

Paelo, Anthea; Robb, Genna

Working Paper

Comparative approaches to key issues in the economic regulation of telecommunications markets in South Africa, Tanzania, Zambia, and Zimbabwe

WIDER Working Paper, No. 2020/84

Provided in Cooperation with:

United Nations University (UNU), World Institute for Development Economics Research (WIDER)

Suggested Citation: Paelo, Anthea; Robb, Genna (2020) : Comparative approaches to key issues in the economic regulation of telecommunications markets in South Africa, Tanzania, Zambia, and Zimbabwe, WIDER Working Paper, No. 2020/84, ISBN 978-92-9256-841-2, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki, <https://doi.org/10.35188/UNU-WIDER/2020/841-2>

This Version is available at:

<https://hdl.handle.net/10419/229308>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



WIDER Working Paper 2020/84

Comparative approaches to key issues in the economic regulation of telecommunications markets in South Africa, Tanzania, Zambia, and Zimbabwe

Anthea Paelo and Genna Robb*

May 2020

Abstract: This paper reviews comparative approaches to key issues in economic regulation in four countries of the Southern African Development Community, and how this has been reflected in outcomes in terms of competition, prices, access, and innovation in telecommunications services. In this paper, regulatory models in South Africa, Tanzania, Zambia, and Zimbabwe are evaluated with a focus on regulation of spectrum assignment, infrastructure sharing, call termination rates, and number portability. While regulators in the four countries are generally implementing measures aimed at facilitating competition, the findings of this paper suggest that, in practice, the level of alignment between countries currently is low, and regulation could be much more effective at stimulating competition. Even finding data and information on regulatory policies and decisions in the different countries is extremely difficult, which frustrates the sharing of knowledge and evidence-based best practice. Key recommendations of the paper, therefore, relate to greater transparency by regulators and a much more serious commitment to the sharing of experiences and fostering harmonization of regulatory approaches.

Key words: competition, economic regulation, Southern African Development Community, telecommunications

JEL classification: L51, L96

Acknowledgements: This paper was presented at a seminar titled ‘The potential for cheap, high quality telecommunications services in Africa panel session’ at the Centre for Competition, Regulation and Economic Development at the University of Johannesburg, South Africa, on 13 February 2020.

* Both authors: Centre for Competition, Regulation and Economic Development, University of Johannesburg, South Africa; corresponding author: gennalrobb@gmail.com

This study has been prepared within the UNU-WIDER project [Southern Africa – Towards Inclusive Economic Development \(SA-TIED\)](#).

Copyright © UNU-WIDER 2020

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-841-2

<https://doi.org/10.35188/UNU-WIDER/2020/841-2>

Typescript prepared by Ayesha Chari.

The United Nations University World Institute for Development Economics Research provides economic analysis and policy advice with the aim of promoting sustainable and equitable development. The Institute began operations in 1985 in Helsinki, Finland, as the first research and training centre of the United Nations University. Today it is a unique blend of think tank, research institute, and UN agency—providing a range of services from policy advice to governments as well as freely available original research.

The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland, Sweden, and the United Kingdom as well as earmarked contributions for specific projects from a variety of donors.

Katajanokanlaituri 6 B, 00160 Helsinki, Finland

The views expressed in this paper are those of the author(s), and do not necessarily reflect the views of the Institute or the United Nations University, nor the programme/project donors.

1 Introduction

This working paper is the second study under the theme of ‘competition and regional regulation of services’ conducted for the sixth workstream of the Southern Africa – Towards Inclusive Economic Development (SA-TIED) work programme on regional growth for Southern Africa’s prosperity. It focuses on the telecommunications services sector due to the potential it holds to enable increased regional integration, cross-border transactions, as well as growth and prosperity in Southern Africa. The first paper in the series considers the competitive dynamics of the telecommunications sector in selected countries in Southern Africa, including South Africa, Tanzania, Zambia, and Zimbabwe (Robb and Paolo 2020). This second paper compares the different economic regulatory approaches in the same countries, while future work will consider cross-border interconnection and interoperability. These papers aim to contribute to the body of knowledge on regional integration by identifying how the competitive dynamics, regulatory approaches, and alignment of regulation in the telecommunications sector may have influenced the current state of telecoms development in Southern Africa and how it may be better harnessed in future for regional integration and growth.

The first paper highlighted the low level of broadband penetration and poor quality of mobile broadband in the Southern African Development Community (SADC) relative to the rest of the world. Using case studies of South Africa, Tanzania, Zambia, and Zimbabwe, it considered the nature of competition in each country in fixed and mobile markets and at the retail and wholesale levels, in order to link competitive dynamics with market outcomes such as prices, quality, and coverage (Robb and Paolo 2020).

From a mobile perspective, a mixed picture of competition in the four countries has emerged. Markets are highly concentrated but smaller players have grown recently in terms of subscribers in Zambia and Tanzania and another new operator is expected to launch imminently in Zambia. However, it is not clear that entrants and smaller players are able to translate increases in subscribers to competing in a meaningful way for all customers. All countries have been steadily reducing mobile termination rates (MTRs) in line with a cost-oriented approach, as will be discussed in more detail in this paper. This appears to have led to increased retail competition in prepaid voice markets in some countries more than others. Prices for mobile services remain extremely high in Zimbabwe, where one operator dominates the mobile market and the related mobile money market. From a mobile data perspective, prices have been falling across all four countries, likely as a result of increasing volumes and falling per-unit costs as well as increased competition. Even though mobile markets have remained concentrated, competition in terms of data is increasingly provided by other providers such as data-only mobile operators and other internet service providers offering fixed wireless, fibre, and satellite services. At the infrastructure level, concerns have been raised about the ability of smaller players to access sites to roll out their networks and the dominance of some tower companies in the provision of mobile sites. This will be discussed in more detail below.

From a fixed-services perspective, the first paper found that the price of services is high and that competition is constrained by a range of factors (Robb and Paolo 2020). Competition concerns arising from vertical integration are a common theme from the case studies as well as the lack of infrastructure leasing, particularly by large incumbents. In South Africa, a competition investigation and remedy forced the fixed incumbent, Telkom, to separate its wholesale and retail divisions in order to reduce its ability to discriminate against downstream rivals. In other countries, it is generally not the state-owned incumbent that dominates the fixed sector today, but rather a

more recent entrant that has invested in building national and international infrastructure. South Africa provides an example of the benefits that pro-competitive developments and interventions can have on the level of competition and prices in fixed markets. Nonetheless, problems remain, demonstrating that incumbent operators may still have an incentive to raise rivals' costs and frustrate entry. Outside of South Africa, fixed markets are small and less of a priority area for regulators who consider mobile a more important area for intervening to improve access. However, this misses the valuable role that fixed services can play, particularly in terms of providing high speeds and high volumes of data at a lower cost.

The effectiveness of economic regulation is of critical importance in determining market outcomes in the telecoms sector. Telecommunications markets are often subject to network effects and substantial scale economies, which tend to favour first-movers and make it difficult for later entrants to grow and compete effectively. Historically, fixed-line services were a natural monopoly, where only one operator could profitably provide services due to the high cost of last-mile infrastructure. Therefore, regulation was necessary to ensure that the monopoly operator did not exploit its market power to the disadvantage of consumers. Increasingly, regulators have forced incumbents to open up their networks to rivals through policies such as local loop unbundling and new technologies such as fibre and fixed wireless have provided competition, bringing lower prices, improved quality, and new products. In mobile too, with high barriers to entry and network effects, markets can tip towards monopoly or duopoly unless pro-competitive regulation ensures a level playing field for new entrants.

In this paper, we consider economic regulation and the ways in which it can be used in SADC to promote efficient, competitive telecoms markets that can assist in expanding access and affordability. In Section 2, we discuss a number of key areas of intervention including spectrum assignment, infrastructure sharing, MTRs, and number portability and how they have been used internationally to promote competition. In Section 3, we consider the approaches taken in the four case study countries to each element of regulation and attempt to link this to the competition outcomes we observed in the first paper. Section 4 provides some themes emerging from the analysis and considers the overall alignment of economic regulation across the case study countries.

In theory, coordination on economic regulation in telecoms markets in SADC already exists in the form of the Communications Regulators' Association of Southern Africa (CRASA), a body made up of regulators in SADC, whose mission is to 'coordinate the harmonisation of communications regulation for the socio-economic benefit of SADC' (Communications Regulators' Association of Southern Africa 2019). Three key areas of emphasis for CRASA are harmonizing the allocation of radiofrequency spectrum, expanding broadband access, and reducing the cost of international call termination and roaming charges in the region (Communications Regulators' Association of Southern Africa 2019). However, the findings of this paper suggest that, in practice, the level of alignment between countries currently is low and regulation could be much more effective at stimulating competition. Even finding data and information on regulatory policies and decisions in the different countries is extremely difficult, which frustrates the sharing of knowledge and evidence-based best practice. Key recommendations of the paper, therefore, relate to greater transparency by regulators and a much more serious commitment to the sharing of experiences and fostering harmonization of regulatory approaches.

2 Regulating for competition in telecoms markets

Telecommunications markets typically involve economies of scale and network effects, both of which make it difficult for small players to compete effectively. In mobile and fixed markets, the high cost of rolling out networks means that there will only be a few large market participants. For example, in 2018, there were 29 European countries with three or fewer mobile operators compared to 19 with four or more (GSMA 2018). The ideal number of operators to maximize investment while ensuring sufficient competition has been the subject of research and debate and, recently, some four-to-three mergers have been allowed by regulators in the European Union (GSMA 2016). From a spectrum assignment perspective, it is important to ensure that potential entrants and smaller operators have an opportunity to acquire spectrum, but the viability of potential spectrum licensees is also a concern because if spectrum is underutilized or lies dormant, then consumers will not fully realize the benefits associated with faster, cheaper broadband. Therefore, there is a balance to be struck between promoting competition and ensuring spectrum is used efficiently.

An important debate in recent years has been around whether it is necessary to have competition at the infrastructure level, or whether effective regulation of infrastructure can instead ensure competition at the services level using shared facilities. An idea which has gained prominence is the ‘ladder of investment’ approach, which suggests that by regulating access to incumbents’ facilities, entrants can be enabled to gradually invest in their own networks and move from services to facilities competitors (Cave 2007). This emphasizes the importance of regulating access at the infrastructure level in driving both services and, eventually, infrastructure competition.

From a cost perspective, it may seem efficient to have just one provider as this will eliminate duplication and reduce costs. However, experience suggests that multiple providers lead to better outcomes for consumers as rivalry drives competition on prices, quality, innovation, and service. Kittl et al. (2006) investigate whether infrastructure or service-based competition in broadband markets is better for economic welfare, using the example of 15 European Union member states. They consider the impact on prices and penetration rates and find that there are clear signs that infrastructure-based competition is more important to business customers and service-based competition to residential customers. Thus, they conclude that both should be promoted by regulators. The study shows that infrastructure-based competition has an immediate downward effect on prices that tends to remain stable going forward. However, service-based competition leads to tariff rebalancing, where access prices for line rental become higher but call prices become lower.

Facilitating competition does not necessarily mean promoting endless entrants at an infrastructure level but is about having enough effective rivals to ensure that customers benefit from competition. This should, in turn, ensure that services competition can thrive.

Various remedies have been implemented by economic regulators attempting to stimulate infrastructure competition. In fixed-line services, countries have employed policies of local loop unbundling and supporting second and third national operators (Hawthorne et al. 2016), as well as access regulations to ensure non-discriminatory access to infrastructure such as ducts, poles, and fibre (Ofcom 2017). Structural separation has been employed in some countries in order to reduce the ability of dominant upstream infrastructure players to exclude downstream rivals (Cadman 2016). In terms of mobile, pro-competitive spectrum assignment requires that regulators balance mechanisms to promote entry while ensuring efficient use of spectrum and viability of

operators (Robb 2019). In some cases, site sharing has also been mandated in order to lower barriers to rolling out network coverage for smaller operators.

Another common pro-competitive intervention is the regulation of mobile call termination rates at the long-run incremental cost of providing the service as a means of stimulating competition and reducing scope for the on-net/off-net tariff differential to be used by large operators as a means of strengthening network effects (Hawthorne 2018). Asymmetry has also been used in some countries to allow new entrants to charge a higher call termination rate for a limited period of time, to compensate for their smaller size and higher per-unit costs. Requiring number portability has also been a common intervention to make it easier for consumers to switch operators and hence stimulate competition. We consider international experience with these interventions in more detail below.

2.1 Spectrum assignment

Spectrum is becoming increasingly important as consumers are using higher volumes of data and require faster speeds. The increased demand for broadband has in turn resulted in an increased demand for spectrum as mobile providers seek to compete by providing more data at faster speeds.

Globally, governments are seeking to assign additional spectrum in response to the demand. What is in contention is the method by which spectrum should be distributed. Formerly, spectrum was distributed using beauty contests (Robb 2019). This largely consisted of governments choosing the entities to which to award spectrum based on a set of criteria. The process was opaque, slow, susceptible to lobbying by operators, and often resulted in the inefficient allocation of spectrum (Cramton 2002).

Auctions, a market-based mechanism of distribution, have now been generally accepted as the more competitive process of distributing spectrum as they are more transparent and, if designed correctly, more competitive as entrants are encouraged to bid for spectrum alongside larger incumbents. A competitive process also ensures that spectrum is acquired by firms that would make more efficient use of it, which is not always the largest or most established players in the market. In Europe, spectrum auctions have been implemented since the early 2000s to varying levels of success. Following an analysis of auctions that have taken place in Europe and Africa, Robb (2019) concludes that in designing an auction consideration should be given to the structure and economic circumstances of the country in which the auction is to take place.

If poorly designed, auctions would benefit large operators with larger capital bases over smaller players and entrants. They could, for instance, be able to buy substantial spectrum and exclude other players. There are also opportunities for collusion in a poorly designed auction where the players collectively bid a low price for the spectrum and agree to share it among themselves (Robb 2019). These challenges are often found where the ascending method of auction is used. The other option is to use a sealed-bid auction in which bidders make anonymous price offers for spectrum. This makes it difficult for firms to collude as there is little opportunity for the firms to signal their prices. However, governments may receive lower final prices as the bids are not transparent. Hybrid auctions that make use of both the ascending and sealed-bid auctions are also possible. In the first stage an ascending auction is used until a small number of bidders remain after which the sealed-bid auction is used.

A small number of spectrum auctions have been held in Africa with a mixed set of results (Table 1). In late 2015, Senegal’s fourth-generation (4G) spectrum auction was suspended after the Regulation Authority of Posts and Telecoms (Autorité de Régulation des Télécommunications et des Postes, ARTP) announced that they had received no bids from operators. The operators boycotted the auction claiming that the reserve price had been set too high, at USD 49.86 million. The ARTP registered its concern with the ‘collective and coordinated non-participation of the operators’ (Comms Update 2016). Subsequently, the incumbent, Sonatel, was licensed with 2×10 MHz of 800 MHz and 2×10 MHz of 1,800 MHz for a price of USD 53.8 million, or a relatively high USD 0.08 per MHz per capita. The other operators did not receive any spectrum.

Table 1: Summary of spectrum auctions in Africa

Band	Country	Details of award	Cost (USD per MHz per capita)
700 MHz	Senegal	Failed attempt at auction	N/A
	South Africa	ITA withdrawn (with 800 MHz and 2,600 MHz)	0.08
	Tanzania	Two lots of 2×10 MHz of 700 MHz	0.001
800 MHz	Ghana	Auction: one lot of 2×10 MHz sold	0.12
	Nigeria	Acquired by MTN through acquisition of licensee	N/A
	Senegal	Auction failed; incumbent awarded 2×10 MHz (plus 2×10 MHz of 1,800 MHz)	0.08
	Kenya	2×10 MHz awarded to each of three operators for USD 25 million	0.03
	Rwanda	Awarded to national wholesale operator	Unknown
	Tanzania	Smile has obtained 800 MHz	Unknown
2,600 MHz	Uganda	Unclear, regulator states 2×30 MHz has been assigned	Unknown
	Ghana	Ghana: awarded to small operators with limited success	0.02
	Nigeria	Auction: six 2×5 MHz lots awarded to one operator	0.01
	Uganda	Unclear, regulator states 2×60 MHz has been assigned	Unknown

Source: various press reports and authors’ analysis.

Nigeria held a spectrum auction in 2016 for 2,600 MHz, which attracted only one bidder, MTN. MTN was able to purchase 6 of the 14 lots at the reserve price of USD 16 million per lot and was licensed with 30 MHz in the 2,600 MHz band (or USD 0.01 per MHz per capita). MTN is the largest operator in Nigeria with a market share of 39 per cent in terms of subscribers. It appears that the main reasons for non-participation in the auction include the reserve price, which may have been set too high—other operators cited this—combined with economic conditions in Nigeria and the cost of rolling out networks. Again, a substantial portion of the offered spectrum was not acquired and only the largest operator received spectrum in the auction.

Ghana held a long-term evolution (LTE) auction in 2015, which attracted four bidders. The largest operator with 50 per cent of mobile data subscribers, MTN Ghana, was awarded one of the two lots of 2×10 MHz. The reserve price set was USD 67.5 million or USD 0.12 per MHz per capita. The auction and high reserve price were controversial, but after the limited success of licensing 2,600 MHz spectrum to smaller operators a few years previously, the Ghanaian authority may have wanted to ensure the spectrum went to a player that would be able to invest in its network. The Ghanaian auction produced the highest price per megahertz per capita of any of the assignment processes for which we have pricing data. However, again it was only partially successful, assigning only half of the available spectrum and only to the largest operator.

Mozambique attempted to hold an auction for five 2×5 MHz blocks of 800 MHz spectrum in 2013 (six blocks were available, but one was withheld to restrict supply). The reserve price was high at USD 30 million per block or USD 0.10 per MHz per capita. None of the mobile operators chose to participate in the auction and the spectrum was left unlicensed.

Tanzania and South Africa have both attempted to hold spectrum auctions, as will be discussed in more detail below. Tanzania's 700 MHz auction was successful in the sense that spectrum was awarded, but the price achieved was relatively low at USD 0.001 per MHz per capita.

In terms of the mechanism for spectrum assignment, it seems that countries that have used an auction approach have generally received higher revenue from the process but have been able to assign less spectrum and spectrum has been left unassigned in many cases. This is not optimal from an efficiency perspective and may suggest that reserve prices have been set too high in some cases. On the other hand, where spectrum has been assigned on a non-competitive basis at much lower prices, spectrum may have been undervalued to some extent, and, based on the principles outlined earlier, may have resulted in spectrum being used less efficiently than would be optimal.

2.2 Infrastructure sharing

Infrastructure sharing has been promoted as a means of reducing the cost of network rollout. It can have environmental benefits (as less infrastructure needs to be built) and can reduce barriers to entry and make it easier for new firms to enter and grow. It may also encourage rolling out infrastructure to underserved areas since firms can share the cost. However, sharing also has important competition implications. Large operators who have a lot of infrastructure can use it as a means of raising the costs of their smaller rivals by charging high rentals or degrading the quality of access. Sharing can also lead to anti-competitive coordinated effects if it leads to information sharing and increased symmetry between competing operators.

In jurisdictions where infrastructure sharing is widely used, there has been a great deal of debate around its overall impact on competition. Losada (2009) uses a theoretical model to explore the impact of infrastructure sharing on competition. The author finds that infrastructure sharing agreements among network operators can lead to increases in the quality of networks, but only when infrastructure decisions are made prior to the signing of the agreement or if the regulator determines which facilities are to be built jointly. However, if operators decide cooperatively on the infrastructure to be built, this tends to decrease the quality of the networks. This suggests that operators acquiring access to existing infrastructure of their rivals is less likely to lead to competition problems than when operators jointly roll out infrastructure as a joint venture. In addition, the sharing of passive infrastructure (such as ducts, towers, or antennas) is less likely to lead to reduced competition than the sharing of active infrastructure (such as radio access networks or RANs) as operators still maintain differentiated networks and have an incentive to compete on quality.

The United Kingdom has allowed several infrastructure-level mergers and joint ventures. The Vodafone–O2 joint venture is an infrastructure sharing agreement to co-manage 18,500 sites to create a national 'grid' (see Vodafone UK 2012). It was approved by the Office of Fair Trading in October 2012. The design, management, and maintenance of sites is managed by O2 in the east of the country and Vodafone in the west. Following the merger of Orange and T-Mobile into Everything Everywhere (EE) and the Vodafone–O2 joint venture, at an infrastructure level, the United Kingdom is now effectively covered by two national networks. In early 2014, it was announced that EE and Three would work together to roll out their 4G LTE networks. The two

will share costs and infrastructure but not antennas, spectrum, or the core network (see Weiland 2014).

In spite of all these developments, the United Kingdom's telecoms regulator, Ofcom, is of the view that the national wholesale level is particularly important for competition (Ofcom 2012). This is since it is the wholesale level that determines quality, and competition between national wholesalers tends to stimulate competition at the retail level both directly (where wholesalers are also retail competitors) and indirectly (where non-wholesalers can obtain access to wholesale services on terms that enable them to be effective retail competitors). Ofcom is of the view that while infrastructure sharing can reduce the fixed costs of building a network, this is at the risk of a reduction in end-to-end competition. Therefore, it is important to ensure that such deals are structured in a way that the participants are still incentivized to compete with one another.

In May 2008, Sprint Nextel and Clearwire Corporation announced plans to form a joint venture to create a fast wireless network in the United States with financial backing from a number of equity partners, including Comcast, Google, and Intel (*Law360* 2009). The Federal Communications Commission (FCC 2008: 35) cleared the joint venture in November 2008, stating that:

with respect to a combined market for mobile telephony/broadband services, upon evaluation of the data, we find that there would be a sufficient number of competitors present post transaction with thoroughly built-out networks, adequate bandwidth, and the ability to offer competitive nationwide services which would make competitive harm highly unlikely.

The FCC also noted that the transaction had the potential to promote competition by facilitating the emergence of a new market entrant. Stakeholders had raised concerns that the agreement, combined with the merger of Verizon and Alltel, would result in a serious consolidation of carriers in the 2.5 GHz service and would make it difficult for any new entrant to duplicate the network. Two stakeholders argued that the transaction could have an adverse impact on roaming arrangements and that the current automatic roaming arrangement was not sufficient to ensure seamless roaming between networks. These stakeholders requested the FCC to impose carrier-to-carrier network interoperability as a condition of the approval. The concern arose from the fact that it took several years of negotiation to achieve automatic roaming agreements with the parties and the stakeholders argued that, in the light of this, the merger may not, in fact, benefit competition. The parties in reply stated that they would provide wholesale access to the network 'to other entities that are willing to negotiate commercially reasonable terms and conditions for this access' (FCC 2008: 37). The FCC saw no need to impose additional commitments on the transaction as, in its view, competition in the retail market was sufficient to protect consumers against potential harm arising from inter-carrier roaming arrangements and practices.

In Sweden, the regulator has allowed two network sharing consortia to form, such that of the five operators, four of them are party to a joint venture, each with two operators and there are effectively three third-generation (3G) networks in the country. Operators in Sweden face an obligation to collocate or provide other opportunities for shared use of property or other resources where sharing will protect the environment, public health, or public security, or achieve the objectives of public planning (GSMA 2012). However, a requirement of the regulator to allow these joint ventures to go ahead was that each operator should keep 30 per cent of its own network separate. Operators may share up to 70 per cent of their networks but must own and operate 30 per cent separately (GSMA 2012).

In Holland, the telecommunications regulator and competition authority issued a joint memorandum in 2001 stating that they would allow collaboration on network development for 3G networks, but on the condition that competition would still exist between the parties. The regulators stated that:

In its assessment of the effects of a collaborative agreement submitted, the NMa will take into account the market structure (e.g. high entry barriers as a result of limited frequency space), the market position of the participants involved in the agreement, and the nature of the product and the service. For instance, a collaborative agreement between participants with a large market share will generally have a greater effect on the market than a collaborative agreement between participants with a smaller market share. If the participants appeal that there is no appreciable effect on competition, these participants will have to substantiate their arguments. (NMa 2001)

The memorandum further stated that collaboration must be limited to the joint construction and use of the universal mobile telecommunications system radio network (such as masts, aerials, and network operation) and that each operator must be able to individually determine the quality of the network at its own discretion. This is so that in practical terms it would be as if the network was constructed entirely by a single operator. This means that separate settings for all parameters relevant to quality must be possible, such as handover parameters and capacity allocation to users.

In 2012, the Danish competition authority allowed two operators, Telia Sonera and Telenor, to form a joint venture to share sites, masts, and RAN. The regulator had a number of concerns about the competition impact of the agreement between Denmark's third and fourth operator, including that it may increase the risk of a collusive outcome on the wholesale market for mobile telephony and mobile broadband in Denmark and that it would reduce the number of antennas and masts in their common RAN, which would limit the available alternatives for competitors that rent space on the parties' masts. Due to these concerns, the agreement was approved only after the parties made a number of commitments including that the joint venture would charge the parties cost-related tariffs, would take measures to avoid information sharing, would bid together in future spectrum auctions (and hence be forced to jointly meet the spectrum cap), and would sell any superfluous sites to other operators.

Overall, regulators and competition authorities have taken the view that infrastructure sharing, up to the level of RAN sharing, should be permitted in order to reduce the cost of rolling out next-generation networks and lower barriers to entry. However, the competition effects of such agreements should be carefully considered and, where necessary, remedied. In particular, it is important to ensure that deals are structured in such a way that the participants are still incentivized to compete with one another, and such that there is no lessening of third parties' ability to compete. Critically, regulators have emphasized the importance of maintaining sufficient competition at the infrastructure level, in order to facilitate entry and competition at the services or retail level.

2.3 Call termination rates and number portability

MTRs are the tariffs charged by mobile operators to one another for terminating calls on their network. High MTRs tend to penalize smaller operators with fewer subscribers, as a greater proportion of the calls made by their subscribers are likely to be to other networks (off-net) and incur call termination charges. Large operators can set high MTRs to make it more difficult for smaller operators to compete. For example, in South Africa, incumbent mobile networks MTN and Vodacom raised MTRs by more than 500 per cent prior to the entry of a third operator, Cell

C (Hawthorne 2018). High MTRs increase the cost of off-net calls at the same time as allowing large operators to offer deep discounts for on-net calls, making it much more attractive to belong to the large network. Economic literature has shown that under certain circumstances, these ‘tariff-mediated network effects’ lead to increased competition between mobile network operators for subscribers but in others, notably where there is a more concentrated market structure, it is predicted that retail prices will fall as MTRs fall (Hawthorne 2018).

In many countries, therefore, MTRs have been regulated at the long-run incremental cost of providing call termination services, and have declined significantly over time. Empirical studies have found mixed results from these interventions but overall seem to find more support for MTR interventions leading to lower retail prices. In an initial study of OECD countries, Genakos and Valletti (2011) found that declining MTRs had led to higher prices in a ‘waterbed effect’; later, they found that this effect had disappeared over time (Genakos and Valletti 2015).

Another pro-competitive intervention is to mandate mobile number portability (MNP), so that consumers can easily switch networks while retaining the same mobile number. Again there are opposing theories on the likely effect of MNP. On the one hand, it should enable easier switching between networks for consumers which could increase competition. On the other hand, where MNP is not available, operators may compete more vigorously for subscribers in the first place. In a situation where mobile penetration is high and there are one or two large incumbent operators, it seems more likely that MNP will lower barriers to entry and facilitate competition. Research on the introduction of MNP in the European Union finds that the intervention led to a fall in retail prices (Cho et al. 2016). In South Africa, which is the only one of the case study countries to have mandated MNP, around 77,000 mobile ports occur per month, or 0.08 per cent of subscribers (NPC 2005). This corresponds to about 1 per cent of subscribers per year.

3 Review of telecommunications regulation in South Africa, Tanzania, Zambia, and Zimbabwe

3.1 Spectrum assignment

Of the four case study countries, only Tanzania has held a 4G spectrum auction, which may go some way to explaining the poor quality of LTE speeds and coverage in the region. In July 2016, the Independent Communications Authority of South Africa (ICASA) published an invitation to apply (ITA) to participate in a spectrum auction for four predetermined lots of 700/800 MHz spectrum bundled with 2,600 MHz spectrum, each with a reserve price of R3 billion or around USD 214 million. Each operator was eligible to purchase only one lot and there were four existing mobile operators in South Africa. If all four lots had been sold at the reserve price, this would have implied a price per megahertz per capita of USD 0.08, a little over half the price of Ghana’s relatively unsuccessful 800 MHz auction and a similar price to Senegal’s failed 800 MHz auction. The ITA was challenged by the Department of Telecommunications and Postal Services on various grounds and ICASA postponed the auction pending a review hearing. The spectrum therefore remains unassigned.

One of the reasons the government cited as motivation for blocking the ITA is that the reserve price is ‘onerous’ and would favour large players. Meanwhile, operators are forced to work within their existing spectrum assignments to provide LTE services. Table 2 displays the current spectrum assignments to MSPs in South Africa. While the assignments are relatively even currently between the four largest operators, operators have complained that the lack of spectrum is impeding their ability to roll out LTE services given that they still need to provide legacy second- and third-generation services as well.

Table 2: Mobile spectrum assignment in South Africa by mobile provider (in MHz)

Spectrum band	Vodacom	MTN	Cell C	Telkom	Rain
900	22	22	22	—	—
1,800	24	24	24	24	24
1,800 unpaired					10
2,100	30	30	30	30	—
2,100 unpaired	5	10			
2,300 unpaired	—	—	—	60	—
2,600	—	—	—	—	15
3,500	—	—	—	28	
3,600 to 3,800 unpaired					80
Total	81	86	76	142	114

Source: from public source ICASA (2019).

The high demand for spectrum may have facilitated an agreement between Rain and Vodacom in which Vodacom is able to place its equipment on Vodacom towers while Vodacom subscribers are able to roam on the Rain network, giving it better coverage and quality of service (Bell and Bosiu 2019). MTN and Cell lodged a complaint with the Competition Commission concerning the agreement, but the commission found no competition concerns associated with the agreement (McLeod 2018). The lack of additional spectrum assignment appears to have encouraged infrastructure sharing between Vodacom and Rain and has enabled Rain to expand. At the time of writing, Rain offered the lowest prepaid mobile data price at R50/GB or just over USD 3/GB.

In July 2019, the Department of Communications published a policy on spectrum. The policy proposed giving a new wholesale open access network (WOAN) preferential access to a portion of spectrum within the 700, 800, and 2,600 MHz bands of spectrum. The department considers it appropriate for the remaining spectrum to be assigned to mobile networks subject to the achievement of certain policy objectives, including:

- leasing of electronic communications networks and electronic communications facilities and provision of wholesale capacity to other licensees, including to the WOAN upon request, as soon as the WOAN is licensed [...];
- universal access and universal service obligations to ensure high-quality network availability in rural and under-served areas; the obligations must be complied with in rural and under-served areas before the assigned spectrum may be used in other areas bearing in mind practicalities such as the unsuitability of certain high-band spectrum for rural areas;
- [that] a single entity may not control the spectrum; and
- compliance with empowerment requirements. (Department of Communications 2019: 8)

The policy draws its open access principle from the Electronic Communications Amendment Bill which was tabled in October 2018 (Government of the Republic of South Africa 2018). It was however withdrawn in February 2019 when the communications minister decided to hold further consultations to align the Bill with the ‘drive towards the fourth industrial revolution’ (*BizCommunity.com* 2019). While the process of spectrum assignment in South Africa has been delayed and protracted, there does seem to be an effort to ensure that the assignment of spectrum results in a level playing field for smaller operators. The process of distribution also appears to have moved from the beauty contests to more competitive market-based auctions. The ultimate decision as to how to assign spectrum lies with the regulator, ICASA, which is currently in the process of running a new assignment process and must decide how best to ensure efficient use of spectrum as well as a pro-competitive outcome.

No spectrum has been assigned in Zambia or Zimbabwe in the last five years. However, in Zambia prior to 2014, spectrum was assigned on a first come, first served basis (Table 3).¹ More recently, Zambia Information and Communications Technology Authority (ZICTA), the communications regulator in Zambia, has favoured a more competitive market-based process and going forward will use this method to assign spectrum.²

¹ Email communication with ZICTA, 12 September 2019.

² Email communication with ZICTA, 12 September 2019.

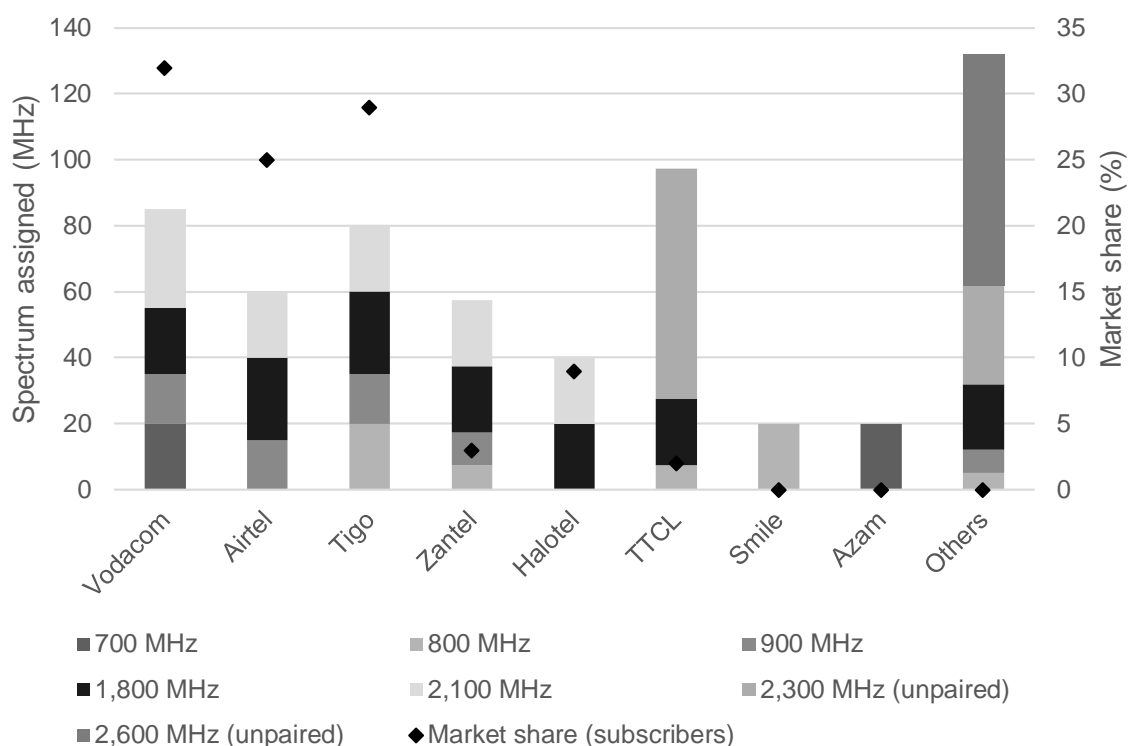
Table 3: Comparison of spectrum assignments in case study countries

	Digital dividend spectrum assigned	Assignment mechanism	Additional requirements	Recipients	Price paid	Sharing/trading allowed?	3G coverage (%)	LTE coverage (%)
South Africa	None; ITA expected in 2020	Competitive process likely	N/A	N/A	N/A	No sharing; no trading; roaming agreements take advantage of spectrum assignments	100	90
Tanzania	700 MHz: two lots of 2x10 MHz	Auction	Spectrum cap; coverage obligations	Vodacom; Azam	USD 20 million or USD 0.001 per MHz per capita	No sharing; no trading	61	28
Zambia	800 MHz None	Competitive process preferred	N/A	Vodacom; Smile N/A	N/A	No sharing; no trading	40	40
Zimbabwe	None	N/A	N/A	N/A	N/A	No sharing; no trading	78	34

Source: authors' compilation based on regulator websites and interviews and GSMA (2019).

In Tanzania, as was the case for most African countries, earlier spectrum assignment was carried out using a beauty contest, first come, first served method of distribution. This was the case for the assignment of 800 MHz. Smile Tanzania was assigned spectrum in the 800 MHz band, but details on the process are currently not publicly available. According to some stakeholders, past assignment processes resulted in the fragmentation of spectrum and ownership of spectrum by companies that left it idle.³ We can see that spectrum is still relatively fragmented and several players with a small number of subscribers have access to a large amount of spectrum (Figure 1). In 2018, the Tanzanian Communication Regulatory Authority (TCRA) released spectrum guidelines that allowed for the allocation and assignment of spectrum based on a competitive process (Minister for Works, Transport and Communication 2018a). The regulations allow for the use of beauty contests or auctions. Assignments based on beauty contests, however, must be based on rollout commitments and the credibility of the applicant (Minister for Works, Transport and Communication 2018b).

Figure 1: Spectrum assignment and market shares in Tanzania, 2018



Source: authors' compilation based on information provided by Vodacom and TCRA.

A spectrum auction took place in June 2018, during which spectrum was assigned to two providers, Vodacom and Azam, subject to coverage obligations that included population coverage for broadband services equal to 60 per cent by the end of 2021 and 90 per cent by the end of 2024 (TCRA 2018). The process appears to have been competitive and largely successful. According to TCRA, its success was likely due to the use of a realistic reserve price, a transparent process, as well as the use of both sealed bids and an auction at different stages of the process.⁴ The reserve price was much lower than that proposed in the South African ITA at only USD 0.001 per MHz

³ Interview conducted with Vodacom, 17 September 2019.

⁴ Email communication with TCRA, 19 September 2019.

per capita. It is worth noting, however, that while there are a number of other large mobile operators in Tanzania such as Airtel, Tigo, and Halotel, the prices paid were very close to the reserve price even though there was only a small number of packages available. This suggests that the auction was not particularly competitive despite the low reserve price. The onerous coverage obligations may be to blame for the lack of greater participation.

For at least three of the countries, South Africa, Tanzania, and Zambia, there has been a shift towards a more competitive market-based method for spectrum assignment. Tanzania, however, is the only country that has carried out a spectrum auction. Perhaps bearing in mind the issues faced in previous auctions held in other African countries, Tanzania set a reasonable reserve price but also placed universal service obligations (USOs) on the recipients of the spectrum. Its regulations also allow the regulator to withdraw spectrum should it not be utilized, giving licensees an incentive to make use of spectrum and also discouraging potential applicants without immediate need of spectrum. The regulator may need to consider such an intervention given the current fragmentation and underutilization of spectrum, as evident from Figure 1. In South Africa the delays in the assignment of spectrum or in the development of regulations has likely contributed to the stalling of data prices in the country. It remains to be seen how the regulator will balance policy directives and the need for a competitive and efficient assignment in the upcoming auction process. Zambia and Zimbabwe are yet to assign spectrum, likely due to low demand for the resource. There are no regulations although the regulators maintain that this is on the agenda.⁵

3.2 Infrastructure sharing

Regulators in the case study countries seem keen to encourage infrastructure sharing, and three of the four countries have published some form of infrastructure sharing regulations (Table 4). Regulations covering interconnection, access, and collocation were published in Zambia in 2013, while specific infrastructure-sharing regulations were published in Tanzania and Zimbabwe in 2018 and 2016, respectively. There are currently no regulations or guidelines in South Africa, although the leasing of certain facilities is mandated in the Electronic Communications Act (2004) provided that leasing is technically and economically feasible and consistent with the efficient use of telecommunications networks.

As explained above, one of the reasons for the regulation of infrastructure sharing is that otherwise large operators may have an incentive to make life difficult for their smaller rivals by refusing to grant access to facilities, charging a high price for access or otherwise making the process more costly, unattractive, and time-consuming. The regulations in all three countries speak to these concerns. The regulations all mandate sharing unless it is found not to be feasible (although the definition of feasible differs), all limit time periods for consideration of sharing requests, all speak of non-discriminatory terms, and all provide for the regulator to step in to adjudicate any disputes. The Zimbabwean and Tanzanian regulations also clarify the circumstances in which the infrastructure owner can reserve space for its own future deployment, limiting the amount of space that can be reserved and ensuring that this is not reserved indefinitely. The Zambian regulations require operators to maintain reference offers for collocation specifically.

⁵ Interviews conducted with ZICTA, 9 September 2019, and POTRAZ, 12 September 2019.

Table 4: Summary of approach to infrastructure sharing in case study countries

	Approach to infrastructure competition	Infrastructure sharing rules	Role of the regulator	Appeal process	Prevalence of sharing in practice	Disputes
South Africa	Mandatory sharing of passive infrastructure if technically and economically feasible	Electronic Communications Act	Can rule on dispute brought under the Electronic Communications Act	Appeal/apply for review at High Court	<ul style="list-style-type: none"> • Mobile site collocation—common • Vodacom/Rain^a • Ducts and poles—some sharing but disputes 	Vodacom/Telkom duct access dispute
Tanzania	Sharing should not compromise competition	Regulations (2018): <ul style="list-style-type: none"> • Provider must respond to a request within 21 days • Provider may not decline unless technically/economically unfeasible/likely to cause undue prejudice/likely to endanger safety or reparably damage property/insufficient space • Where required to share, operators can charge a fee to recover economic costs and a reasonable rate of return • Non-discriminatory terms • Owner can reserve up to 50% of remaining space for up to 2 years • Provider to remove unnecessary/abandoned/obsolete equipment 	Regulator to make finding on disputes in 30 days	Parties may appeal to the Fair Competition Tribunal	Helios Towers acquired towers from Vodacom, Airtel, and Zantel	Complaints of high prices
Zambia	Access and collocation should be provided unless not feasible	ICT (Access) Regulations (2013): <ul style="list-style-type: none"> • A licensee may only refuse to provide access to an electronic communications network or parts thereof to another licensee if it is not reasonably feasible, the request will lead to harmful interference, or the licensee does not have the same category of licence 	Either party may request ZICTA to intervene; ZICTA may also intervene of its own accord	ZICTA is the final decision maker	<ul style="list-style-type: none"> • IHS acquired almost all towers from MTN and Airtel • Very little sharing of fibre and cost of access for internet service providers is a concern 	Complaints to ZICTA around high pricing of collocation

Zimbabwe	Objective to 'eliminate unnecessary duplication of telecommunication infrastructure' and to promote competition Demonstrate when constructing new infrastructure that not possible to share/upgrade existing infrastructure No sharing without regulatory approval—will not approve if anti-competitive	<ul style="list-style-type: none"> • Application must be copied to ZICTA and any refusal with reasons • Agreement concluded within 20 days • Provision for non-discriminatory unbundled access on reasonable terms • Collocation at non-discriminatory rates • Reference offers to be maintained Regulations (2016): <ul style="list-style-type: none"> • Provider must respond to a request within 14 business days • Provider may not decline unless technically/economically unfeasible/likely to cause damage to infrastructure • Pricing based on cost including return on capital • Charges detailed enough for seeker to only pay for elements it requires • Non-discriminatory terms • Provider can reserve up to 50% of remaining space for up to 2 years 	<ul style="list-style-type: none"> • POTRAZ to make finding on disputes in 21 business days • Regulator to carry out infrastructure audits to identify shareable infrastructure and to develop and maintain a database on sharing 	POTRAZ final decision maker	<ul style="list-style-type: none"> • Site sharing between Econet and NetOne finally agreed in 2019^b • Site pairing common but not leasing—lack of investment in new sites by smaller operators • Duct sharing not happening 	No complaints but sharing not common
----------	---	---	---	-----------------------------	---	--------------------------------------

Notes: POTRAZ, Postal and Telecommunications Regulatory Authority of Zimbabwe. ^aSee My Broadband (2019a). ^bSee Adepoju (2019).

Source: authors' compilation based on regulator websites and interviews.

These features are pro-competitive. The provision of a clear timeline for dealing with requests prevents delay tactics by large operators. The clear obligation, dispute mechanism, and threat of price regulation if commercial terms are not agreed will tend to disincentivize strategic behaviour by infrastructure owners. South Africa, by contrast, has a legal provision but no clear framework by which the regulator will intervene to enforce it.

One concern with the Zimbabwean regulations is that they take a rather extreme view on the balancing of cost saving with the need to promote competition. The Zimbabwean regulations list their first objective as to ‘eliminate unnecessary duplication of telecommunication infrastructure’, although to ‘promote competition in the provision of telecommunication networks and services’ is also an objective. Of further concern is Section 4(b) which states that firms should:

- when constructing new infrastructure, first establish and demonstrate that—
- (i) all reasonable steps have been taken to investigate the possibility of utilising existing infrastructure before constructing new infrastructure;
 - (ii) it is not technically or practically feasible to share existing infrastructure; and
 - (iii) the costs of upgrading the existing infrastructure exceed that of building infrastructure. (Minister of Information Communication Technology, Postal and Courier Services 2016: 1062)

As discussed in Sections 2.1 and 2.3, an element of duplication of infrastructure is necessary in order to ensure effective competition. Regulators should not seek to intervene to reduce duplication but to promote the granting of access in order to lower barriers to entry. Where firms see an investment case in constructing duplicate infrastructure, regulators should generally not seek to prohibit this.

Another potential difficulty in the regulations is the lack of clarity around the meaning of economic feasibility. Neither the Zimbabwean nor the Tanzanian regulations provide a definition of the term, which means it is difficult for operators to know how applications should be adjudicated. It is possible that a working definition may be developed through the process of dispute adjudication by the regulator, but it would assist operators (particularly applicants for access) if the term was clearly defined and understood.

As important as the legal and policy position on sharing is the practical experience of sharing in telecoms markets. Here, the evidence from our interviews suggests that, in practice, sharing may be sub-optimal from a competition perspective. As discussed in the companion paper on competition (Robb and Paelo 2020), an important development from an infrastructure perspective in Tanzania and Zambia has been the selling off of mobile towers by operators to independent tower companies. In Zambia, the two incumbent operators have sold off the majority of their towers to IHS, a large African tower company. IHS acquired 100 per cent of MTN’s 710 towers in 2014 and 929 of Airtel’s in 2015. Therefore, it owns more than half of the 2,759 towers in Zambia. In Tanzania, Vodacom sold 100 per cent of its 1,149 towers to Helios Towers on the basis that it would lease back the infrastructure subject to a long-term contract (*IT News Africa* 2013). In 2019, Helios Towers owned 3,650 sites in Tanzania with a tenancy ratio of 2.18, and it had a market share of 68 per cent in 2018 (see Helios Towers 2020).

This may have positive and negative effects on competition. Since they are not vertically integrated, the tower companies should be inclined to supply collocation services to all operators on equal terms, as opposed to the incumbents who may have had an incentive to disadvantage their rivals. However, the concentration of such a large proportion of towers in the hands of one competitor could lead to high prices and a lack of competition for collocation services. This appears to have been the case in practice in both countries as the regulators have received complaints of high

prices. While infrastructure regulations may assist in tackling any anti-competitive conduct by tower companies, a competitive market structure would significantly alleviate the need for regulatory monitoring and intervention and is likely to lead to better outcomes.

An additional concern in Zimbabwe is that not much sharing of mobile infrastructure seems to be taking place. The operators interviewed and the regulator suggested that the main form of site sharing is through pairing (a site for a site) rather than leasing. While this may assist in allowing increased coverage and retail competition, it tends to limit the amount of access available to smaller operators, as they have fewer sites to offer in exchange. While this is a factor of the greater investment in sites by larger operators, an ideal scenario from a competition perspective would be to have more dispersed site ownership so that any operator looking for space on sites would have access to competing alternatives. Where site leasing does not materialize through commercial negotiation, the regulator may need to be more proactive in encouraging leasing and enforcing its regulations.

In terms of fixed infrastructure, all the regulators complained that there is not much sharing taking place. Again, this is not necessarily a problem if it results in several competing infrastructure providers, as this will provide downstream retail service providers with greater choice of wholesale providers. Where an operator with market power refuses access to its infrastructure, however, it may be a means of creating barriers to the entry and expansion of rivals, and of preventing them from moving up the 'ladder of investment' to ultimately become infrastructure competitors. In countries such as the United Kingdom, access to ducts and poles is regulated and subject to reference offers for this reason, as a large proportion of this infrastructure is owned by one provider (Ofcom 2010). In South Africa, a dispute around duct access was recently heard by the courts as the fixed-line incumbent, Telkom, was reluctant to lease space in its ducts in a residential estate to its rival, Vodacom (see My Broadband 2019b). The Supreme Court of Appeal ruled that Vodacom was allowed to place its fibre in the ducts as they belonged to the homeowners' association and not to Telkom (see McLeod 2019).

Given the high market shares in fixed-line wholesale markets that were found in the companion paper on competition (Robb and Paelo 2020), there may be a case for more aggressive intervention by regulators in the region, possibly to the extent of requiring reference offers.

3.3 MTRs

All four countries regulate MTRs using a cost-based methodology. Tanzania uses a 'bottom-up long-run incremental cost' (LRIC) approach that uses a notional modern efficient operator and calculates the incremental cost to such an operator of providing call termination services (TCRA 2017). This is a standard commonly used internationally⁶ and tends to result in low call termination rates as it focuses purely on the incremental costs associated with call termination and does not include any network or common costs. Zimbabwe, on the other hand, uses LRIC+ which is LRIC with an added mark-up for network and common costs (POTRAZ 2012). Since 2014, South Africa has set the MTR for large operators at LRIC and has allowed a higher (above LRIC) rate for smaller operators (ICASA 2014).

Pure LRIC is generally considered to be a more appropriate standard as it tends to level the playing field for competition. As the Commission for Communications Regulation in Ireland explains in relation to mobile service providers (MSPs):

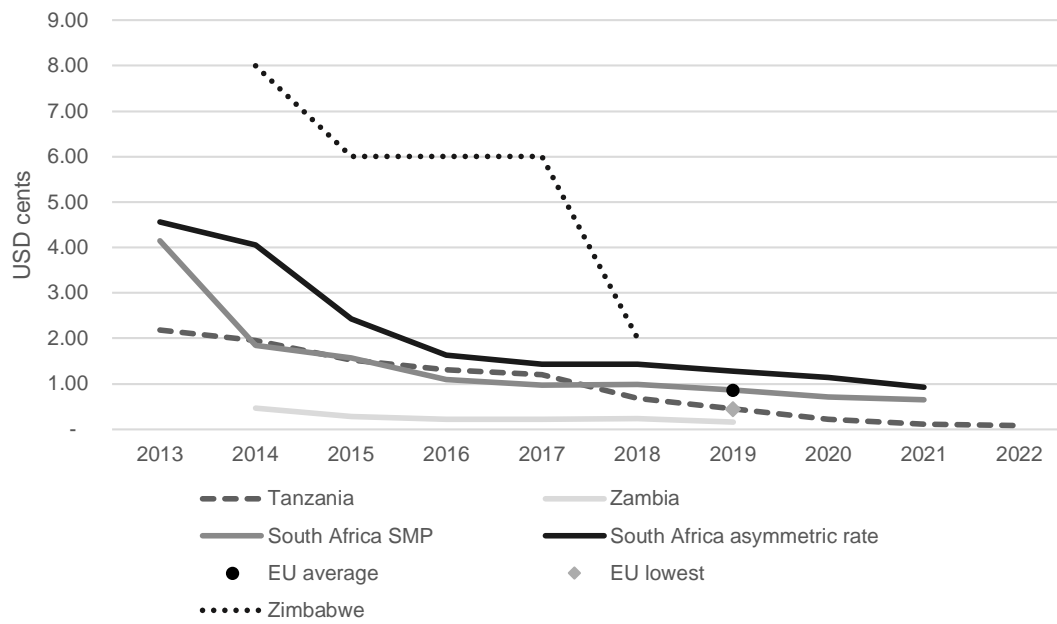
⁶ For example, 24 out of 37 European countries use a pure bottom-up LRIC methodology (BEREC 2019).

Pure LRIC MTRs enable smaller MSPs to compete more easily with larger MSPs whereas MTRs that exceed incremental cost i.e. LRAIC+ can lead to more pronounced tariff-mediated network externalities, which may cause inertia in the retail market, and make it difficult for smaller MSPs to win customers from large MSPs. Pure LRIC MTRs lower the floor for the retail pricing of off-net calls which strengthens the ability of smaller MSPs to construct competitive packages. This easing of barriers to entry/expansion (associated with large financial transfers at wholesale level and tariff-mediated network externalities at retail level) therefore facilitates a more competitively neutral framework. (Commission for Communications Regulation 2018: 120)

Regulators outside of Europe are also moving towards the use of pure LRIC or have already done so. In April 2008, the East Africa Regulatory, Postal and Telecommunications Organization issued guidelines on interconnection arrangements for members of the East African community which recommended the phasing in of LRIC within two years (Research ICT Africa 2009). In 2009, a study performed by Research ICT Africa for the Namibian Communications Commission concluded that pure LRIC was the most appropriate approach to determining termination rates. The use of only the incremental costs of wholesale termination services makes sense as ‘operators do not build networks and provide coverage to terminate calls, but to provide services to their customers and gain new customers’ (Research ICT Africa 2009: 15). Interconnection rates in Namibia were then set based on international benchmarks using countries that implemented LRIC. Rates were subsequently reduced in 2013 and again in 2014 and 2016 (Communications Regulatory Authority of Namibia 2016). The Communications Commission of Kenya (2010: 8) determined that ‘the pure LRIC methodology is the most efficient method for setting termination rates as it set termination rates close to the marginal cost of providing termination services to third parties. It also considered that the lower termination rates associated with the pure LRIC model would lead to increased competition and not present a financial risk to operators.

Although not all use a pure LRIC methodology, all the case study countries have followed a declining glide path since at least 2014, as illustrated in Figure 2. South Africa’s MTRs declined from over USD 0.04 per minute in 2013 to just under USD 0.01 per minute in 2019. South Africa has maintained asymmetry between operators with substantial market power (SMP) (MTN and Vodacom) and those without (Cell C and Telkom Mobile) but the level of asymmetry has declined over time. In 2019, the MTR for SMP operators was very close to the average MTR level in the European Union, while the MTR for non-SMP operators was higher. Tanzania has one MTR for all operators and it has fallen from just over USD 0.02 per minute in 2013 to around USD 0.005 per minute in 2019, which is around the level of the lowest MTR in the European Union. The rate in Zambia has been extremely low throughout the period. Zimbabwe, on the other hand, had by far the highest MTR of around USD 0.08 per minute in 2014 and, while it has fallen steeply, still had the highest rate of USD 0.02 per minute in 2018. The rates in South Africa and Zambia are set to continue on a downward trajectory until at least 2021 and 2022, respectively.

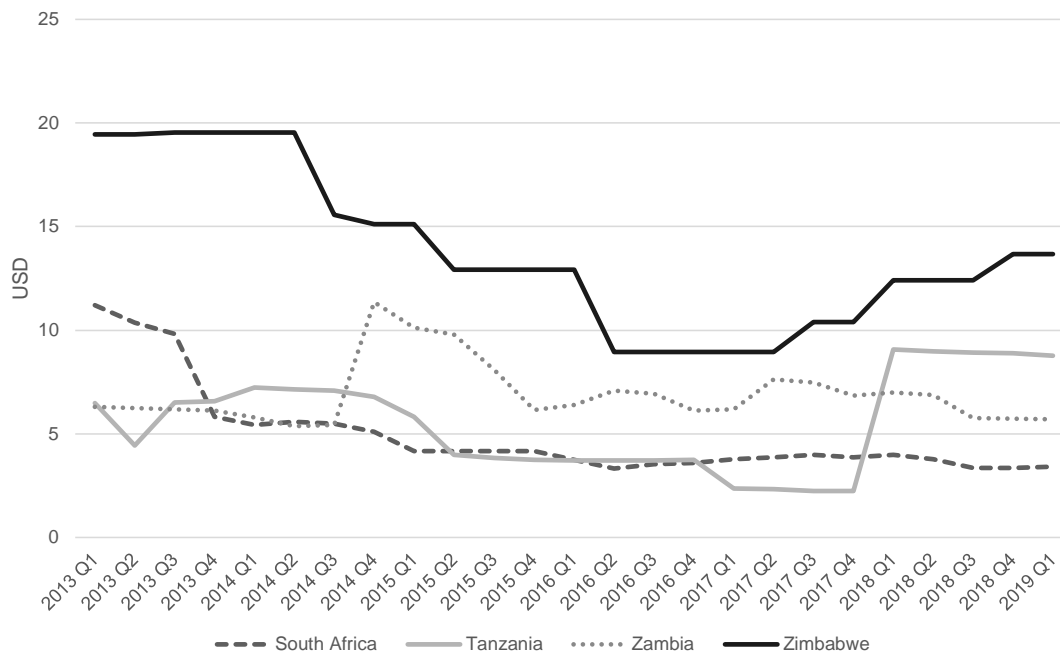
Figure 2: Call termination rates, 2013–22



Source: authors' compilation based on data from regulator websites and interviews.

Figure 3 compares the price of the cheapest mobile voice bundles in each country from 2013 to 2019. Prices have fallen quite dramatically in South Africa, falling to a third of their Q1 2013 level by Q2 2016. Thereafter, they have remained fairly stable. In Zimbabwe, prices fell significantly between Q3 2014 and Q2 2016 before eventually starting to rise again. Zimbabwe has had the highest voice prices throughout the period. Tanzania also saw falling prices before an extremely sharp rise in Q1 2018. It is unclear what caused this steep increase. Finally, in Zambia, prices have been similar throughout the period.

Figure 3: Price of cheapest mobile voice bundle, 2013–19



Source: authors' compilation based on data from Research ICT Africa (2019).

Hawthorne (2018) shows that lowering MTRs in South Africa led to lower retail prices. Between 2009 and 2017, MTRs were reduced by 90 per cent in South Africa. Hawthorne (2018) finds that over the same period, prepaid prices and quality-adjusted post-paid prices declined by over 40 per cent. The study finds that 30 and 60 per cent, respectively, of the fall can be attributed to the MTR intervention and that on-net and off-net prices also converged as MTRs fell.

In Zimbabwe, a relatively high MTR combined with one extremely large operator whose market power has been growing (see Robb and Paelo 2020) suggests that tariff-mediated network effects may be acting as a barrier to entry and expansion by smaller operators and as an impediment to greater competition. Ideally, Zimbabwe should also move towards a pure LRIC approach and bring its MTR more in line with benchmarks in Zambia and Tanzania. A related concern in Zimbabwe is that retail tariffs are extremely high in spite of a maximum tariff being set by the regulator. This raises the question of whether the price regulation is providing a focal point for coordination on prices and preventing more vigorous price competition. As there is one operator much larger than the rest, we would expect the smaller operators to have an incentive to undercut their larger rival in order to win market share. However, this does not appear to be happening, perhaps due to the challenges with financing faced by the two state-owned rival businesses which may impact their ability to lower prices if it affects revenues and profits in the short to medium term. The lack of investment in sites could also have limited their capacity to accommodate a large increase in subscribers. At the least, the regulator should be concerned that a process designed to set cost-related tariffs is arriving at prices that are so high relative to prices elsewhere in the region.

There is a less obvious impact of falling MTRs on prices in Tanzania and Zambia, although voice prices in Tanzania had fallen quite significantly before the sudden increase in Q1 2018. More detailed pricing data for individual operators in each country may show a stronger impact of declining MTRs on prices. Robb and Paelo (2020) found that Tanzania has a relatively competitive mobile market, with three large competing operators (Vodacom, Airtel, and Tigo) and another fast-growing smaller player (Halotel). Thus, it seems that MTRs are likely not a barrier to entry for smaller players. While Zambia only has three operators (MTN, Vodacom, and Zamtel), the market share of the smallest operator, Zamtel, has recently grown. A fourth operator, Uzi, has also been licensed, and the regulator indicated that an asymmetric MTR will be considered for the new entrant when it begins operating, as a means of lowering barriers to entry and growth.⁷

3.4 Number portability

Of the four countries considered for this study, only South Africa and Tanzania have number portability regulations, with varying levels of success in terms of increasing competition. In South Africa, number portability was implemented as early as 2006 but the regulations were amended in October 2018 (ICASA 2018). While there have been complaints from rival operators about the lack of efficiency in the portability process (Cell C 2019), subscribers are able to port their number should they decide to. However, it is doubtful that this alone would bring about competitive outcomes since the more lucrative post-paid customers are often locked in to their original contracts and face challenges and delays when they do decide to switch. The network externalities and dominance of MTN and Vodacom in South Africa in terms of coverage and quality of service also mean that price offerings from rival networks may be ineffective in attracting the more lucrative customers to their networks.

⁷ Interview with ZICTA, 9 September 2019.

In Tanzania, number portability regulations were implemented in 2018 to limited effect.⁸ This is likely due to multi-simming, where several mobile subscribers in Tanzania have more than one SIM card from different mobile operators (Blechman et al. 2017). Given this market context, number portability may not have a major impact on competition.

In Zambia and Zimbabwe, there are no number portability regulations although many subscribers also hold more than one SIM card and are able to access a form of number portability in which they can request for numbers from a rival operator that is similar to their original mobile number apart from the prefix. Given the lack of success of number portability in Tanzania, which similarly has high levels of multi-simming, the mandating of number portability may not have a significant competitive impact in these countries either. Nonetheless, it may be worth considering in order to provide consumers with the option to switch their main number between networks.

4 Emerging themes and recommendations

The lowering of call termination rates has been effective in promoting competition in the region and should continue to be brought lower in line with a pure LRIC approach in order to dampen tariff-mediated network effects and drive further competition in mobile markets. This is particularly pertinent in Zimbabwe, where rates are still relatively high relative to the other case study countries. With respect to the regulation of retail tariffs, however, although the aim may be to improve affordability, the evidence suggests that this may not be effective in promoting competition. The setting of maximum tariffs in particular risks providing a focal point for coordination and, conversely, keeping prices high. Interventions focused on promoting infrastructure competition between a few effective rivals are likely to provide greater benefits for consumers in the long run. Number portability does not seem to have had a major impact in Tanzania where multi-simming is common but may still be worth considering as a means of facilitating switching.

In order to facilitate competition in data markets, regulators should ensure there is a converged licensing framework and a level regulatory playing field for different types of provider. Increasingly, data-only providers such as LTE-only mobile networks and even fixed wireless and fibre providers can provide competition to mobile networks, as the popularity of voice and messaging services provided over data grows. While the adoption of data-enabled devices is still a concern, the regulatory regime should seek to promote converged competition as much as possible. In addition, measures to regulate over-the-top (OTT) providers should be considered cautiously, as these services in particular are an important part of the move towards converged data services. Care should be taken not to dampen the adoption of OTT services by consumers through heavy-handed regulation.

From a spectrum perspective, the trend seems to be towards the use of competitive assignment mechanisms, which is likely to promote efficiency. However, it is also important for countries to consider affordability and participation as illustrated by recent spectrum auctions in the region. In addition to setting a realistic reserve price and considering spectrum caps and small packages to maximize competition, care should also be taken not to make USOs too onerous such that they deter smaller players from bidding. One possible approach could be to apply different USOs to different packages, keeping the most onerous obligations for the most attractive spectrum. Consideration should also be given to allowing spectrum trading and sharing, which none of the

⁸ Interview with Vodacom, 17 September 2019.

countries do currently, because this lowers the risk associated with acquiring spectrum as it can be sold later. Spectrum caps may be required where trading is permitted in order to ensure that there is no excessive spectrum concentration or spectrum hoarding.

With regard to infrastructure sharing, it is positive that this is being encouraged in most countries, as a clear obligation to lease facilities can be an important means of lowering barriers to entry and allowing entrants to move up the ladder of investment to become infrastructure competitors. However, regulators need to move away from the perception that the duplication of infrastructure is problematic. Infrastructure competition is necessary in order to ensure that retail markets are competitive and, therefore, there is a balance to be set between encouraging sharing and not disincentivizing investment in competing infrastructure. The trend towards the concentration of towers in the ownership of one company in each country is concerning and future proposed tower acquisitions by these companies should be carefully considered by regulators. A regional approach to the issue may also be informative as the major tower companies, such as ATC, Helios, and IHS, seem to have each invested in different countries rather than competing directly with one another.

From a fixed perspective, the main recommendation is that regulators should not assume that they are unimportant for broadband penetration and affordability. Instead, they should ensure that the licensing regime allows for entry at all levels of the value chain and that access to existing infrastructure is provided on reasonable terms in order to allow entrants to climb the ladder of investment.

From a regional integration perspective, there are a number of findings. The discussion above illustrates the disparity of approaches to economic regulation across countries, in spite of the attempts of the regional regulator body, CRASA, to foster greater harmonization. The difficulty of finding information for the study on the nature of competition, competitive outcomes, regulatory approaches, and impact has highlighted that there is a lack of transparency on the part of regulators on all matters relating to the industry, but particularly in terms of the nature of regulatory interventions and their effects on competition.

Greater communication and coordination between regulators in SADC can facilitate the transfer of learnings as well as assist in the political economy of regulation by providing regulators with more evidence and support for their proposed interventions. The growth of mobile money provides an example of how particular dynamics can be important in developing countries and where, consequently, developed country best practice may not be the best source of information for regulators seeking to grow African telecoms markets. Unfortunately, often, information on local success stories and learnings does not exist or is not public, meaning that it cannot be shared and used to build consensus around proposals.

In addition, the growth of multi-country operators, such as the tower companies and Liquid Telecom as well as mobile operators like Vodacom, MTN, and Airtel, suggests that an understanding of the broader regional context is going to be important for regulators going forward. In order to ensure that they regulate appropriately, regulators will need to have a regional view of developments.

References

Adepoju, P. (2019). 'Zim Telcos Commit to Infrastructure Sharing'. *ITWeb Africa*, 31 May. Available at: <https://itweb.africa/content/mQwkoq6PAEE73r9A> (accessed April 2020).

- Bell, J., and T. Bosiu (2019). 'Rain Brings Hope in the Mobile Telecoms Sector'. *CCRED Competition Review* (March). Available at: <https://www.competition.org.za/review/2019/3/11/rain-brings-hope-in-the-mobile-telecoms-sector> (accessed April 2020).
- BEREC (2019). Termination Rates at European Level. Report of the Body of European Regulators for Electronic Communications. Available at: https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8900-termination-rates-at-european-level (accessed April 2020).
- BizCommunity.com* (2019). 'Electronic Communications Amendment Bill Withdrawn'. Legislation News, South Africa, 12 February. Available at: <https://www.bizcommunity.com/Article/196/717/187303.html> (accessed April 2020).
- Blechman, J., F. Odhiambo, and S. Roberts (2017). 'Competition Dynamics in Mobile Money Markets in Tanzania'. Working Paper 22/2017. Johannesburg: Centre for Competition, Regulation and Economic Development, University of Johannesburg. Available at: https://www.researchgate.net/publication/321974683_Competition_dynamics_in_mobile_money_markets_in_Tanzania (accessed April 2020).
- Cadman, R. (2016). 'Three Forms of BT Separation: Objective, Solutions and Effects'. CCP Working Paper 16-10. Norwich: Centre for Competition Policy, University of East Anglia. Available at: <http://competitionpolicy.ac.uk/documents/8158338/11320618/CCP+WP+16-10+complete.pdf/cc3555dc-ca19-41d7-94fe-83cef086fc7b> (accessed April 2020).
- Cave, M. (2007) 'Six Degrees of Separation Operational Separation as a Remedy in European Telecommunications Regulation'. *Communications & Strategies*, 64(2006): 89.
- Cell C (2019). Notice of Motion in the High Court of South Africa. Available at: <https://www.ellipsis.co.za/wp-content/uploads/2019/04/2019-03-28-Cell-C-Notice-of-Motion-Number-Portability.pdf> (accessed April 2020).
- Cho, D., P. Ferreira, and R. Telang (2016). 'The Impact of Mobile Number Portability on Price, Competition and Consumer Welfare'. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2265104 (accessed April 2020).
- Commission for Communications Regulation (2018). Price Consultation: Further Specification of Proposed Price Control Obligations for Fixed and Mobile Call Termination Rates. Dublin, Ireland: Commission for Communications Regulation. Available at: <https://www.comreg.ie/publication-download/price-consultation-specification-proposed-price-control-obligations-fixed-mobile-call-termination-rates> (accessed April 2020).
- Comms Update (2016). 'Senegal's Incumbent Cellcos 'Boycott' 4G Licence Tender; ARTP Invites Bids from New Entrants'. Available at: <https://www.commsupdate.com/articles/2016/01/19/senegals-incumbent-cellcos-boycott-4g-licence-tender-artp-invites-bids-from-new-entrants/> (accessed April 2020).
- Communications Commission of Kenya (2010). Determination on Interconnections Rates for Fixed and Mobile Telecommunications Networks, Infrastructure Sharing and Co-Location; and Broadband Interconnection Services in Kenya. Interconnection Determination No. 2 of 2010. Nairobi: Communications Commission of Kenya. Available at: <https://ca.go.ke/wp-content/uploads/2018/02/Determination-on-Interconnection-Rates-for-Fixed-and-Mobile-Telecommunications-Networks-Infrastructure-Sharing-and-co-location-and-Broadband-Services-in-Kenya-16th-August-2010.pdf> (accessed April 2020).

- Communications Regulators' Association of Southern Africa (2019). Introducing CRASA: GSR 19—Regulators Associations Meeting. Available at: <https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/RA-Meeting19/CRASA.pdf> (accessed April 2020).
- Communications Regulatory Authority of Namibia (2016). 'Reduction in Fixed and Mobile Termination Rates' [General Notice 401]. *Government Gazette*, 6141: 44. Available at: https://www.cran.na/images/docs/Infrastructure_Sharing/6141-Gen_N393-402_4_Oct_2016.pdf (accessed April 2020).
- Cramton, P. (2002). 'Spectrum Auctions'. In M. Cave, S. Majumdar, and I. Vogelsang (eds), *Handbook of Telecommunications Economics* (pp. 605–39). Amsterdam: Elsevier Science.
- Department of Communications (2019). 'Policy Direction on High Demand Spectrum'. *Government Gazette*, 649(42597): 1–12. Available at: <https://www.ellipsis.co.za/wp-content/uploads/2019/07/Policy-Direction-on-High-Demand-Spectrum-and-Policy-Direction-on-the-Licensing-of-the-WOAN-26-July-2019.pdf> (accessed April 2020).
- FCC (2008). 'FCC Approves, with Conditions, Sprint–Nextel/Clearwire Transaction'. Decision in the Matter of Sprint Nextel Corporation and Clearwire Corporation, 7 November. Available at: <https://www.fcc.gov/proceedings-actions/mergers-transactions/sprint-and-clearwire> (accessed April 2020).
- Genakos, C., and T. Valletti (2011). 'Testing the Waterbed Effect in Mobile Telephony'. *Journal of European Economic Association*, 9(6): 1114–42.
- Genakos, C., and T. Valletti (2015). 'Evaluating a Decade of Mobile Termination Rate Regulation'. *The Economic Journal*, 125(586): F31–48.
- Government of the Republic of South Africa (2018). Electronic Communications Amendment Bill. Available at: https://juta.co.za/media/filestore/2018/09/B31_2018.pdf (accessed April 2020).
- GSMA (2012). Mobile Infrastructure Sharing. Available at: <https://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf> (accessed April 2020).
- GSMA (2016). Competition Policy in the Digital Age: Case Studies from Asia and Sub-Saharan Africa. Appendix 1—Spectrum in Competition Policy. Available at: <https://www.gsma.com/publicpolicy/resources/competition-policy-digital-age-case-studies-asia-sub-saharan-africa> (accessed April 2020).
- GSMA (2018). The Mobile Economy: Europe 2018. Available at: https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_Europe.pdf (accessed April 2020).
- GSMA (2019). GSMA Mobile Connectivity Index. Available at: <https://www.mobileconnectivityindex.com/> (accessed April 2020).
- Hawthorne, R., M. Mondliwa, G. Robb, and T. Paremoer (2016). Competition, Barriers to Entry and Inclusive Growth: Telecommunications Sector Study. 2/2016. Johannesburg. Available at: https://static1.squarespace.com/static/52246331e4b0a46e5f1b8ce5/t/576916b3e58c62969208f300/1466504893026/CCRED+Working+Paper+2_2016_BTE_Telecommunication+Sector.pdf (accessed April 2020).
- Hawthorne, R. (2018). 'The Effects of Lower Mobile Termination Rates in South Africa'. *Telecommunications Policy*, 42(5). doi:10.1016/j.telpol.2018.02.007.

- Helios Towers (2020). Helios Towers website. Available here: <https://www.heliostowers.com/where-we-work/tanzania/> (accessed April 2020).
- ICASA (2014). Call Termination Regulations: Reasons for Decision. *Government Gazette*, 259(38609): 5-41. Available at: <https://www.ellipsis.co.za/wp-content/uploads/2015/03/CTRs-2014-Reasons-Document-25-March-2015.pdf> (accessed April 2020).
- ICASA (2018). 'Number Portability Regulations'. *Government Gazette*, 640(41949): 1–16. Available at: <https://www.icasa.org.za/uploads/files/Number-Portability-Regulations-2018-41949.pdf> (accessed April 2020).
- ICASA (2019). 'Discussion Document on the Market Inquiry into Mobile Broadband Services in South Africa'. <https://www.icasa.org.za/legislation-and-regulations/discussion-document-on-the-market-inquiry-into-mobile-broadband-services> (accessed April 2020).
- IT News Africa* (2013). 'Vodacom Tanzania Acquires Helios Towers Tanzania Network', 22 July. Available at: <https://www.itnewsafrika.com/2013/07/vodacom-tanzania-acquires-helios-towers-tanzania-network/> (accessed April 2020).
- Kittl, J., M. Lundborg, and E. Rulhle (2006). 'Infrastructure-Based Versus Service-Based Competition in Telecommunications'. MPRA Paper 3571, 14 June 2007. Available at: <http://mpra.ub.uni-muenchen.de/3571/> (accessed April 2020).
- Law360* (2009). 'FTC OKs Sprint Nextel's Takeover of Virgin Media'. Available at: <http://www.law360.com/articles/118173/ftc-oks-sprint-nextel-s-takeover-of-virgin-mobile> (accessed April 2020).
- Losada, R. (2009). 'On Infrastructure Sharing Agreement: Should Network Operators Be Allowed to Build Facilities Jointly?'. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1582326 (accessed April 2020).
- McLeod, D. (2018). 'Commission Clears Vodacom, Rain Deal'. *Tech Central, News Central Media*, 11 June. Available at: <https://techcentral.co.za/nothing-wrong-with-vodacom-rain-deal-commission-says/81761/> (accessed April 2020).
- McLeod, D. (2019). 'Judgement against Telkom Seen As a Victory for Competition in Home Fibre'. Available at: <https://techcentral.co.za/judgment-against-telkom-seen-as-a-victory-for-competition-in-home-fibre/88719/> (accessed April 2020).
- Minister for Works, Transport and Communication (2018a). 'Section 27(1) of the Electronic and Postal Communications (Radio Communication and Frequency Spectrum) Regulations, 2018'. Government Notice 24. Available at: https://tcra.go.tz/images/documents/regulations/15._The_Electronic_and_Postal_Communications_Radio_Communication_and_Frequency_Spectrum_Regulations_2018.pdf (accessed April 2020).
- Minister for Works, Transport and Communication (2018b). 'Section 27(3)(a) of The Electronic and Postal Communications (Radio Communication and Frequency Spectrum) Regulations, 2018. Available at: https://tcra.go.tz/images/documents/regulations/15._The_Electronic_and_Postal_Communications_Radio_Communication_and_Frequency_Spectrum_Regulations_2018.pdf (accessed April 2020).
- Minister of Information Communication Technology, Postal and Courier Services (2016). Postal and Telecommunications (Infrastructure Sharing) Regulations, 2016. Statutory Instrument 137 of 2016. Available at: http://www.veritaszim.net/sites/veritas_d/files/SI%202016-137%20-

- [%20Postal%20and%20Telecommunications%20%28Infrastructure%20Sharing%29%20Regulations%2C%202016.pdf](#) (accessed April 2020).
- My Broadband (2019a). ‘The Amazing Story Behind Rain and Its Partnership with Vodacom’. Available at: <https://mybroadband.co.za/news/cellular/308797-the-amazing-story-behind-rain-and-its-partnership-with-vodacom.html> (accessed April 2020).
- My Broadband (2019b). ‘Vodacom Is Allowed to Use Telkom Ducts—Supreme Court’. Available at: <https://mybroadband.co.za/news/fibre/301454-vodacom-is-allowed-to-use-telkom-ducts-supreme-court.html> (accessed April 2020).
- NMa (2001). ‘Joint Construction and Use of UMTS Network Parts: A Memorandum of the NMa, OPTA and V&W’ [in Dutch]. Available at: https://www.acm.nl/sites/default/files/old_publication/publicaties/7954_UMTS_sharing_notitie_def_uk121001.pdf (accessed April 2020).
- NPC (2015). Number Portability Company (Pty) Ltd. Available at: <http://3500/www.number-portability.co.za/28142> (accessed April 2020).
- Ofcom (2010). Review of the Wholesale Local Access Market. Statement on Market Definition, Market Power Determinations and Remedies. Available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0027/37935/wla_statement.pdf (accessed April 2020).
- Ofcom (2012). Second Consultation on Assessment of Future Mobile Competition and Proposals for the Award of 800 MHz and 2.6 GHz Spectrum and Related Issues. Annex 6: Revised Competition Assessment. Available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0021/58314/2nd_condoc_annex_6.pdf (accessed April 2020).
- Ofcom (2017). Wholesale Local Access Market Review: Consultation on Duct and Pole Access Remedies. Available at: https://www.ofcom.org.uk/__data/assets/pdf_file/0008/101051/duct-pole-access-remedies-consultation.pdf (accessed April 2020).
- POTRAZ (2012). Consultation Paper on Telecommunications Network Cost Analysis and Modelling. Consultation Document No. 1 of 2012, Version 2.
- Research ICT Africa (2009). *Namibian Interconnection Benchmarking Study. Public Final Report*. Johannesburg: The Edge Institute. Available at: <http://thornton.co.za/resources/Namibia%20Interconnection%20Study.pdf> (accessed April 2020).
- Research ICT Africa (2019). Research ICT Africa Mobile Pricing (RAMP). Available at: https://researchictafrica.net/ramp_indices_portal/ (accessed April 2020).
- Robb, G. (2019). ‘Spectrum Policy for Competition and Development: A Comparative Study of Approaches and Outcomes in Africa’. In J. Klaaren, S. Roberts, and I. Valodia (eds), *Competition and Regulation for Inclusive Growth in Southern Africa* (pp. 395–420). South Africa: Jacana Media.
- Robb, G., and A. Paelo (2020). ‘Competitive Dynamics of Telecommunications Markets in South Africa, Tanzania, Zambia, and Zimbabwe’. WIDER Working Paper 2020/83. Helsinki: UNU-WIDER. <https://doi.org/10.35188/UNU-WIDER/2020/840-5>
- TCRA (2017). Determination No. 5 on Cost Based Interconnection Rates Among Telecommunications Network Operators in the United Republic of Tanzania, issued in December 2017. The United Republic of Tanzania: Tanzanian Communication Regulatory

Authority. Available at:
https://www.tcra.go.tz/images/documents/reports/Cost_Based_Interconnection_Rates.pdf (accessed April 2020).

TCRA (2018). 'Results of the 700 MHz Spectrum Auction'. TCRA Media Release. Available at:
https://tcra.go.tz/images/headlines/Public_Notice_-_Spectrum_Auction_Results.pdf (accessed April 2020).

Vodafone UK (2012). 'Telefónica UK and Vodafone UK to Strengthen Their Network Collaboration'. News release, 7 June. Available at:
<https://www.vodafone.co.uk/cs/groups/public/documents/webcontent/vftst162773.pdf> (accessed April 2020).

Wieland, K. (2014). 'EE, 3 Take Passive Route to 4G Network-Sharing'. *Mobile World Live*, 3 February. Available at: <http://www.mobileworldlive.com/ee-three-take-passive-route-4g-network-sharing> (accessed April 2020).