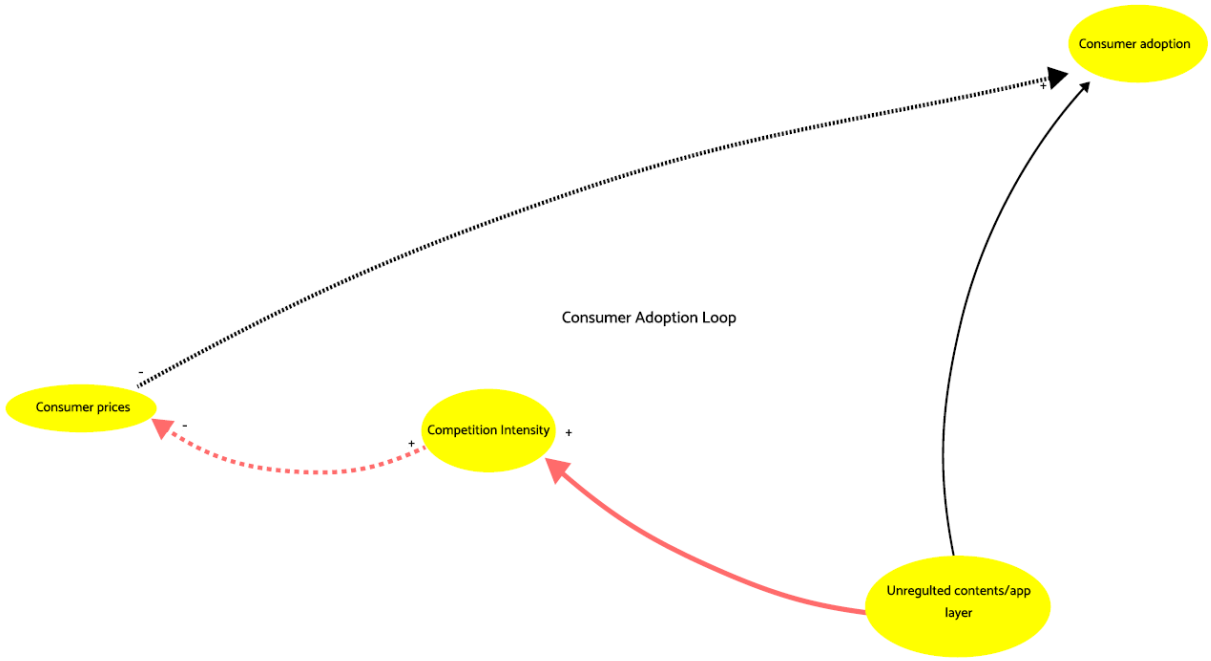


**Figure 21: Consumer Adoption Loop; graphical colours are only for clarity**

Figure 21 depicts a stabilizing[116] Consumer Adoption Loop.[117] As with the MNO Sustainability Loop I, the author asserts that consumer adoption within the Nigerian telecommunications market is significantly driven by the unregulated contents/app layer, i.e., the OTTs. With the induced competition intensity,[118] as previously explained, the commoditization of telecommunications offerings and services in both voice and Internet data segments in the short term drives down consumer prices, leading to an increase in consumer adoption, particularly Internet adoption within the Nigerian ecosystem.

[116] Feedback mechanisms are keeping the system from getting to a worse state

[117] The interrelationships indicated here relate to both the OTT market segment and the MNO market segment. E.g., "competition intensity" refers to competition between OTT services app providers, between MNOs, and between app providers and MNOs. However, "consumer prices" indicate MNO prices as prices for OTT services apps are near-zero. Nevertheless, more OTT apps make mobile services more valuable for users, other things being equal, and hence increase their willingness to pay, other things being equal. Thus, the effect of having more apps on consumer prices and on adoption depends on the relative strength of these opposing effects and is contingent on how these ambiguous effects net out.

[118] The "competition intensity" referred to here relates to the competition between MNO and OTT rather than the rivalry between MNOs.

### 6.2.4 Competition Loop

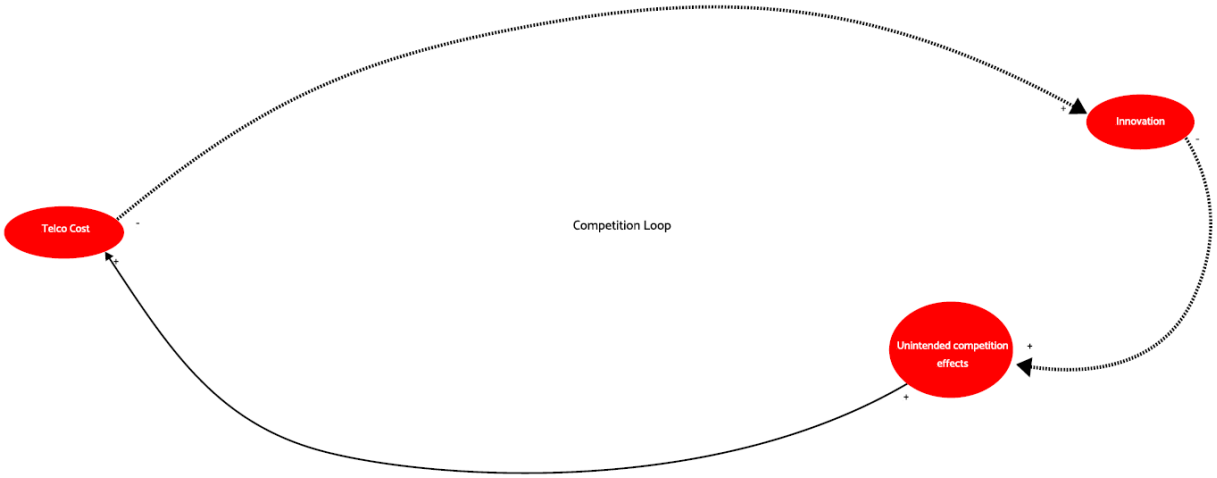


**Figure 22: Competition Loop**

Figure 22 portrays a stagnating[119] Competition Loop. Following on from the Consumer Adoption Loop, the unregulated contents/app layer creates an unintended competition effect[120] in the form of an endogenous market entry barrier for MNO competitiveness within the Nigerian telecommunications market. This market situation arises from the attendant escalation of network traffic and incidental interconnect and site costs due to increased data demand and, in some cases, voice traffic by new and existing mobile subscribers. On the other hand, this prohibitive MNO cost structure is amplified by scale economies of increased consumer adoption of OTT services (via pricing mechanisms such as bundling of OTT offerings with their traditional offerings), leading to higher levels of business model innovation by MNOs within the ecosystem. This dynamic is in concurrence with the theoretical postulation in Section 3.3 that in resource-scarce environments, price structuration within unique institutional arrangements plays a significant part in counterbalancing innovation and investment trajectories in order to avoid competition lock-in by dominant technologies.[121] However, the innovation dynamic within the Nigerian ecosystem is

[119] Feedback mechanisms are keeping the system from getting to a better state

[120] Endogenous market entry barriers for Telco competitiveness could arise as more OTT services app innovation scales, which induces more user demand, higher data needs, infrastructural capacity requirements etc.).

[121] This mechanism is significant in the case of Nigeria with regard to apparent lock-in of 2G network technologies by incumbent mobile network operators.

further constrained by the unregulated contents/app layer, as explained in both the Consumer Adoption Loop and the MNO Sustainability Loop I.

### 6.2.5 Innovation Loop

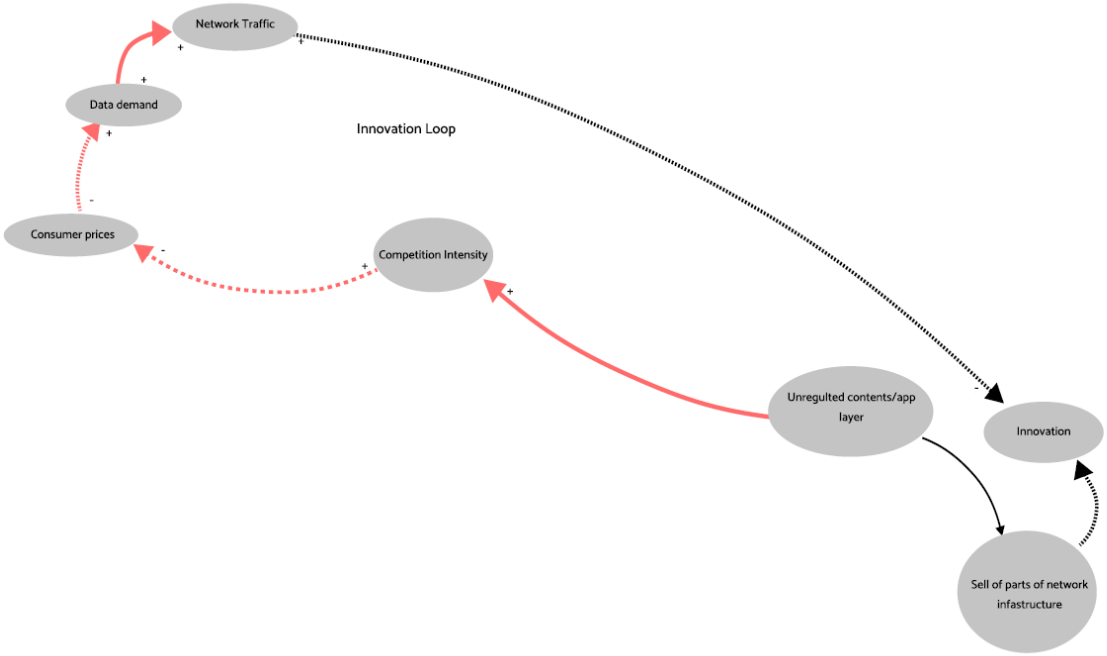


**Figure 23: Innovation Loop**

Figure 23 crystallizes a vicious Innovation Loop. Again, in concurrence with the systemic loops previously defined — competition, consumer adoption, and MNO sustainability — the unregulated contents/app layer is the critical driver of innovation within Nigeria's telecommunication market. On the one hand, while the consequent increasing competition intensity lowers consumer prices in the short term, encouraging more data demand and consequently scaling up network traffic[122], on the other hand, the unintended competition effect of non-regulation and the consequent intensification of competition led to the sale of parts of network infrastructure by the MNOs — impeding their ability to differentiate their network services, especially for VAS providers. Again, as seen in the imperatives of Sustainability Loop 1, this outcome contrasts with the theoretical

[122] Which also decreases network quality of service (QoS)

postulation in Section 3.3 that a more stringent competition policy, especially at early stages of telecommunication maturity, will engender recombinant innovation while increasing investment uncertainty — requiring a hybrid solution. More so, the migration towards an all-IP next-generation mobile technology within the converging Nigerian telecommunication ecosystem[123] is also an innovation mechanism adopted by the MNOs in "escaping" OTT competition effects due to increased bandwidth requirements via the capture of temporary market power rents (see Briglauer, 2014). However, as OTT substitutionary impacts increase, the investment appropriation rents will likely be significantly reduced, counteracting MNO investments in the longer term (see Czarnecki & Dietze, 2017).

### 6.2.6 Convergence Loop

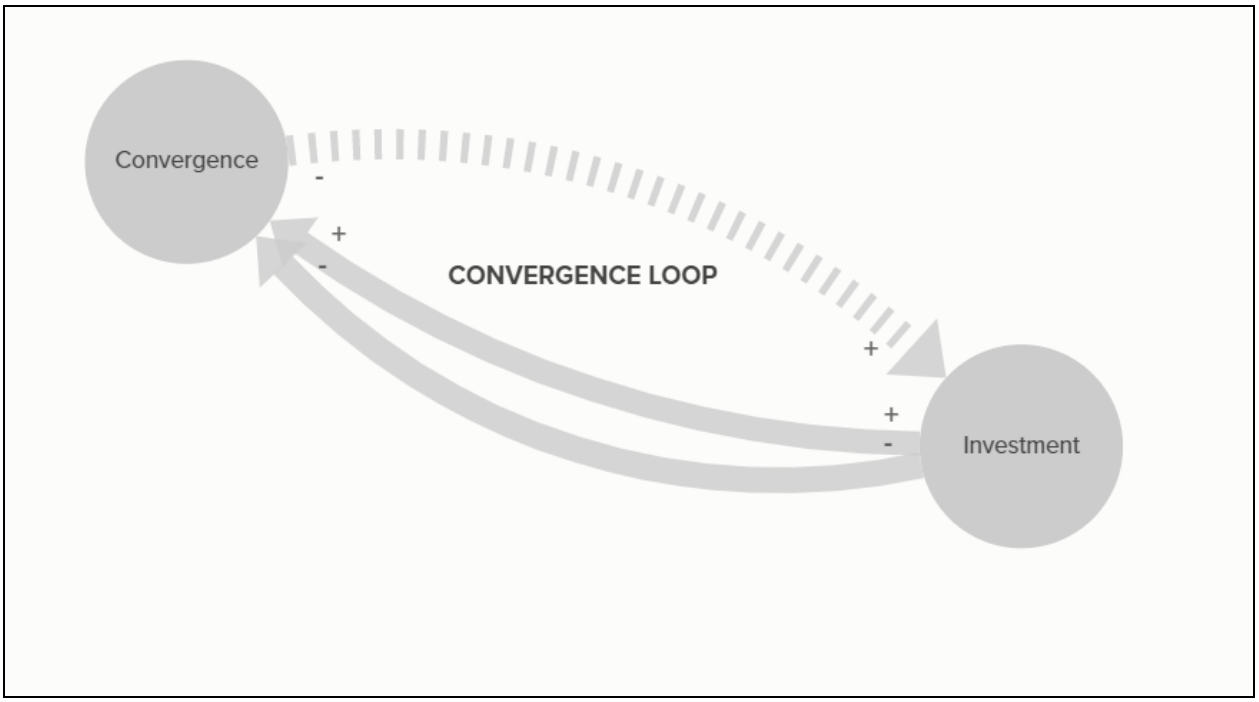


**Figure 24: Convergence Loop**

The convergence dynamics within the Nigerian ecosystem are still relatively nascent and not yet fully established compared to the more mature digital ecosystems. Figure 24 depicts a stagnating

[123] Albeit taking place currently only with investments in 4G networks within highly commercial urban areas

Convergence Loop. The author argues that the convergence maturity of the Nigerian telecommunications market is critically determined by the level of foreign and local investments, as well as co-investments by MNOs and OTTs in building out next-generation network infrastructure. Increased deployment of next generation networks (NGN) within the country's telecommunications market will drive further convergence of voice, data, and on-demand digital services, facilitating the provision of a triple-play convergent ecosystem that will further intensify competition within the telecommunications market. However, based on the current MNO investment disincentive to expand data networks, this has a negative effect on the convergence maturity of the Nigerian ecosystem. In contrast, considering the full cycle of investment-innovation interrelationship, the lower convergence maturity creates an increased investment incentive for next-generation network infrastructure, considering the lower Internet penetration level for a large market such as Nigeria's telecommunications industry.

### 6.2.7 Pricing Loop

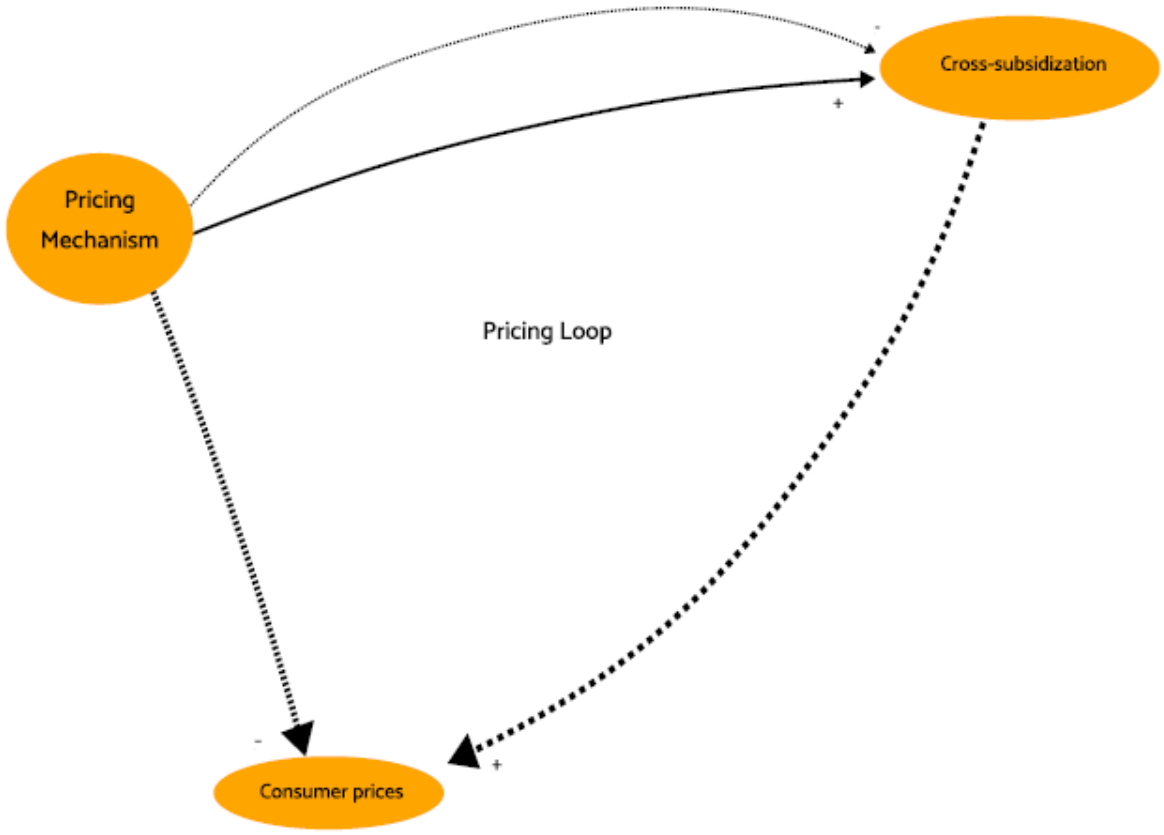


**Figure 25: Pricing Loop**

Figure 25 represents a stabilizing Pricing Loop, as consumer prices within Nigeria's telecommunications market are critically determined by the extant pricing mechanisms operating within the ecosystem. On the one hand, the current non-floor price regime instituted by the NCC on mobile data services and the bundling price mechanism adopted by MNOs in deference to OTT incursion (often priced below actual cost and even zero-rated in some cases) reduces consumer prices in the short term. On the other hand, the cost-based pricing framework[124] has made the wholesale data segment a target market for discriminatory cross-subsidization schemes that are based on negotiation — increasing consumer prices in the long term as the wholesale data segment becomes expensive.

[124] Which was intended to prohibit cross-subsidization (with exceptions only for universal access promotion)

### 6.2.8 Revenue Loop

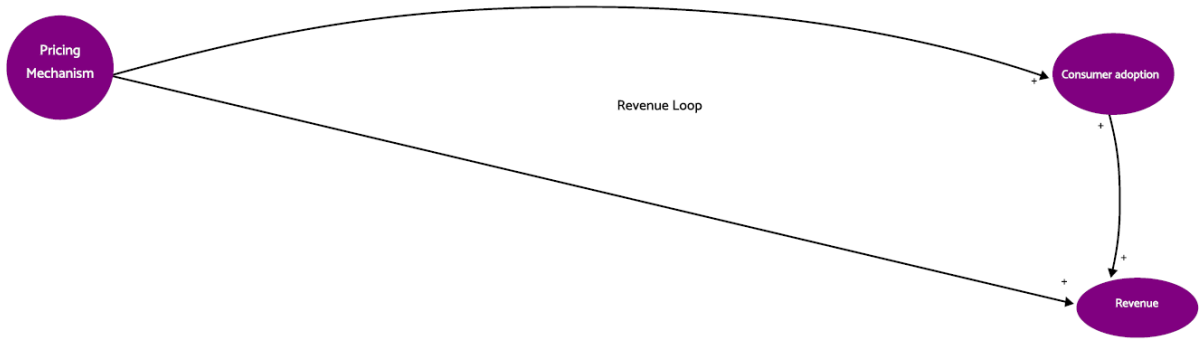


**Figure 26: Revenue Loop**

Figure 26 crystallizes a virtuous[125] Revenue Loop, in congruence with the postulation of Interviewee 1 (in Section 5.1.2) — that "there is a not sufficiently acknowledged 'virtuous circle' between OTTs and MNO networks." This notion is, in particular, in reference to the increase in data revenues for the MNOs due to OTT operations (also supported by Interviewees 7 and 15). As with the Pricing Loop, the extant pricing mechanism is the critical determinant of revenues within the Nigerian telecommunications market. While the cost-based pricing mechanism increases the revenues accruable to MNOs, the bundling of OTT and traditional service offerings by the MNOs increases consumer willingness to pay for traditional services such as voice, simultaneously increasing consumer adoption of OTT services and, ultimately, the Internet. Increased consumer adoption consequently increases both OTT and MNO revenues, primarily due to data consumption. However, if the MNOs have some pricing flexibility (with price elasticity of demand being <1), revenues may decline despite increased subscriber numbers. In that case, only some form of price differentiation will help with respect to sustainable revenues.

[125] System feedback mechanism leads to an emergent better outcome

### 6.3 Ecosystem Leverages: Implications for Regulation and Policy

Scholars' fundamental proposition of complex systems theory is that sustainable large-scale systemic change can only be catalysed within a system if the deep-seated and entrenched patterns that drive the system are changed. These deep-seated and ingrained patterns are represented in the ecosystem map by the deep structure[126] and the systemic loops prior identified, respectively. Based on complex systems theory[127], their interconnections determine the most critical pathways for large-scale sustainable change within the Nigerian telecommunications ecosystem. The author identifies these ecosystem leverages:

#### 6.3.1 Regulating Contents/App Layer: Imperatives for Competition Intensity, Consumer Prices and Adoption, MNO Market Sustainability and Institutional Arrangements

Within the complex and adaptive Nigerian telecommunications ecosystem, regulating the contents/app layer of the industry has critical consequences for market competition intensity, consumer prices and adoption (access and affordability), as well as long-term ecosystem innovation. Nevertheless, considering the dynamic efficiency characteristics of a converging telecommunications ecosystem, regulating emerging pricing practices such as zero-rating[128] should be held off in the short term until the regulatory authority discretely establishes a market-distorting effect on consumer welfare, given the strong market liberalization and net neutrality position of the Nigerian Communications Commission (NCC). More so, guaranteeing long-term MNO market sustainability justifies the reinstatement of the data price floor — to safeguard and grow new generation access network infrastructure in alignment with increasing data traffic and lessen the erosion of market

[126] The deep structure of an ecosystem map is the central interaction loop that critically drives the behaviour of the system, serving as the anchor point for most of the other interaction loops within the systems map, and on which they coalesce. In this context, it emerged through a reflective interconnection of the prior identified ecosystem loops, comprising consumer adoption, market competition, innovation dynamics, convergence mechanism, pricing and revenue loops, in alignment with the evidence established from the interview analysis and policy documents review.

[127] Complexity theory posits that the satisfaction of dynamic efficiency by the necessary and sufficient conditions in a multiplicity of constraints within a system is contingent on the initial conditions and path dependence (Cherry, 2006: 378; Espinosa, 2016). This is consequent on the fixed or cycle points within the system when influenced by external factors (Holland, 1992; Christensen and Albert, 2007).

[128] Which could enhance incentives for price-sensitive consumer adoption of the Internet

value for network operators who, due to intensifying OTT-induced competition, have priced data often below cost, thereby constraining their capacities to reinvest in network expansion. This process will be imperative to address the poor quality of service and experience for users, especially in underserved market segments. Furthermore, the author argues that as some OTT content and services are not traditionally covered within the mandates of sector-specific regulation concerning the NCC, there needs to be an expedition of an appropriate institutional arrangement[129] towards a converged regulator to administer the overall ICT regulatory regime and guarantee equal market access to all participants, as well as balance regulatory concerns of market stakeholders especially in respect to pricing structures[130], spectrum resource allocation, and licensing. The policy consequences of this proposition will have an ultimate net positive effect on social welfare concerning ubiquitous network access, especially for underserved areas, as well as more innovative data and voice offerings from operators. From an institutional perspective, this position is akin to creating an optimally efficient equilibrium in the "Hardin herder game"[131] context by leveraging a centralized regulatory agency (see Ostrom, 1990). From an ecosystem path-dependency perspective as well, this position is in alignment with the historical pathway established by NITEL during the pre-deregulation era by the merging of the Posts and Telecommunications Department (P&T) and the Nigerian External Telecommunications Ltd (NET) to deal with the market failures that arose because of resource allocation inefficiencies and poor institutional coordination (see Hassan, 2011).

### 6.3.2 Balancing MNO Costs, Investment, Innovation, and Infrastructure Disintermediation

Adjusting to the increase in bandwidth demand within the Nigerian converging telecommunications market will necessitate significant investments in new-generation network infrastructure. This proposition becomes even more imperative considering the extant broadband access gaps and the need to ensure continuous market innovation concerning developing new digital services. However, incentivizing this mechanism will require a regulatory review of the current cost-based pricing regime[132]. This argument is because they statically do not take into optimal consideration the full

[129] In alignment with the 2012 National ICT Policy

[130] In particular relation to bundling, exclusivity contracts et cetera.

[131] A "non-zero-sum" noncooperative game of herders (see Yang & Wu, 2009).

[132] Which allows for recovery of investment cost over the total economic life of the investment on a forward-looking basis.

weight of risks associated with infrastructure development costs, which are mostly sunk investments (see Hausman, Pakes, & Rosston, 1997). A static cost-based pricing framework (which works well for a perfectly contestable market) does not provide a competitive pricing mechanism. Within the above framework, MNOs cannot shift the externalities of sunk investments to more viable uses if the economic return goes below competitive levels without a costless exit. The author proposes an adaptive pricing structure[133] that calibrates social welfare impact to sunk investments within the Nigerian telecommunications market — akin to Ramsey pricing — which will balance the static cost efficiency challenge with more significant dynamic efficiency consumer gains from new generation infrastructure investments (see Baumol & Bradford, 1970; Brown et al., 1991). More so, with the increasing risk of MNO infrastructure disintermediation, which may arise due to co-investments with OTTs, regulatory forbearance on the MNO side may also be required, especially where co-investors are expected to compete in downstream market segments.

### 6.3.3 Managing Network Traffic: Imperatives for Infrastructure Investments, Consumer Prices, and Quality of Service (QoS).

Another critical policy pathway to ensure the sustainability of Nigeria's converged telecommunications market is to enable a regulatory framework that will optimize the harmonious co-existence of both MNO network infrastructures and the OTT services that run on them, as one side of the market cannot survive without the other in maximizing user welfare. As telecommunication ecosystem players transit their legacy network infrastructure to all-IP platforms, in order for MNOs to catalyse sustainable business models in relation to the network infrastructure investments requisite for managing upscaling Internet traffic within the converging telecommunications market, they will need the regulatory capacity to re-assess their current pricing models to incorporate variable usage pricing in alignment with consumer demand. In addition, the author asserts that a regulatory readjustment is required to allow the application of traffic-dependent termination charges for OTT traffic based on voluntary commercial peering agreements, which would guarantee an optimal quality of service (QoS). This mechanism, in effect, will imply that MNOs can transit their business models to act as ecosystem content delivery networks (CDNs) within Nigeria's converging telecommunications market. This pathway can be realized via a

[133] That is subject to both technological and economic uncertainty

functionally equivalent and technology-neutral regulatory regime that prioritizes the structural separation of both market sides. The above proposition provides MNOs with the option to sell network capacity on a wholesale basis to OTTs within a regulated pricing regime that can help reduce the current expensive data tariff in the data services wholesale segment of the market.

### 6.4 Chapter Six Summary

A critical insight of dynamic approaches to the governance of complex socio-technical systems is that policy outcomes resulting from ecosystem cause-effect relationships must be well aligned. The author asserts that policymakers must realize this alignment within a coherent framework encapsulating the ecosystem's technical and socio-economic dimensions (see Finger, Groenewegen, & Künneke, 2005). Therefore, the objective of the ecosystem mapping was to generate a concise picture of the converging Nigerian telecommunications industry, detailing the complex interrelationships and situating it within it in relation to regulatory governance mechanisms, outcomes, and ecosystem stakeholders and institutions. The author leveraged this snapshot of the telecommunications ecosystem to identify critical opportunity pathways for regulatory evolution both in the short and long terms for effectively addressing the competition dynamics related to OTTs and MNOs, furthering consumer welfare within the ecosystem. As detailed in Chapter Seven (that follows next), the crystallized opportunity pathways have critical imperatives for theory and practice. The author re-emphasizes that, as previously indicated, additional steps would still need to be undertaken by ecosystem stakeholders and scholars in further developing this initial framework presented here to the point of validation that can inform policy beyond providing a framing of the issues assessed. Critical aspects to consider would be quantitative validation, determination of the relative strengths of the ecosystem feedback loops, and simulation of the effectiveness of specific policy interventions as recommended by the author. Until then, this framework can guide policy development more qualitatively in the short-term policy evolution of the converging Nigerian telecommunications market.

## Chapter Seven: Conclusion

### 7.0 Thesis Conclusion

This thesis has triangulated the evolution of regulatory policy within Nigeria's converging telecommunications market, providing critical policy pathways for transitioning from a more static regulatory regime toward a dynamic regulatory framework with the emergence of more complex and multi-sided elements within the industry. It builds on the literature on the optimal governance and policy design of socio-technical systems within adaptive external environments, leveraging initial contributions to complex adaptive systems theory (see Longstaff, 2003; Bauer, 2004; Cherry & Bauer, 2004). In extending the domain discourse, a critical regulatory challenge that has crystallized in assessing this market transitioning phase is an appropriate regulatory structure that optimizes investment and innovation incentives on both sides of the two-sided market[134], especially in the mobile broadband market, and across retail and wholesale segments. In addressing this regulatory challenge under conditions of workable competition, the thesis has established the imperative to consider the preconditions of specific institutional arrangements for effective competition regulation in Nigeria's telecommunications sector in such a manner that dynamic efficiency and, ultimately, social welfare are maximized. According to Bauer and Bohlin (2008: 48), it is also imperative within this purview to note that "in dynamic market environments, the present regulatory framework is not only contingent upon past and present but also the expected future state of competition."

Within these considerations, realizing the competition policy objective of consumer welfare maximization concerning both innovation and infrastructure investments requires understanding the systemic linkages between the different elements that drive the digital ecosystem evolution within unique institutional structures of the Nigerian telecommunications market. This collective, conceptualized as a complex adaptive system, presents significant policy challenges, especially for less digitally mature ecosystems such as Nigeria's telecommunications market. This dissertation explored whether these conditions would require greater levels of innovative forbearance and unique regulatory adaptiveness to the dynamic global environment within which its converging ecosystem is situated in the long run rather than a best practice approach concerning economic and social outcomes. Given the highlighted increased convergence risks, this forbearance position (lighter

[134]Infrastructure and new generation services provisioning

sector-specific regulation) is imperative concerning incentivizing telecommunication operators for inclusive infrastructural investment and expansion (see Blackman, 1998; Kelly & Rossotto, 2011).

In direct response to the research question(s) established by the thesis:

> *RQ: How can regulatory policy optimize investment and innovation in Nigeria's converging telecommunications market while maximizing social welfare?*

The question was interrogated by the author specifically via two interrelated sub-questions. In direct answer to the first sub-question:

- *Which pricing structure in the two-sided telecommunications market in Nigeria can achieve the most optimal efficiencies for investment and innovation in the two interdependent markets — Internet infrastructure provision and Internet content supply — while maximizing social welfare?*

With respect to pricing structures, the thesis posits that on the premise of a regulated converged telecommunications market, optimal price mechanisms need to consider sunk investment costs and technological innovation uncertainties to enhance welfare (overall surplus) in the long term. This proposition deviates from traditional cost-based approaches for a dynamically adaptive telecommunications industry (see Brown, Einhorn, & Vogelsang, 1991). This position aligns with conceptualizing the converging telecommunications industry as a series of interlinked two-sided markets. Most of these markets are not perfectly competitive. Assessing them using traditional economic analysis would likely produce adverse unintended policy outcomes (see Genakos & Valletti, 2012). This requirement is because in two-sided markets, setting prices based solely on economic competition in relation to cost will mostly produce socially suboptimal prices due to the impact of market externalities. This understanding aligns with the position of Levy and Spiller (1993) for guaranteeing private investments at socially optimal levels. Complementarily, the ecosystem mapping crystallizes that the relationship between pricing, consumer adoption, and revenues is non-linear (another CAS attribute), in contrast to perfectly price-elastic markets where the players are price takers.

In response to this position, the thesis proposes explicitly an adaptive pricing structure — analogous to Ramsey pricing — that calibrates social welfare impact to sunk investments within the Nigerian telecommunications market, which will balance the static cost efficiency challenge with more significant dynamic efficiency consumer gains from new generation infrastructure investments (see Baumol & Bradford, 1970; Brown et al., 1991). Ramsey pricing focuses on the price structure rather

than pricing levels in optimizing market investments and innovation in relation to maximum social welfare (see Danzon & Towse, 2003; Bergman, 2004; Frischmann, 2012). Proponents of this pricing regime popularized it within public policy research in the 1970s for the regulatory assessment of natural public monopolies (Boiteux, 1971; Vogelsang & Finsinger, 1979; Hausman & MacKie-Mason, 1988). However, the optimality of a Ramsey-like differentiation pricing structure for a converging telecommunications ecosystem in which average marginal costs are declining[135] is that the percentage mark-up over costs for infrastructure providers is inversely correlated to the elasticity of demand[136] for the digital services that run over them. The proposed mechanism is based on a willingness-to-pay assumption that permits cross-subsidization across market segments (see Baumol, 1976; Young, 1985; Brunekreeft, 2003; Farrell & Weiser, 2003; Jack & Lanjouw, 2005; Cave & Crocioni, 2007). A qualitatively similar implication of this postulation for regulatory policy in an emerging ecosystem context is that it can help facilitate further access to IP-based digital services beyond the traditional voice and messaging services that are still dominant within the Nigerian market via the incentivization of new-generation infrastructure investments on a risk-adjusted return basis in relation to technological evolution. However, this proposition will have to be implemented in alignment with the proffered regulatory regime[137] that prioritizes the structural separation of both sides of the market[138] in maximizing consumer welfare[139] rather than the current laissez-faire regulatory posture of the NCC. In this case, licensing will intensify the competitive pressure on both sides of the market concerning pricing, especially to protect consumers who may not have bargaining power in their adoption of digital services within the imperfectly competitive market

[135] This shift in the digital ecosystem has been driven by the liberalization of markets that has spawned lower cost technology innovation. With respect to pricing within the converging digital ecosystem, the supply-side characteristic of two-sided digital markets in relation to their network effects and economies of scale have complementarity with their cost structures — a high fixed cost relative to marginal cost (assuming there is capacity) (see Veljanovski, 2007). While this is not exactly the same dynamics for pricing in traditional telecommunications markets (with significant fixed and variable costs), for example, in pricing of mobile data by MNOs, it has complexity implications for consideration in relative areas such as in QoS arrangements between OTT content providers and network operators, and for voice call termination requirements in relation to social welfare (Armstrong, 2001; Crandall & Sidak, 2004). This mechanism is distorted within the converged digital market where marginal costs are almost zero, and prices can be zero for some sides of the multi-sided market — implying above marginal cost pricing structures for the complementary sides (see Hüschelrath, 2009; Elzinga & Mills, 2011; Krämer & Wohlfarth, 2018).

[136] With regard to both volume and value.

[137] In particular respect to a licensing regime

[138] MNO and OTT

[139] See Veljanovski (2007), Peitz, Schweitzer and Valletti (2014)

(Crandall & Sidak, 2004). Within that purview, the experimental model of Jack and Lanjouw (2005) indicates that Ramsey prices realize the highest level of social welfare in relation to firm innovation and investment.

In direct response to the second research sub-question:

- *What institutional arrangements are necessary to sustain this configuration in the short and long term?*

In furtherance, assessing the Nigerian telecommunications ecosystem has shown forms of path dependency, particularly from an infrastructure evolution perspective. This position is further ascertained, given that the mechanisms of liberalization, privatization, and commercialization were the principal drivers of network investments and expansion in the ecosystem (see Jerome, 2002). Its convergence maturity is in the same vein, hence, critically determined by the level of foreign and local investments, as well as co-investments by MNOs and OTTs in building out next-generation network infrastructure (see Perrucci & Cimatoribus, 1997).

Therefore, the author posits that the regulatory system must show the requisite institutional adaptability capacity for Nigeria's telecommunications market's current infrastructure-based competitive mechanism to be effectively incentivized. This proposition would ensure the complementarity of a simultaneous service-based and facility-based market entry rather than a substitutional one in the longer-term consumer welfare consideration in relation to network access, balancing both static and dynamic efficiency considerations. In the converging digital ecosystem, such an access regulation mechanism presents a qualitatively different policy problem in contrast to the infrastructure regime transition from monopolistic to competitive market structures. This policy situation is with respect to the dynamic regulation challenges of facilitating high capital investment in deploying new generation network infrastructure optimally and sustaining large-scale innovation in applications and services. Next generation network infrastructure investment requirements become even more substantial for a primarily mobile-based broadband ecosystem such as the Nigerian telecommunications market, with near-zero fixed broadband penetration. This situation will require scoping the same level of necessity for both incumbent operators and market entrant platforms in realizing ubiquitous broadband penetration. In this regard, access regulation policies that incentivize infrastructure co-investments by mobile network operators (MNOs) and OTTs become imperative,

especially for downstream market segments, but would have to be assessed on a contextual market basis.

Concerning an appropriate institutional arrangement to foster the realization of the above objectives, the author highlights the criticality of implementing a converged regulator in alignment with the provisions of the Nigerian National ICT Policy. This regulatory transition will help administer the overall digital regulatory space by encouraging and protecting investments in the sector within a fair and competitive market environment. The converged regulator will guarantee equal market access to all ecosystem participants and balance regulatory concerns of market stakeholdership, especially with respect to pricing structures. In adapting the regulatory processes and institutional arrangements in this regard, the regulatory environment will benefit from a unified policy approach. This proposed approach integrates both the basic policy design (in this case institutional mechanisms and structures for regulatory constraints and discretion concerning competition policy in Nigeria's multi-sided telecommunications market) and the detailed design (rules that govern the interrelationships between the critical market elements, in this case pricing structure, investment, and innovation in the multi-sided telecommunications market as they affect social welfare). This requirement is in order not to disincentive investments into the converging industry. Still, it should also be flexible enough not to hamper innovation — a critical source of competition in global information technology markets.

Ultimately, shifting from a vertical to horizontal regulation of the converging digital ecosystem will necessitate a policy shift from the "no regulation" stance of the NCC concerning OTT services in the Nigerian telecommunications industry. While this position aligns with the jurisdictional capacity of NCC concerning both the connectivity and network layers of the converging digital value chain, the converged regulator will need to assess the competitive effects of data-centric innovations such as bundling and zero-rating on a case-by-case basis and collectively with regard to the content and applications layer. This assessment is imperative for the Nigerian market — still dominated by few players — to ascertain predatory pricing, margin squeezes, or non-price effects of market power in relation to barriers for market entry.

Concerning the institutional dimension above, regulation of the emerging complex adaptive system will require investment models that depend on evolving the institutional arrangements in relation to the regulatory capacity of agencies. This plausibility will enhance investors' confidence, especially within a more open infrastructure ecosystem, beyond the traditional considerations of static efficiency that have prevailed in the Nigerian telecommunications market. This condition is even more imperative considering the critical issue of ubiquitous and affordable access within the Nigerian ecosystem — where increased infrastructure investments are crucial for enhancing inclusive broadband adoption via demand stimulation and supply of OTT services. Moreover, institutional arrangements that constrain the independence of the regulatory agencies will lead to failure in creating an environment of stability and certainty that will guarantee returns on infrastructure investments.

### 7.1 Implication of Findings and Contributions to Knowledge

The thesis extends the research paradigm on the dynamic effects of competition policy on innovation and investments for the multi-sided telecommunications industry, with a contextual focus on a developing economy. This contribution lends an evidence base to the value of the Internet for developing countries and its implications concerning optimal trade-offs for policy and regulatory options in a complex digital ecosystem, in alignment with the position of Bauer (2005a).

Theoretically, it applies concepts from complexity theory and its intersections with the complementary insights from the institutional analysis and development (IAD) framework, complemented by a process tracing mechanism. Its contribution to the field includes the extension of the theoretical and methodological arguments based on the complex systems approach, especially as it applies to understanding the nature of the influencing governance factors for enhancing broadband infrastructure systems in relation to the digital platforms that run upon them (see Oughton & Tyler, 2013). This lens inculcates the multi-dimensional degrees of freedom of socio-technical systems. It, therefore, demands complex governance frameworks to effuse better heuristics for more optimal problem assessment and outcomes that will be stakeholder-agreeable (see Hitchens, 2011; Shin & Kweon, 2011; Bauer, 2014). In critically re-assessing the complex systems approach to telecommunications policy-making, the value-added of ecosystem mapping elucidated interdependent factor dynamics with consequent fundamental ecosystem leverage points for both short- and long-term policy pathways for meeting current and future market exigencies (including

both supply (investments and innovation) and demand (consumer welfare) imperatives, under exogenous local and global institutional conditions.

Consequently, regarding the domain of institutional analysis, the thesis substantiates the notions of social welfare economics. First, this concerns appropriate institutional arrangements to foster the realization of telecommunications policy, specifying within the Nigerian case the requirement for a converged regulator to administer the converging telecommunications regulatory regime that will incentivize investments in the sector within a fair and competitive market environment. Implementing this regulatory principle in practice will help guarantee equal market access to all participants and balance regulatory concerns of market stakeholdership. This imperative is especially concerning critical adaptations to extant pricing structures and licensing, in alignment with the global ecosystem evolution for maximizing social welfare effects while minimizing unintended consequences of the new market dynamics with respect to innovation (see Levy & Spiller, 1994). Secondly, concerning infrastructure evolution, the thesis assessed the development of the telecommunications ecosystem in Nigeria, incorporating both the social and technical dimensions. This assessment allowed the interrogation of the dynamic complexities in its evolution. From a technical standpoint, the thesis assessed the heterogeneous technological capacity of the ecosystem; on the other hand, from a social dimension, it evaluated the interplay between the ecosystem stakeholders and the institutional mechanisms driving the ecosystem's growth. The author ascertained this mechanism from an infrastructure evolution perspective, establishing the causation for its weakness as due to the traditional top-down process of policy development, which creates significant regulatory asymmetry among ecosystem stakeholders and neglects the social context of infrastructure adoption and use within Nigeria's industry.

The thesis, therefore, proposed the need for socio-technical infrastructural flexibility and adaptability in overcoming the unplanned scaled capacity requirements as a consequence of OTT services adoption by users (see Hanseth & Lyytinen, 2016). Within the purview of complex adaptive regulation, the thesis posited from an institutional dimension, the requirement for investment models that co-evolves in relation to the regulatory capacity and independence of policy agencies, whose plausibility will provide enhanced confidence for investors, especially within a more open infrastructure ecosystem, beyond the traditional considerations of static efficiency that has prevailed in the Nigerian telecommunications market (see World Bank, 2014; Gillwald, 2017). In this respect,

both postulations above substantiate, contextually, the second theorem of welfare economics, which posits that "every Pareto-optimal allocation of resources is an equilibrium for a perfectly competitive economy, provided a redistribution of initial endowments is permitted" (see Blaug, 2007:1; North, 1990; Pressman & Summerfield, 2000; Swedberg, 2003; Bauer, 2005a; Jaag & Trinkner, 2011).

In the practitioner domain, this thesis contributes to the understanding of the optimal conditions under which regulatory and policy factors lead to stakeholder-agreeable outcomes in contextual market environments (see Holzinger & Knill, 2005; Xia, 2012), whether via ex-ante sector regulation (network neutrality approach) or ex-post competition regimes (see Garcia, 2016). This position incorporates demand-side value assessments to balance the commercial supply-side value that has dominated policy since the start of the market reform period, and which has not been as social welfare enhancing as claimed at the time of reforms. Furthermore, the thesis elucidates more elaborate and consistent patterns for understanding stakeholder behaviour within unique institutional frameworks for effective governance and sheds more light on why broadband governance policies have failed or produced unintended outcomes in the past and current dispensations (see Weeks & Williamson, 2006; Tan & Tang, 2016). This position required evaluating and modifying the extant institutional arrangements for the regulatory system, considering the appropriate balance for contextual uniqueness and the global digital ecosystem that will enhance investment and innovation (see Cherry, 2006). In the complete cycle, the theory-based arguments should serve as solid foundations for more informed policy and regulatory practice that generate consensus outcomes in tackling complex governance issues in the contemporary and the future (see Innes & Booher, 1999; Schneider & Somers, 2006).

In particular, concerning pricing structures, assessing the two-sidedness of the Nigerian telecommunications market elucidated the dynamic inefficiencies of the current cost-based approach that prohibits cross-subsidization.[140] This market inefficiency consequently led to an expensive wholesale data services segment[141] . The author asserted that the market condition was exacerbated by the current non-floor price regime and the bundling price mechanism adopted by MNOs in deference to OTT incursion (see Genakos & Valletti, 2012). Complexity assessments, therefore, have helped elucidate policy pathways for achieving optimal pricing efficiencies beyond non-price

[140] with exceptions only for universal access promotion

[141] While retail prices were going down

elements. This proposition was in particular reference to regulating interconnections between OTTs and MNOs based on voluntary commercial peering agreements and the adoption of a network diversity approach for price-discriminating content suppliers, which would also guarantee the optimal quality of service (QoS) in the long run (see Cave & Mason, 2001; Garcia, 2016). This voluntary position from an ecosystem path-dependency perspective is imperative considering the market extinction of MTEL[142] due to non-compliance with the mandatory payment of interconnection charges to its parent establishment, NITEL (see Nkordeh et al., 2017).

Furthermore, in considering the dynamic efficiency characteristics of a converging telecommunications ecosystem, the dynamic systems framework developed in the thesis shows the potential effects of regulating emerging pricing practices, such as zero-rating, which could enhance incentives for price-sensitive consumer adoption of the Internet. The thesis framework suggests that such interventions should be held off in the short term until a market-distorting effect on consumer welfare is discretely established, given the strong market liberalization and net neutrality position of the Nigerian Communications Commission (NCC). This proposition aligns with the existing assumption within the Nigerian National Broadband Plan 2020 - 2025[143] that the value of the Internet for the ecosystem does not depend principally on speed alone but also on inclusive coverage and adoption, which significantly enhances the network effect of the Internet for the ecosystem. However, in extension, the thesis further proposes that instead of the application-based zero-rating mechanism as currently applicable within the Nigerian ecosystem, the MNOs should be incentivized to zero-rate lower generation network services such as 2G for the bottom-of-pyramid consumer segment, in alignment with the net neutrality position of the NCC. This position has significant imperatives for spurring the adoption of data services on the demand side and innovation in the low-bitrate consumer services market on the supply side within the Nigerian ecosystem.

Complementarily, regarding telecommunications infrastructure development and investments, by drawing on critical elements of a complexity theory approach, the thesis crystallizes contextually within the Nigerian ecosystem the optimality of leveraging the installed infrastructure base in catalysing a dynamic growth for new generation network infrastructure via a bootstrapping and

[142] The mobile telephony arm of NITEL in the pre-deregulation era

[143] Nigerian National Broadband Plan 2020 – 2025. Accessed November 23, 2021: https://www.ncc.gov.ng/documents/880-nigerian-national-broadband-plan-2020-2025/file

adaptive infrastructure growth mechanism (see Hanseth & Lyytinen, 2016). The author posits this bottom-up policy mechanism as a sustainable balance to the Nigerian telecommunications ecosystem's traditional top-down policy development process. The author identified the latter policy mechanism as a fundamental cause for the poor development of complementary stakeholder capacity (particularly from a user dimension) for demand-driven infrastructural development (see Lindskog & Johansson, 2005; Kakekaspan et al., 2014; Salemink & Bosworth, 2014). This position further highlights the path-dependency attribute of Nigeria's telecommunications infrastructure evolution, which goes beyond technical considerations to the socio-economic imperatives for regulatory design — expounded via complexity theory and policy process tracing (see David, 2001a).

In addition, conceptualizing telecommunications services as a public good (in relation to common pool resource[144] allocation) within the confines of the IAD framework highlighted the policy trade-offs critical for selecting optimal institutional arrangements for a regulatory design that considers a balance in both redistributional equity and long-term sustainability, beyond the narrow perspective of economic efficiency that scholars base on traditional market mechanisms developed for mature telecommunications ecosystems (see Ostrom, 2011; David, 2001a; Trogen, 2005). Considering this position within a converging telecommunications ecosystem allows for re-examining the basis for regulatory policy design appropriate for competition in the emerging telecommunications market (see Blackman, 1998). Deploying elements of complexity theory enabled the author to elucidate the specificities of the layer-separate digital markets, the product/service, spatial, and temporary dimensions, which stakeholders must consider in relation to the evolution of the ecosystem.

This position implicates asymmetric reconfiguration of the value boundaries across layers[145] for a functionally equivalent and technology-neutral regulatory regime that prioritizes the structural separation of both sides of the market (MNO and OTT) in maximizing consumer welfare (see Peitz, Schweitzer & Valletti, 2014). Contextually, this institutional posture aligns with the lower convergence maturity of the Nigerian telecommunications ecosystem, which in this case is still considered a loosely coupled complex system (see Fligstein, 2001; Longstaff, 2003). Within this

[144] According to Frischmann (2004), common pool resources are rivalrous in consumption, but however non-excludable for the public.

[145] Both vertical and horizontal

purview, the thesis proposes a proportionate ex-ante regulatory regime (in reference to price regulation and licensing) in alignment with the current network neutrality position of the Nigerian Communications Commission (NCC), structured within an ex-post competition regime for dispute resolution on a case-by-case basis (see Whitt, 2003; Ismail, 2003; Koboldt, 2012; Garcia, 2016). This proposition considers both the slow agility of an ex-post regulatory regime to react to a converging telecommunications market's dynamic and adaptive complexities. It also considers its plausibility for global governance enforcement of broad ex-ante regulations (see Van Oranje et al., 2008; Monopolkommission, 2015; Krämer & Wohlfarth, 2018).

### 7.2 Limitations and Recommendations for Further Work

A key limitation of the thesis is that the author purposefully scoped the research design to assess a single case study. The author adopted this position to provide a deep analysis of the policy mechanisms and regulatory objectives in acknowledgment of the uniqueness of the national context as shaped by local socio-economic factors. This approach, however, constrains the study's generalizability across countries to similar effects (see Picard & Pickard, 2017). While this constraint is duly acknowledged, the principles expounded exploratively from both theoretical and empirical perspectives concerning telecommunications market regulation and policy can nonetheless be transferred across countries with respect to competition and the institutional conditions requisite for optimizing consumer welfare, especially under similar conditions found in other developing countries (see Glaser, 1992; Roson, 2005; Eisenmann et al., 2006; Armstrong & Sappington, 2006; Bauer, 2014; Hagiu & Wright, 2015a; Jacobides, Cennamo & Gawer, 2018).

Empirically, the author assessed the Nigerian telecommunications ecosystem through a qualitative analysis of available secondary data from relevant sector-specific reports and archival sources, triangulated with semi-structured intensive interviews. Nevertheless, the empirical data collected may not have captured all the complexity factors — demand, supply, and institutional — impacting competition outcomes within the Nigerian telecommunication ecosystem (see Gillwald, 2009; LaRose et al., 2012; Bauer & Tsai, 2014b; Bauer, 2015). This limitation was further influenced by the unwillingness of a selection of ecosystem stakeholders within the study context to share critical commercially sensitive information bordering on the issues raised within the dissertation for a more comprehensive assessment, with a few altogether declining to participate. Hence, analytical caution

is required when interpreting the plausibility of both the positive and negative policy outcomes as causal effects within the Nigerian telecommunications ecosystem (see Bauer & Bohlin, 2008). However, to ensure convergent validation, the interview questions were pre-tested using expert reviews to provide higher levels of instrument validity while incorporating the branching and building technique where appropriate to enhance flexibility, in the traditions of Lounsbury and Ventresca (2002), Golicic and Davis (2012), and Charmaz (2014).

Furthermore, historicity and contextual analysis were critical in understanding and resolving some of the complex regulatory policy problems within the Nigerian telecommunications ecosystem via process tracing and applying the IAD framework.[146] However, to the extent that the socio-technical evolution of the ecosystem depends on micro-scale events that may be below the resolution of the conceptual model adopted, this implicates theoretical and practical certainty limits to the predictability of the policy outcomes espoused within the thesis (see Arthur, 1989). Nevertheless, to bridge this limitation, the author validated the historical data sources internally and externally to reduce confirmation bias via source criticism (see Jonas, Schulz-Hardt, Frey, & Thelen, 2001; Kipping, Wadhwani, & Bucheli, 2014). In addition, case study arguments were developed qualitatively using a process tracing technique that is theoretically informed and validated based on existing data evidence to understand the causal mechanisms between the domain constructs (Checkel, 2006; Beach & Pedersen, 2013). More so, the author generated qualitative data from secondary sources, which were used to examine propositions descriptively in a nested manner[147] — to optimally balance the trade-off between conceptual generalizability and empirical validity (see Mahoney, 2010; Baker, Edwards, & Doidge, 2012).

Theoretically, according to Weick (1989), no theory is absolute. This statement is also true for complexity theory — which has critically underpinned this thesis. While complexity theory and its extension within the complex adaptive systems (CAS) framework helped to elucidate the feedback-based regulatory and policy implications of the multi-interrelationships within the Nigerian telecommunications ecosystem — conceptualized as an evolving complex socio-technical system — the theory has applicability limitations in estimating the economic consequences of choosing the

[146] See Rittel & Weber, 1973; Arthur, 1994; and De Vries, 2008, Bowen, 2009

[147] In particular, via an ecosystem mapping

recommended plausible policy pathways. This limitation is, in particular, with respect to investment and innovation, as they are complicated by contingent technological uncertainties of expected payoffs and irreversibility of sunk cost in a fast-changing domain (see Fichman, 2004). More so, the application of the theoretical framework within the Nigerian context does not evaluate the plausibility of policy outcomes under counter-factual conditions, and this is imperative for further work with respect to assessing the theoretical implications across different country cases in reference to their telecommunications ecosystem evolution (see Hanseth & Lyytinen, 2016).

Furthermore, in mapping the Nigerian telecommunications ecosystem as a complex adaptive digital system, the author acknowledges that the boundaries between social and technical outcomes across the different identified directions are dynamic; as such, there is no one plausible correct mapping of an adaptive socio-technical system (see Cherry & Bauer, 2004; Edwards et al., 2007; Oughton et al., 2018). More so, the ecosystem mapping may not provide a more nuanced discussion of additional feedback loops that might exist within the Nigerian case but are beyond the scope of the dissertation and could not be substantiated with the collected data — both primary and secondary. For example, the thesis proposes that instead of the application-based zero-rating mechanism as currently applicable within the Nigerian ecosystem, the MNOs should be incentivized by the regulatory authority to zero-rate lower generation network services such as 2G for the bottom-of-pyramid consumer segment, in alignment with the net neutrality position of the NCC. However, the author does not substantiate the feedback mechanisms for spurring this adoption of newer-generation network services as more users are adopted within the evolving Internet-based ecosystem. This situation is mainly because the requisite MNO capacity regarding network investments[148] and the consumer adoption data[149] for expounding the cost model plausibility is unavailable to the researcher. This point again provides an ample opportunity for further research. In addition, the net effect of the ecosystem loops is contingent on the relative strengths of the positive and negative effects, which the author cannot substantiate without further empirical validation. Addressing this limitation will require a different research route incorporating modelling and simulation. While this is plausible, the needed data for this (being yet an exploratory study) makes it beyond the scope of this dissertation and provides ample opportunity for further research. In conclusion, considering all

[148] Including spectrum allocations and terrestrial backhaul limitations

[149] In relation to network traffic

the prior highlighted complexities, this thesis's ultimate end is not to put forward an all-encompassing policy bouquet but rather to provide a broader lens for interrogating telecommunications policy outcomes, especially within a resource-constrained developing country context (see Cummins et al., 2017).

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**Appendix 1: Abbreviations**

2G: Second-generation cellular network

3G: Third-generation cellular network

4G: Fourth-generation cellular network

CAS: Complex adaptive system

ETNO: European Telecommunications Network Operators' Association

ICT: Information and communication technology

IP: Internet Protocol

ISP: Internet service provider

IAP: Internet access provider

ITU: International Telecommunication Union

MNO: Mobile network operator

MVNO: Mobile virtual network operator

NCC: Nigerian Communications Commission

NITEL: Nigeria Telecommunications Limited

OTT: Over-the-top services

PSTN: Public switched telephone network

QoS: Quality of service

RQ: Research question

SMS: Short message service

SSNIP: Small but significant and non-transitory increase in price

Telco: Telecommunications company

TowerCo: Tower company

VoIP: Voice over Internet Protocol

Wi-Fi-: Wireless fidelity

WTO: World Trade Organization

**Appendix 2: Detailed Interviewee Sample Table**

| Interviewee code | Medium | Date | Time (GMT+1) | Designation | Affiliation | Gender | Country |
|---|---|---|---|---|---|---|---|
| 1 | Text-based (e-mail) | 7-Aug-20 | 9:33 | Professor/Managing Partner | Telecommunications Advisory | Male | Nigeria/UK |
| 2 | Skype | 26-Mar-20 | 13:30 - 14:30 | Senior Consultant | Telecommunications Advisory | Male | India |
| 3 | Zoom | 12-May-20 | 12:00 - 13:00 | Senior Manager | Regulatory Authority | Male | Nigeria |
| 4 | WhatsApp | 24-Mar-20 | 12:00 - 13:00 | Country Partner | Research Think-Tank | Male | Nigeria |
| 5 | Zoom | 24-Mar-20 | 14:00 - 15:00 | Director | Telecommunications Advisory | Male | Nigeria |
| 6 | Voice Call | 18-Apr-20 | 12:50 - 13:30 | Senior Consultant | Telecommunications Advisory | Male | Nigeria |
| 7 | WhatsApp | 10-May-20 | 11:00 - 12:00 | Director | Telecommunications Advisory | Male | Nigeria |
| 8 | Text-based (e-mail) | 25-Aug-20 | 14:57 | Africa Public Policy Manager | OTT | Male | UK |
| 9 | Text-based (e-mail) | 2-Jun-20 | 21:46 | Chairman | Telecommunications Operators' Association | Male | Nigeria |
| 10 | Zoom | 27-Jun- | 8:00 - 8:45 | General Counsel | Telecommunications | Male | Nigeria |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 20 | | | Operator | | |
| 11 | Voice Call | 11-Jul-20 | 10:00 - 11:00 | National Coordinator | VAS Association | Male | Nigeria |
| 12 | Zoom | 17-Jul-20 | 16:00 - 16:45 | Competition Policy Expert | Telecommunications Advisory | Male | Nigeria |
| 13 | WhatsApp | 5-Aug-20 | 19:00 - 20:00 | Senior Manager | Telecommunications Operator | Male | Nigeria |
| 14 | Zoom | 2-Sep-20 | 10:30 - 11:05 | Legislator | House of Representatives | Male | Nigeria |
| 15 | Voice Call | 26-Jun-20 | 13:00 - 13:30 | President | Civil Advocacy Group | Male | Nigeria |
| 16 | Zoom | 7-Apr-20 | 16:00 - 17:00 | Managing Director | Telecommunications Operator | Male | Nigeria |
| 17 | Skype | 9-Apr-20 | 14:00 - 15:00 | Chief Executive Officer | Telecommunications Advisory | Male | Nigeria |
| 18 | Zoom | 15-Jun-20 | 15:00 - 16:00 | Senior Development Manager – Africa | Civil Advocacy Group | Male | Kenya |
| 19 | Zoom | 16-Jun-20 | 15:00 - 16:01 | Senior Policy Advisor – Africa | Civil Advocacy Group | Male | Zimbabwe |
| 20 | Zoom | 3-Jul-20 | 16:00 - 16:45 | Managing Director | Telecommunications Operator | Male | Nigeria |
| 21 | Zoom | 3-Aug- | 14:00 - | Senior Consultant | Telecommunications | Male | South Africa |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 20 | 15:00 | | Advisory | | |
| 22 | Text-based (e-mail) | 21-Sep-20 | 7:54 | Director, Legal and Regulatory Services | Regulatory Authority | Female | Nigeria |
| 23 | Zoom | 25-Aug-22 | 12:30 - 13:20 | Chief Executive Officer | Telecommunications Operator | Male | Nigeria |
| 24 | Written Statement | 09-Jan-23 | N/A | Senior Manager | Telecommunications Operator | Male | Nigeria |
| 25 | Email/WhatsApp exchanges | 06-Dec-22 – 03-Feb -23 | N/A | Director | Regulatory Authority | Male | Nigeria |

**Appendix 3: Sample Informed Consent Form**


# Consent Form: Participation in Research Interview

Informed consent form for participation in research interview.

*This research has been approved by the Commerce Faculty Ethics in Research Committee*

This informed consent form is for……....., who I am inviting to participate in my research project titled "*Pricing policy in two-sided telecommunications market: investment and innovation imperatives for social welfare in a developing economy*".

*Name of investigator:* Raymond ONUOHA

*Name of the Academic Institution:* Nelson Mandela School of Public Governance (NMSPG), University of Cape Town

*Name of the Academic Advisor:* Alison Gillwald (Adjunct Professor, NMSPG UCT)

*Name of the Second Reader:* Johannes M. Bauer (Professor, Dept. of Media and Information, Michigan State University, United States)

This informed consent form has two parts following:

1. Information Sheet
2. Certificate of Consent

**Part I: Information Sheet**

1. *Introduction*: I am a student of the Nelson Mandela School of Public Governance (NMSPG), University of Cape Town, South Africa. As part of my studies, I am now producing my doctoral thesis and conducting a research focusing on assessing alternative pricing models that will balance innovation and investment incentives on both sides of the telecommunications market in Nigeria — infrastructure and services provisioning.
1. *Type of Research Intervention*: This research will involve a semi-structured interview.
2. *Duration*: This interview will last about 35 minutes.
3. *Voluntary Participation*: Your participation in this research is entirely voluntary.
4. *Reimbursements*: You will not be given any incentive or reimbursement to participate in this research.
5. *Procedures*: If you accept to participate in this research study, you will be asked questions on telecommunications pricing structures and over-the-top (OTT) services regulation. Depending on your location, this interview may occur in person or over Skype or Zoom. If, for whatever reason, you do not wish to answer a question, simply let the interviewer know.
6. *Risks of Participation/Confidentiality:* There are no known risks or dangers to you associated with this study. The researcher will not attempt to identify you with the responses to your questionnaire or to name you as a participant in the study, nor will they facilitate anyone else's doing so. The interview will be recorded unless you do not wish to be recorded. Please inform the interviewers of this, who will then take notes. The tape will be confidential, and no one besides the researcher will have access to it. The information recorded is confidential, and no one besides the researcher will have access to it.
7. *Sharing the results:* The content that originated from this interview will be part of a thesis. This dissertation is intended to be completed by 2023.
8. *Right to refuse or withdraw*: You do not have to participate in this research if you wish to. You may stop participating in this discussion at any point.

**Part II: Certificate of Consent**

I have been invited to participate in this research about pricing structures in two-sided telecommunications markets.

I acknowledge that I am participating in this study of my own free will. I understand that I may refuse to participate or stop participating at any time without penalty. I will be given a copy of this consent form if I wish.

I have read the preceding information, or it has been read to me. I have had the opportunity to ask questions about it, and any questions I had been asked were answered to my satisfaction. I consent voluntarily to be a participant in this study.

Name: _____

Signature of Participant:

_____

Date _____

Day/month/year

**Statement by the researcher/person taking consent**

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm

that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this consent form has been provided to the participant.

_____

Signature of Researcher /person taking the consent

_____

Date _____

Day/month/year

**Appendix 4: Updated Interview Guide**


**Regulation of complex adaptive systems: optimizing competition and consumer welfare outcomes in Nigeria's converging telecommunications market**

*Preamble:*

In leading African ICT markets that include South Africa, Nigeria, and Kenya, the ubiquity of smart phone penetration is driving the prevalence of OTTs in the ICT ecosystem — challenging traditional revenue streams in the mostly pre-paid mobile domains, especially with respect to voice and SMS. While some experts argue that enhanced data usage resulting from increased use of OTTs increases the flow of revenues for the network providers as evidenced in markets successfully transitioning from voice to data as compared to markets which have not transitioned, the jury is still out on whether this positive externality sufficiently counterbalances the investment requirements by operators. Arguments in this regard have focused on not only the impact of static regulatory frameworks, but also the effects of incumbency and market dominance.

Within this purview, findings from the World Bank's *World Development Report* for 2016 indicate that a major impediment to ubiquitous internet access provisioning and digital content innovation is the emerging risk of regulatory uncertainty with respect to platform competition policy, especially in the telecommunication industry. At the root of this problem is the challenge of balancing investing incentives in new-generation network infrastructure and optimizing access and service-based intra-platform competition in the multi-sided telecommunication market, consisting of the traditional operators and new-entrant over-the-top players. In the micro-analysis, the platform competition policy problem in the multi-sided telecommunication market is a quagmire of three critically interlinked components — investment, innovation, and pricing. The key challenge is finding a pricing model with the correct mix of incentives to boost investment and innovation in both markets (infrastructure and services provisioning), especially in developing country markets that are largely governed by ex-ante sector regulation and ex-post competition regimes. While lower prices might benefit consumers in the short term especially in underserved areas, it might as well restrain investment and complementary market innovation in the longer term, and therefore requires the right mix of policies to optimize these critical elements. Specifically, a critical prognosis of contemporary pricing

structures such as zero-rating of online content in the two-sided mobile market, and its implications for innovation and investment, becomes imperative.

Based on the above narrative, the emergent interview questions for this thesis are as follows:

***Question 1:*** How is the growth of OTTs in Nigeria impacting the revenue streams of the MNOs?

**(a)** *Which specific activities by OTTs are generating network spillovers (both positive and negative) for MNOs in Nigeria?*

*(b) What institutional conditions (both market and regulatory) support these activities?*

*(c) How are the effects of these externalities distributed or realized by consumers in the Nigerian market?*

**(d)** *Is the increase in data revenues of the TSPs as a consequence of OTT operations sufficient to compensate for this impact?*

*(e) How willing are consumers in the Nigerian market to pay for the cost of OTT spillovers?*

**Please comment with reasons**

***Question 2****:* What are the *pros* and *cons* of having OTTs contribute to the cost of using the network infrastructure provided by the MNOs over and above data charges paid by consumers?

*(a) What is the estimate cost (network operating and maintenance costs etc.) of providing universal service in Nigeria?*

*(b) Is the cost of providing basic universal service in the Nigerian telecommunications market more significant or negligible compared to more mature markets?*

*(c) Does the provision of USO cause a net revenue loss for MNOs in Nigeria?*

*(d) If negative revenue impact is negligible, can therefore a part of the revenues of the telecommunication business, which are known to be considerable, be used to optimally finance additional social and public services in the Nigerian market?*

*(e) How should network upgradation costs be optimally distributed between MNOs and OTTs?*

*(f) How should Nigeria's Universal Service Provision Fund (USPF) be optimized in the converging telecommunications industry?*

- *Should USOs cover only access to basic telecommunications infrastructure (i.e. affordable broadband access connectivity with minimum capacity/speed?) rather than digital services?*
- *What kind of digital services can or should be considered appropriate for USPF intervention in the contemporary market?*

*(g) how does network infrastructure co-investment between MNOs and OTTs impact competition in Nigeria's telecommunication market?*

- *How does co-investment impact sector regulation?*

***Please comment with reasons***

***Question 3**:* Which pricing options can be adopted in such a way that balances investment and innovation incentives on both sides of the market? ***Please comment with justifications***

*(a) What is the degree of inter-and intra-platform infrastructure-based and services-based competition in Nigeria's telecommunication industry?*
*(b) How far should unbundling go with regard to Nigeria's converging telecommunications market?*
*(c) What should be the optimal pricing mechanism for unbundled network elements within the Nigerian ecosystem? [in such a way that balances investment and innovation incentives on both sides of the market — OTT and MNOs]*
*(d) In your view, should the industry issues of unbundling and pricing arrangements be resolved by private negotiation, or by regulation, or by hybrid approaches?*
*(e) What forms of price discrimination or traffic management practices are reasonable and consistent with a pragmatic approach? If so, under what circumstances are such practices acceptable? What restrictions, if any, need to be placed so that such measures are not abused (for example with regard to range of applications available, incentives for end-users to use certain applications, and the extent to which end-users have access to alternative offers and / or other ISPs)? What measures should be adopted to ensure transparency to consumers?*

- *Should the MNOs be allowed to price-differentiate between OTT players based on the services they provide?*
- *Should MNOs be allowed to implement non-price-based discrimination of services?*
- *Should there be a review therefore of the current tariff and regulatory framework for telecommunication services in the country, considering also the current net-neutrality stance of the regulator?*
- *What are the social welfare implications of imperfect price discrimination in Nigeria's converging telecommunications industry?*

***Question 4**: What institutional conditions are requisite for efficient OTT-mobile network competition regulation in Nigeria*? ***Please comment with justifications.***

*[Probes]>*

*(a) What licensing structure would be appropriate for OTTs if necessary?*
*(b) The National ICT Policy of 2012 specifies a converged regulator to administer the overall ICT regulatory regime (in the light of global technological evolution and market convergence) by encouraging and protecting investments in the sector within a fair and competitive market environment. What are your perspectives on this institutional arrangement?*

***Question 5**: Are there any complementary documentation (archival or current) or referable responder(s)? Are there further issues that we should discuss that I have not raised?*

*Adapted from:*

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**Appendix 5: Interviews Thematic Categorization Table**

| Categories | Sub-category 1 level | Sub-category 2 level | Sources | Sample Quote |
|---|---|---|---|---|
| | | | | |
| ***Market Segmentation*** | Market Definition | Market definition framework | 5 | "Most developing countries hardly have any clear frameworks for OTTs, yet alone have defined them to really…" |
| | | Market value chains | 11 | "in the new Value chain, OTTs and Connectivity players sit in different segments" |
| | Market Scoping | Broad-based market segmentation | 7 | "Broad-based (well designed) regulation would best help to distribute and address challenges across segments of the value chain" |
| | | Value-based segmentation | 6 | "The Internet should not be segmented based on the category of values" |
| | | | | |
| ***Market Disruption*** | Market Trends | Internet value chain | 7 | "The encroached Internet value chain into the telecoms sector is upon us…" |
| | | Technology disruption | 4 | "What OTT does is to take advantage of the technology by disrupting the telecom space in Nigeria" |
| | | Pricing structures | 12 | "They will say they have, because they are making a lot of…. doing lots of skits, doing lots of promos, a lot of data but the pricing structures have not made a transition out of the analog world into a digital world" |
| | | Voice commoditization | 3 | "now voice becomes a commodity that is carried on a data network" |

| | | | | |
|---|---|---|---|---|
| | | Complementarities | 11 | "There is a not sufficiently acknowledged 'vicious circle' between OTTs and MNOs networks" |
| | | Intensified competition | 11 | " the unintended competition effect of non-regulation and the consequent intensified competition led to the sale of parts of network infrastructure by the MNOs " |
| | | Market dominance | 5 | "It's a monopoly game" |
| | Demand | Data traffic | 17 | "With the apparent overburdening of MNO network infrastructure by increasing OTT data traffic reaching their capacity limits, especially in the densely populated commercial centres in Nigeria, an economically cost-efficient option for the MNOs to upgrade their network quality of service (QoS) will be to densify their network by adding more cell sites to their macro network layers for higher spectrum re-use." |
| | | Voice calls and SMS | 12 | "The substitutive power of OTTs for traditional voice calls is of more significant effect due to affordability constraints." |
| | | | | |
| | Revenues | Data-led revenues | 15 | "OTT-induced increases in the demand for data and its consequent uptick impact on data revenues surpasses possible declines in voice and SMS revenues." |
| | | Revenue decay | 8 | "With Nigeria's telecommunications market maturing, there has been a continuous consumer shift from traditional GSM services to data bundles that allow the usage of cheaper over-the-top (OTT) services. This has generated increased competition among the telecom operators in delivering cheaper voice and Internet data services with a consequent decline over time in revenues." |

| | | | | |
|---|---|---|---|---|
| | | Revenue increases | 7 | "Enhanced data usage increases the flow of revenues for the network providers " |
| | | Price crash | 9 | "Because of operations of the OTTs, you'll discover that the pricing for data and voice has totally crashed." |
| | | | | |
| | Costs | Network operator cost | 9 | "A key impact of the emergent OTT-MNO market competition is the rapid growth of network traffic and incidental interconnect and site costs due to an increase in data demand, and in some cases voice traffic by new and existing mobile subscribers " |
| | | OTT network cost | 12 | "The upswing in the adoption of OTT services negatively impacts incoming international traffic at substantial cost implications to Telcos, while generating significant revenues for OTTs." |
| | | Data services cost | 10 | "The service uses public Wi-Fi hotspots to provide low-cost Internet access (much cheaper than the average mobile data plans) to subscribers on phones with just an SMS capability." |
| | | | | |
| ***Regulatory Structures*** | Regulatory considerations | Novel regulation | 6 | "So regulators are not only still needed, but they have to regulate differently." |
| | | IP-based regulation | 7 | "Internet Protocol (IP)-based regulation necessitates enhanced market differentiation for sustained competition — in response to variations in consumer demand and regulatory jurisprudence — from traditionally national to transnational boundaries." |
| | | Ex-ante/post | 15 | "Some types of OTT would emerge to be regulated ex- |

| | | | | |
|---|---|---|---|---|
| | | regulation | | ante; others ex-post" |
| | | Net neutrality | 13 | "An MTN having an exclusive pricing agreement with Facebook, zero rating some of their services and all that. Is that congruent with net neutrality principles and all that if they are trying to revamp their own pricing models to be alive and survive something like that" |
| | | Responsible regulation | 10 | "…acknowledging the complex particularities of infrastructure industry regulation, where natural monopoly elements need to keep prices as high as possible initially to meet up with investment requirements in network extension, consideration of other public interest objectives, such as universal access, precipitates the need for a more inclusive regulation." |
| | | Regulatory limit | 11 | "With respect to regulatory limits, unintended policy consequences can be limited by understanding their complex interrelationship dynamics in unique historical and socio-technical contexts." |
| | | Open access regulation | 6 | "This funding mechanism can be structured as a termination charge requirement for OTTs, balanced out by open access to bottleneck infrastructure provided by the MNOs." |
| | | Regulatory balancing | 12 | "…there should be a [regulatory] balance between crashing the price and also ensuring the sustainability of the investment." |
| | | | | |

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|---|---|---|---|---|
| | Regulatory actions | Regulatory assessment | 12 | "For the Nigerian telecommunication ecosystem to maximize the positive externalities associated with broadband infrastructure investments, this access constraint needs to be bridged beyond the technical network measurements assessments." |
| | | Non-regulation | 4 | "The OTTs are coming from a world without regulation." |
| | | Light-touch regulation | 7 | "The evolving consumer preference may therefore necessitate regulatory forbearance on the side of the telecommunication operators to provide the required incentive for further infrastructure investment and expansion." |
| | | Full-scope regulation | 8 | "A full-scope regulatory model leverages the demand-side network effects generated by having more users signing onto the platform to create higher economies of scale and scope." |
| | | Regulatory Licensing | 10 | "You can only regulate what you have licensed." |
| | | | | |
| ***Investment & Innovation imperatives*** | Infrastructure Investment | Investment incentive | 12 | "If OTT is motivated through a regulatory incentive for them to support the network infrastructure investment in Nigeria that would be a very positive one." |
| | | Investment deficit | 13 | "While this complementary effect increases the attractiveness of the network access to consumers, the value accruable in relation to investments required to sustain the business model is disproportionately in favour of OTTs." |

| | | | | |
|---|---|---|---|---|
| | | Investment providers | 8 | "— a connectivity service provider — is building a 750-kilometre open-access fibre infrastructure in Nigeria with co-investment from Facebook and support from local state authorities in Ogun and Edo States." |
| | | Co-investment | 9 | "The increasing investment incentive for data networks will be driven in part by co-investment arrangements between MNOs and OTTs." |
| | | Investment shifts | 3 | "Nigeria is a critical telecommunications market, especially in relation to the demand for data as well as non-data services and products from both mobile operators and OTTs, with significant imperatives for network infrastructure investment." |
| | | Infrastructure disintermediation | 5 | "…want to literally disintermediate the MNOs as the infrastructure providers unto the last mile." |
| | | | | |
| | Innovation | Innovation rate | 9 | "...While the sale of these towers helped to free up some capital for the Telcos to reinvest in innovation capabilities required to survive the OTT onslaught, it is also creating the unintended consequence of network infrastructure consolidation mostly in the hands of foreign-owned TowerCos…" |
| | | Innovation capacity | 8 | "Unlike OTTs, MNOs are limited in innovation." |
| | | Innovation regulation | 9 | "Regulatory considerations for OTT-Telco investment dynamics must not stifle innovation, especially on the side of the OTTs — who are significant contributors in expanding the innovation space in that regard." |
| | | | | |

| | | | | |
|---|---|---|---|---|
| ***Social Welfare imperatives*** | Consumer imperatives | Consumer benefits | 16 | "These positive benefits for consumers and citizens also include social media apps like WhatsApp, Facebook, Viber, etc." |
| | | Consumer harm | 13 | "More so, consumer effects such as price commoditization may portend adverse consolidation effects within the industry in the longer term risk." |
| | Externalities | Positive externalities | 12 | "…for optimally leveraging generated positive externalities, access constraint needs to be bridged beyond the technical network measurements assessments, to encompass more broadly the ecosystem components. |
| | | Negative externalities | 8 | "Although this might be beneficial to consumers temporarily, the overall negative impact on the industry might impede consumer welfare in the long run, especially with the tendency of concentration to increase prices drastically in the long run." |
| | | | | |