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Digital Infrastructure as a Driver of Inclusive Growth

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Fouché Venter

Executive Director

An Agenda for Economic Growth in South Africa

Lukasz Grzybowski[1]

Abstract

South Africa's persistent growth and employment underperformance have drawn renewed attention to structural reform in network industries. Over the past decade, GDP per capita growth has remained well below population growth, while unemployment has stayed above 32 percent. Digital transformation has recently been added to the priority reform areas under Operation Vulindlela Phase II, creating an opportunity for reassessing the role of digital infrastructure in inclusive growth. Drawing on an extensive empirical literature, much of it focused on sub-Saharan Africa, this paper examines South Africa's digital infrastructure landscape: a progressively deconcentrating mobile market with near-universal 3G and extensive 4G coverage; a fixed broadband sector reshaped by the conditional approval of the Vodacom–Maziv transaction; and persistent gaps in affordability, adoption, and effective use. The central argument is that South Africa's digital infrastructure challenge is no longer primarily one of basic network coverage. The binding constraints now lie in affordability, effective adoption, regulatory modernisation, energy reliability, and the institutional capacity to implement complex reforms.

Keywords: Digital infrastructure; broadband; mobile telecommunications; South Africa; inclusive growth; digital divide; competition policy; telecommunications regulation; spectrum policy; fixed broadband.

JEL classification: L96, L51, L43, O33, O18, O55

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EXECUTIVE SUMMARY

South Africa requires substantially faster economic growth than the 0.7 percent annual average of the past decade if it is to reverse the steady decline in GDP per capita and address unemployment of 32.7 percent on the narrow definition. Digital infrastructure is not sufficient to generate such growth on its own. However, a now-extensive empirical literature, much of it focused on sub-Saharan Africa and other developing-country settings, shows that it is an important complementary input. Improvements in mobile and fixed broadband coverage, affordability, and effective use have been associated with measurable gains in aggregate growth, firm productivity, household consumption, and employment, particularly for women and for previously underserved geographic areas. The recent inclusion of digital transformation among the priority reform areas in Operation Vulindlela Phase II provides a framework for coordinating an integrated policy response.

The South African mobile and fixed broadband sectors have advanced over the past decade. The 2022 spectrum auction alleviated the short-term constraint on capacity. The market is becoming less concentrated, with Vodacom's share declining from above 60 percent in the early 2000s to approximately 37 percent in 2025 and Telkom Mobile and Rain growing into smaller competitors. Mobile penetration has reached approximately 200 percent (reflecting multi-SIM ownership), 3G population coverage is essentially universal, and 4G coverage exceeds 95 percent on the larger operator networks. Mobile data prices fell substantially in the early part of the period, but recent price dynamics differ sharply by bundle size. Small prepaid bundles, which are most relevant to lower-income users, have largely stabilised since 2022, while larger post-paid allocations have continued to fall. Moreover, the Competition Appeal Court's August 2025 conditional approval of the Vodacom–Maziv merger has reshaped the fixed broadband market.

Notwithstanding these advances, constraints remain. Affordability remains a central issue for lower-income segments: as documented in Hawthorne and Grzybowski (2021), regulatory interventions on mobile termination rates have delivered larger consumer surplus gains than market entry, but the benefits have been skewed toward higher-income consumers and metropolitan dwellers. The substitution between fixed and mobile broadband documented in Grzybowski and Hawthorne (2025) implies that, for lower-income households, mobile broadband affordability remains the primary lever for digital inclusion. Rural and former-homeland areas continue to lag substantially on coverage and quality. The regulatory framework, particularly the Electronic Communications Act of 2005, was drafted for an earlier technological and market generation. Energy unreliability imposed operating cost shocks on the sector during 2020–2024.

The recent empirical literature provides a clearer picture of how digital infrastructure affects growth and employment than was available a decade ago. Hjort and Poulsen (2019) document large employment effects from the arrival of submarine cables in sub-Saharan Africa, with average incomes also rising. Chiplunkar and Goldberg (2022) establish that 3G mobile internet raises labour-force participation among women and employment rates for both genders in 14 developing countries. Bahia et al. (2023) show that 3G coverage in Tanzania reduces poverty through labour-market channels. Goldbeck and Lindlacher (2024) estimate that early submarine cable arrival raised nighttime-light intensity in mid-sized sub-Saharan African towns by 10 percent. Hjort and Tian (2025) survey the field. The South African evidence parallels these findings: Grzybowski and Patel (2023) document that mobile-phone access facilitates transitions from unemployment to employment.

The market structure and competition literature is similarly more developed. Elliott et al. (2025) show that consumer surplus in mobile markets is maximised at a moderate (not maximal) number of firms once economies of scale in spectrum and infrastructure are accounted for. Bourreau et al. (2021) document the consumer welfare gains from market entry that disrupts tacit collusion. Genakos et al. (2018) and the subsequent Duso et al. (2024) debate around the Draghi report provide a basis for assessing the South African mobile market structure, which is less concentrated than most European markets. Houngbonon et al. (2025)

document that telecom infrastructure sharing in 28 low-income countries reduces mobile and data prices and expands rural internet access by 4.7 percentage points.

The author's own research provides additional South-Africa-specific evidence. Bourreau et al. (2026) document that French state aid for broadband crowded out approximately €902 million of private investment, with implications for the design of South African universal service architecture. Grzybowski et al. (2023a) establish that mobile money supports financial inclusion in sub-Saharan Africa primarily through remittance channels, with the elderly and poor as the principal recipients. Grzybowski and Mothobi (2017) document that mobile money substitutes for traditional banking precisely in infrastructure-poor environments. Grzybowski (2015) shows that network effects are operator-specific and that pricing/subsidy policies that exploit network effects can expand adoption among low-income consumers.

Five reform priorities follow from the analysis. First, future spectrum allocation should adopt the coverage-obligation auction design demonstrated successfully in Brazil's 2021 5G auction, channelling a substantial share of headline value into rural rollout, school connectivity, and backhaul investment rather than fiscal revenue. Second, the Electronic Communications Amendment Bill should be advanced to address the recognition of Equity Equivalent Investment Programmes (EEIPs), modernise the licensing framework, and clarify the relationship between Ministerial direction-setting and regulatory independence. Third, the implementation of the Vodacom–Maziv conditions should be monitored rigorously and complemented by access regulation on Openserve in non-competitive geographic areas. Fourth, a successor to SA Connect Phase 2 should be designed around competitive reverse-auction mechanisms rather than state implementation, given the documented underperformance of the legacy model and the evidence from Bourreau et al. (2026) on the crowding-out risks of poorly designed state aid. Fifth, complementary measures to address the energy constraint on digital infrastructure should be coordinated through Operation Vulindlela Phase II.

The paper's central observation is that coverage is no longer the binding constraint it once was. What now limits the contribution of digital infrastructure to growth and employment is a cluster of harder problems: affordability at the lower end of the income distribution, market structure, regulatory modernisation, energy, and the institutional capacity to implement complex reforms.

1. Overview of the Current Context

1.1 The role of digital infrastructure

South Africa's economic growth has averaged only 0.7 percent per year over the past decade, well below the rate of population growth and substantially below the rates required to make inroads into unemployment. Narrow unemployment of 32.7 percent in Q1 2026 and expanded unemployment exceeding 40 percent reflect a structural problem rather than a cyclical downturn. Recent diagnostic work by the World Bank and the OECD has identified a familiar set of constraints: the operational performance of network industries (electricity, freight logistics, water); the institutional capacity of the state at multiple levels; skills and educational inequality; and the structural features of product and labour markets. Operation Vulindlela, established in October 2020 as a joint Presidency–National Treasury reform mechanism, has driven progress in several of these areas, with documented outcomes including substantial private investment in renewable electricity generation and reduction in load-shedding intensity (The Presidency, 2025).

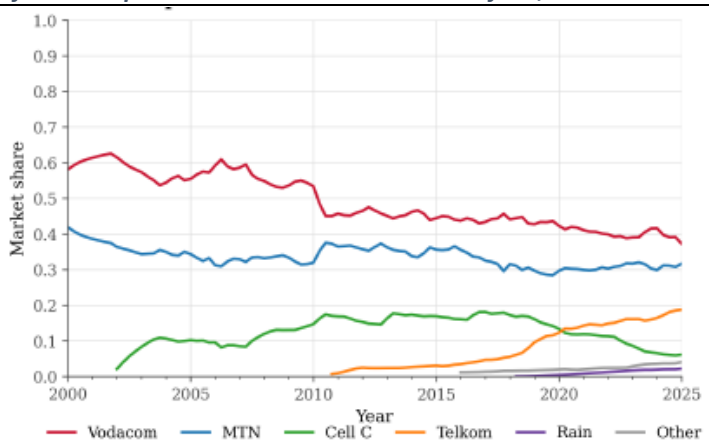
The integration of digital infrastructure into this growth diagnostic has been more recent. Operation Vulindlela Phase II, launched on 7 May 2025, formally added digital transformation as one of three new priority reform areas alongside spatial inequality and local government performance. This is the most consequential recent institutional development for South African digital infrastructure policy and provides the institutional framing for the analysis developed below.

The empirical literature reviewed in Section 2 indicates that digital infrastructure, specifically broadband and mobile, affects growth and employment through multiple channels. The recent survey of Hjort and Tian (2025) concludes that the economic impacts of internet connectivity are sizeable in many developing-country settings, operating through firm productivity, labour-market matching, financial inclusion, trade facilitation, and access to public services. The contribution is contingent on complementary inputs including skills, electricity reliability, and market institutions. South African policy must therefore situate digital infrastructure within the broader reform agenda rather than treat it as a standalone domain.

1.2 Mobile networks: structure, prices, and coverage

The South African mobile market has undergone substantial structural transformation over the past two decades. Figure 1 shows the evolution of operator market shares from 2000 to 2025. Vodacom's share has declined from approximately 60 percent in the early 2000s to approximately 37 percent in 2025; MTN's share has declined from approximately 40 percent to approximately 32 percent. Cell C, which entered as the third operator in the early 2000s and grew to approximately 17 percent share by the early 2010s, has subsequently declined to below 10 percent and transitioned to a virtual model relying on MTN's radio access network. Telkom Mobile, which entered in 2010, has grown steadily to approximately 19 percent share. Rain, the most recent entrant, has reached approximately 3 percent. The market is now four-operator on a retail basis (Vodacom, MTN, Telkom Mobile, Rain), with Cell C operating as a fifth distinct retail brand on MTN's network.

Figure 1: Evolution of mobile operator market shares in South Africa, 2000–2025.

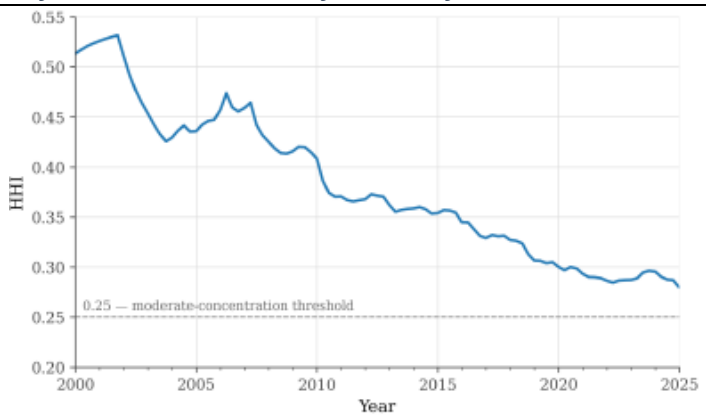


Source: GSMA Intelligence

Several features of the South African market-share trajectory stand out. The Vodacom and MTN combined share has fallen from approximately 100 percent of the addressable market in the early 2000s to approximately 70 percent in 2025, indicating large market-share gains by competitors. The Cell C trajectory, initial rapid growth from market entry in 2001 followed by decline since the mid-2010s, illustrates the difficulty of sustaining infrastructure-based competition in a market with substantial scale economies, a pattern consistent with the structural evidence from Elliott et al. (2025) on scale economies in mobile telecommunications. The Telkom Mobile growth, from market entry in 2010 to approximately 19 percent share by 2025, demonstrates that large market-share gains by a new entrant are achievable on a 10–15 year horizon, supported in this case by Telkom's preexisting customer relationships and fixed-network infrastructure. The Rain trajectory, approximately 3 percent share by 2025 after market entry in 2018, is at a much earlier stage but indicates that further entry remains commercially viable in specific segments (in this case, fixed-wireless data).

The deconcentration of the market is reflected in the Herfindahl–Hirschman Index (HHI), shown in Figure 2. The HHI has fallen from above 0.5 in 2000, consistent with an effective duopoly, to below 0.3 in 2025. This represents substantial deconcentration, although the market remains concentrated by conventional competition-law thresholds. The trajectory illustrates two distinct phases: a more rapid decline from 2000 to 2010 as Cell C built share, and a slower but steady decline from 2010 to 2025 as Telkom Mobile and Rain established themselves and Vodacom's share continued to erode.

Figure 2: Evolution of the Herfindahl–Hirschman Index for South African mobile telecommunications, 2000–2025.

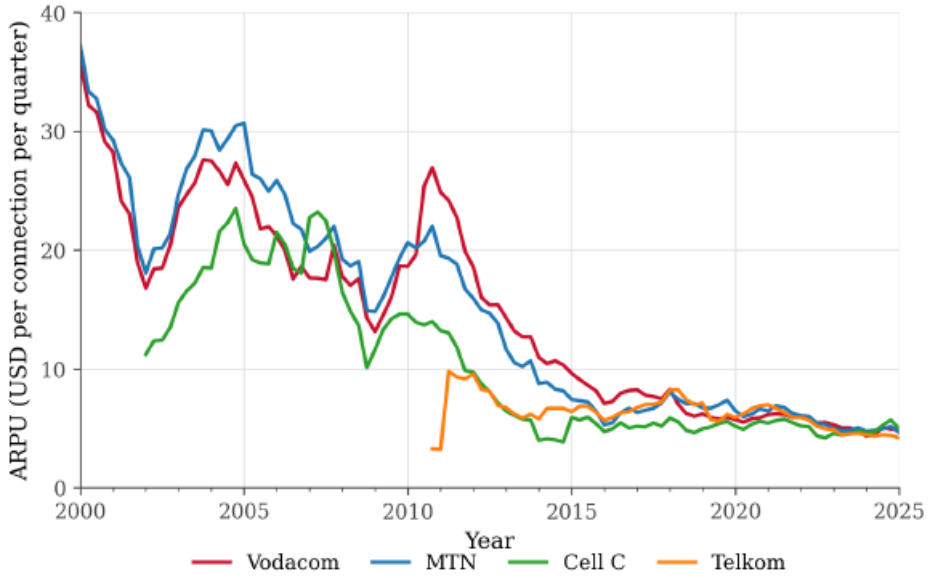


Source: GSMA Intelligence. Author's calculation from quarterly market share data; HHI computed as the sum of squared operator shares

The structural transformation has been accompanied by a substantial decline in average revenue per user (ARPU), shown in Figure 3. ARPU for Vodacom and MTN, which exceeded USD 30 per connection in the early

2000s, has fallen to approximately USD 5 by 2025. The decline reflects both price reductions for existing customers and the addition of lower-value customers as the market has expanded into lower-income segments. ARPUs across the four major operators have substantially converged at the lower end, indicating that price-driven competition is now active across operators rather than confined to specific segments.

Figure 3: Evolution of average revenue per user (ARPU) by mobile operator in South Africa, 2000–2025 (USD per connection per quarter).



Source: GSMA Intelligence

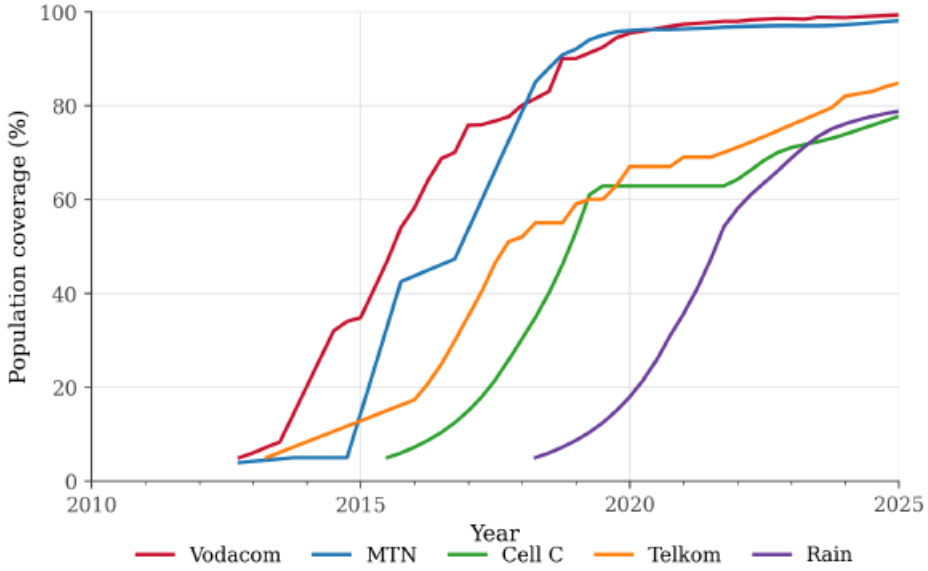
The ARPU trajectory illustrates the joint effects of price competition and market expansion. The early 2000s peak of approximately USD 30–35 per connection per quarter reflected pricing of voice services to a small, relatively high-income subscriber base. The decline through 2010 reflected both price competition (particularly following the entry of Cell C and the regulatory intervention on mobile termination rates documented by Hawthorne and Grzybowski (2021)) and the addition of lower-income subscribers as market penetration expanded. The accelerated decline between 2010 and 2015 coincides with the smartphone-driven transition to data services and the further regulatory intervention on MTRs. The convergence of operator ARPUs at the lower end, all four major operators within USD 4–6 per connection per quarter by 2025, indicates that price-driven competition is now active across operators and that the segments served are increasingly homogeneous in revenue terms.

The 2022 spectrum auction conducted by the Independent Communications Authority of South Africa (ICASA) released substantial high-demand spectrum across the 700 MHz, 800 MHz, 2.6 GHz, and 3.5 GHz bands, raising ZAR 14.4 billion for the fiscus and supporting the rollout of 4G and the initial deployment of 5G (Independent Communications Authority of South Africa, 2022). The auction is widely regarded as having alleviated the short-term constraint on capacity expansion, though the design choice to prioritise fiscal revenue over coverage obligations contrasts with alternative approaches discussed in Section 2.

Coverage outcomes vary substantially across operators. Figure 4 shows the evolution of 4G population coverage by operator from 2010 to 2025. Vodacom and MTN reached approximately 99 percent population coverage by the mid-2020s. Telkom Mobile and Cell C reached approximately 80–85 percent, with substantial geographic differences in coverage quality. Rain's coverage, reflecting its later market entry, expanded rapidly from 2018 to reach approximately 80 percent by 2025. The widening gap between the two largest operators and the smaller competitors during the 2016–2020 period, visible in the figure as the parallel

plateaus of Cell C and Telkom Mobile around 65 percent while Vodacom and MTN exceeded 95 percent, reflects the substantial capital investment required to extend coverage into rural and lower-density areas.

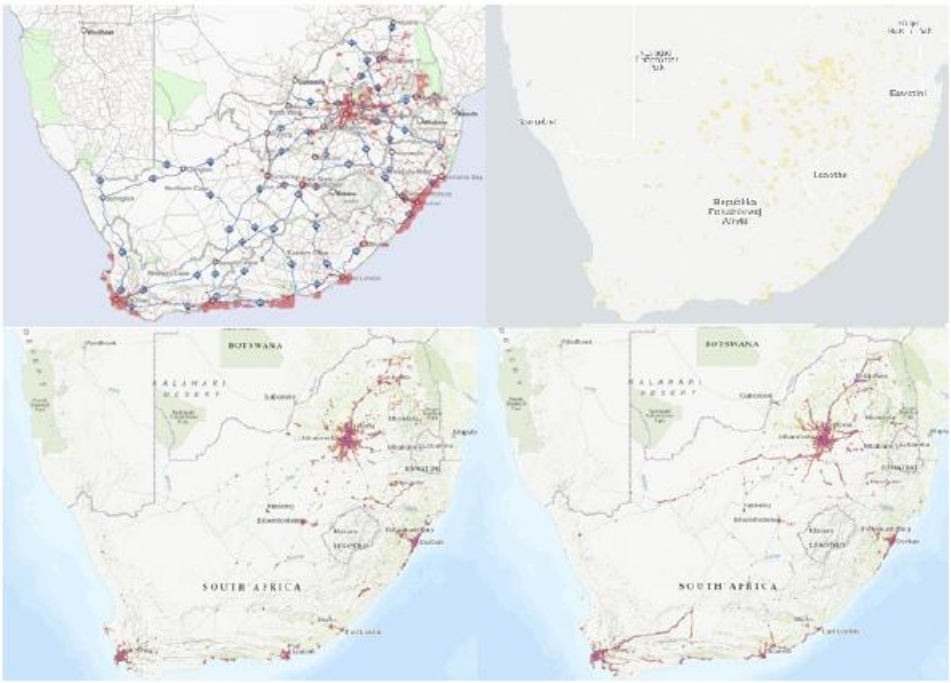
Figure 4: Evolution of 4G population coverage by mobile operator in South Africa, 2010–2025.



Source: GSMA Intelligence

Figure 5 compares the geographic distribution of 5G coverage, which closely tracks the broader pattern of fibre and high-quality broadband access, across operators. The maps show two patterns. First, even the larger operators (top left) achieve high coverage concentrated along the Johannesburg–Cape Town corridor, with substantial gaps across rural areas, particularly in the Eastern Cape, the Free State, and the Northern Cape. Second, the coverage of smaller operators (lower panels) is even more spatially concentrated, with 5G presence essentially only in metropolitan cores.

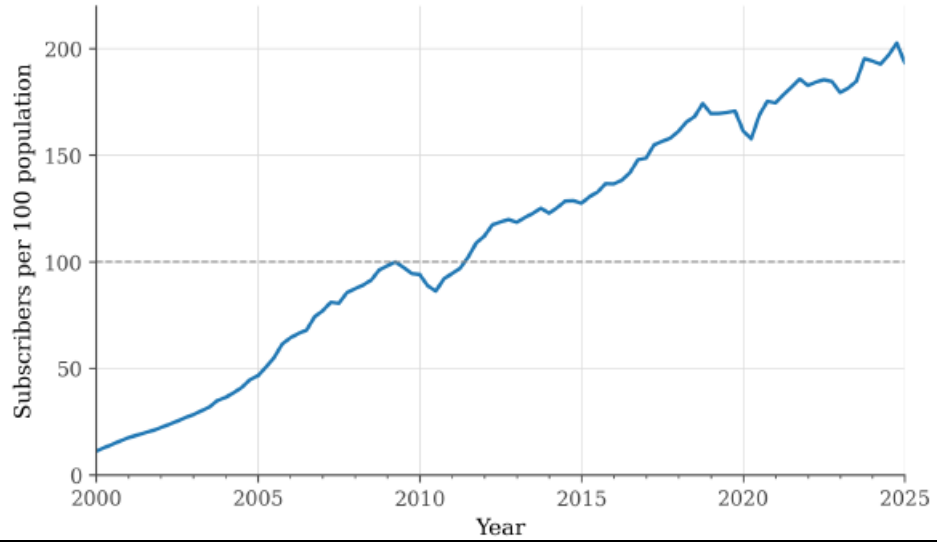
Figure 5: 5G coverage in South Africa by operator, 2025



Source: https://www.nperf.com/ and operators' websites

The aggregate mobile penetration trajectory in Figure 6 shows that subscriber numbers (rather than unique users) have grown from approximately 10 percent in 2000 to approximately 200 percent in 2025, reflecting multi-SIM ownership common to many emerging-economy mobile markets and indicating that the gross access constraint at the population level has been substantially relieved.

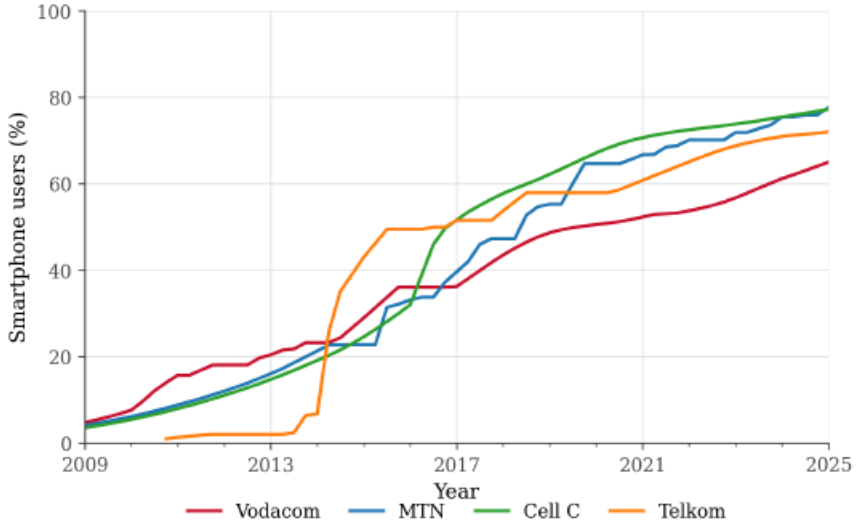
Figure 6: Mobile penetration in South Africa (subscribers per 100 population), 2000–2025.



Source: GSMA Intelligence

The smartphone share among mobile users, shown in Figure 7, has risen from below 10 percent in 2009 to approximately 75–80 percent across all operators by 2025. The convergence across operators is notable: Cell C's smartphone share has caught up with and modestly exceeded Vodacom's by the mid-2020s, indicating that smartphone adoption is no longer concentrated in higher-income segments served disproportionately by particular operators. This convergence has implications for the demand-side discussion below, as the device constraint has eased substantially over the decade.

Figure 7: Smartphone share of mobile users by operator in South Africa, 2009–2025.



Source: GSMA Intelligence

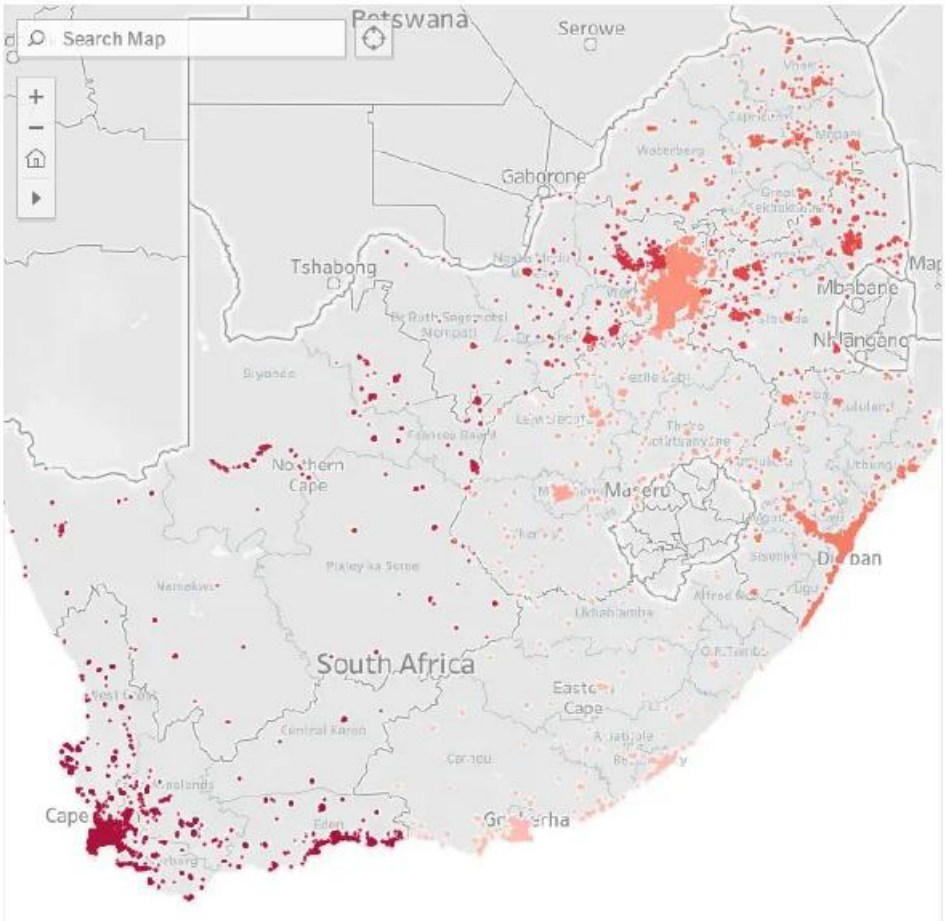
1.3 Fixed broadband and the Vodacom–Maziv transaction

Fixed broadband in South Africa has been transformed over the past decade by the rapid expansion of fibre-to-the-home (FTTH), led by independent fibre network operators (FNOs) including Vumatel, Openserve, MetroFibre, Octotel, HeroTel, and Frogfoot. The wholesale-open-access model under which most FNOs

operate has produced active retail competition in covered areas, with multiple internet service providers competing on price, speed, and bundle composition over a common infrastructure.

Figure 8 illustrates the spatial distribution of fixed broadband activity using the density of speed tests as a proxy for fixed-line presence and use. The pattern reinforces the affordability and deployment-gap discussion below: fixed broadband activity is heavily concentrated in the metropolitan cores of Gauteng (Johannesburg–Pretoria), Cape Town, and the eThekwini (Durban) corridor, with a thinner scattering along secondary urban centres and the coastal belt. Vast areas of the interior, particularly the Northern Cape, the eastern parts of the Eastern Cape, much of the Free State, and rural Limpopo and Mpumalanga, record little or no fixed-line testing activity, consistent with negligible FTTH or fixed-wireless presence. The map is a proxy rather than a direct coverage measure: the density of speed tests reflects both the availability of fixed infrastructure and the intensity of its use, so areas with low population density or low adoption will appear sparse even where some coverage exists. With that caveat, the figure provides bottom-up support for the administrative picture. Fixed broadband remains predominantly metropolitan, and the spatial divide in fixed connectivity closely follows the broader economic geography of the country.

Figure 8: Fixed broadband coverage in South Africa in 2026



Source: Distribution of speed tests over South African provinces. Research ICT Africa and SpeedChecker

Recent commercial strategies, including Vumatel's sub-ZAR 30,000 household segment targeting and Fibertime's township prepaid model, suggest that the commercial frontier is expanding into lower-income urban segments, though the underserved rural areas are unlikely to be reached by commercial investment alone.

The Vodacom–Maziv transaction has altered the fixed broadband market structure. The transaction, which combines Vodacom's mobile capabilities and retail customer base with Maziv's fibre infrastructure (including

Vumatel and Dark Fibre Africa), was prohibited by the Competition Tribunal in October 2024 (Competition Tribunal of South Africa, 2024) but subsequently approved on appeal by the Competition Appeal Court in August 2025, subject to extensive conditions (Competition Appeal Court of South Africa, 2025). The conditional remedies include continued open-access wholesale obligations on Maziv, explicit rollout commitments in low-income reach areas, school and health-facility connectivity commitments, and broader capital expenditure commitments. The transaction is the most significant structural change in the South African fixed broadband market in over a decade, and its post-merger conduct will shape coverage and competition outcomes over the next five years.

The specific design of the merger conditions is of particular interest. The Competition Appeal Court required Vodacom to commit to extending fibre coverage to a substantial number of additional low-income reach areas over a defined period, with non-discrimination obligations on wholesale access to Maziv's existing network. The remedy package was designed to address two distinct competition concerns: the horizontal concern that Vodacom's downstream retail operations might foreclose access to wholesale fibre by competing internet service providers, and the vertical concern that the integrated firm might cross-subsidise its own retail activities through favourable internal pricing. The international literature on behavioural remedies suggests that these arrangements typically require active monitoring to be effective; the South African experience over the next five years will provide empirical evidence on the relative effectiveness of behavioural versus structural remedies in this context.

1.4 Demand-side conditions and the digital divide

The demand for digital infrastructure is jointly determined by supply-side availability and demand-side conditions, including affordability, devices, skills, and complementary inputs. The South African digital divide is large, and the constraints have shifted over time from supply-side access to demand-side adoption and use.

The General Household Survey indicates that internet access in South Africa has expanded substantially over the past decade, with the share of households reporting some form of internet access rising from approximately 28 percent in 2010 to nearly 79 percent in 2023. However, these headline figures conceal substantial geographic and income-based disparities. Internet access rates remain significantly higher in Gauteng and the Western Cape than in provinces such as the Eastern Cape and Limpopo, while access among upper-income households substantially exceeds that of lower-income households. Access is also overwhelmingly mobile-based: approximately 70–73 percent of households accessed the internet through mobile devices in 2023, whereas fixed-line internet connections at home remained far less common at roughly 14–15 percent[2]

The technology composition of South African internet access has direct implications for the diagnosis in Section 3. The mobile-dominance of South African access is structurally similar to other African comparators (Kenya, Nigeria, Tanzania) and differs substantially from OECD comparators, where fixed broadband accounts for a larger share of household connectivity. This suggests that South African policy on mobile broadband affordability and quality is the primary lever for household-level inclusion, with fixed broadband investment focused on higher-bandwidth uses, including small business, education, and entertainment.

Mobile data prices fell substantially in the early part of the period but have since largely stabilised, and the recent dynamics differ across bundle sizes. Because the vast majority of South African consumers use prepaid tariffs, and because prepaid pricing is subject to frequent promotions and personalised offers, the most

[2] Source: General Household Survey 2023, Statistics South Africa.

consistent published series is ICASA's record of the most affordable bundle available in each size category, reported annually in its *State of the ICT Sector Report*. Table 1 reports the prepaid series.
The large reductions occurred between 2020 and 2022: the cheapest 1 GB bundle fell from ZAR 100 to ZAR 79, the 1.5 GB bundle from ZAR 149 to ZAR 89, and the 100 MB bundle from ZAR 29 to ZAR 15. Between 2022 and 2025, however, no prepaid bundle in the ICASA basket recorded a price decrease, and the smallest bundles, those most relevant to lower-income consumers, were flat or rising, with the 2 GB bundle increasing from ZAR 139 to ZAR 146 and the 500 MB bundle ending the period above its 2022 level.

Table 1: Most affordable prepaid mobile data bundle prices in South Africa, 2020–2025 (ZAR, incl. VAT, 30-day validity)

Bundle	2020	2021	2022	2023	2024	2025
100 MB	29	20	15	15	15	15
500 MB	70	69	65	69	65	69
1 GB	100	95	79	79	79	79
1.5 GB	149	149	89	89	89	89
2 GB	140	139	139	139	146	146

Source: ICASA, State of the ICT Sector Report of South Africa (31 March 2025), Graph 14; intermediate years corroborated by the 31 March 2024 and March 2022 editions. Figures are the lowest available standard prepaid price for each bundle size across mobile operators and MVNOs, captured as an early-year snapshot. No prepaid bundle recorded a price decrease between 2022 and 2025.

The contrast with the post-paid series is instructive. Table 2 shows that the most affordable post-paid allocations fell substantially over the full period, but the reductions were concentrated in the larger allocations: the cheapest 50 GB allocation fell from ZAR 907 to ZAR 389 and the 30 GB from ZAR 605 to ZAR 215, while the smaller allocations stabilised after 2022. The joint pattern across the two tables is that the price reductions of the recent period accrued disproportionately to high-volume users, who are concentrated in higher-income, metropolitan segments, rather than to the low-volume prepaid users at the lower end of the income distribution.

Table 2: Most affordable post-paid mobile data allocation prices in South Africa, 2020–2025 (ZAR, incl. VAT, 30-day validity).

Allocation	2020	2021	2022	2023	2024	2025
5 GB	199	221	199	99	99	99
6 GB	129	129	129	99	99	99
10 GB	200	200	149	149	149	149
20 GB	355	355	199	199	199	199
30 GB	605	645	399	399	215	215
50 GB	907	959	499	499	499	389

Source: ICASA, State of the ICT Sector Report of South Africa (31 March 2025), Graph 15; intermediate years corroborated by the 31 March 2024 and March 2022 editions. Figures are the lowest available post-paid allocation price for each size. The 2024 reduction in the 30 GB allocation reflects the entry of MTN's Super Data price plan (filed with ICASA, November 2023).

This bundle-size gradient has a direct distributional reading. Because the unit price of data falls steeply with bundle size, and because the recent reductions were concentrated in the largest bundles, the effective per-megabyte price faced by lower-income consumers, who purchase small prepaid bundles, has remained higher than that faced by higher-income consumers, able to buy in volume. This pattern reinforces, on the supply side, the distributional finding of Hawthorne and Grzybowski (2021) that the consumer-surplus gains from the sector's evolution have been skewed toward higher-income and metropolitan users.

Despite the early-period declines, affordability remains a key issue for lower-income segments. The cost of a basic mobile broadband basket represents a higher share of monthly income for households in the bottom income deciles than for households in the top deciles (Competition Commission South Africa, 2019), a gap that the stagnation of small-bundle prices since 2022 has done little to close. Fixed and mobile broadband also substitute for one another in a way that bears directly on inclusion policy. Grzybowski and Hawthorne (2025), using approximately 134,000 individual-level survey observations from 2009 to 2014 in a discrete-choice model that allows for both substitution and complementarity, find that fixed and mobile broadband function as substitutes for lower-income households and as complements for digitally engaged higher-income users. The consequence is that even where fibre is available, lower-income households will continue to rely on mobile networks, and the cost of mobile data therefore remains the primary lever for digital inclusion at the household level.

Device affordability has eased substantially over the past decade, as Figure 7 above documented. The convergence of smartphone share across operators implies that the device affordability dimension of the digital divide is becoming less binding, though feature phones still account for approximately 20 percent of mobile users and the device-replacement cycle remains slower in lower-income segments. Electricity reliability for charging, particularly during the 2020–2024 load shedding episode, compounded the connectivity affordability constraint and remains a relevant complementary input.

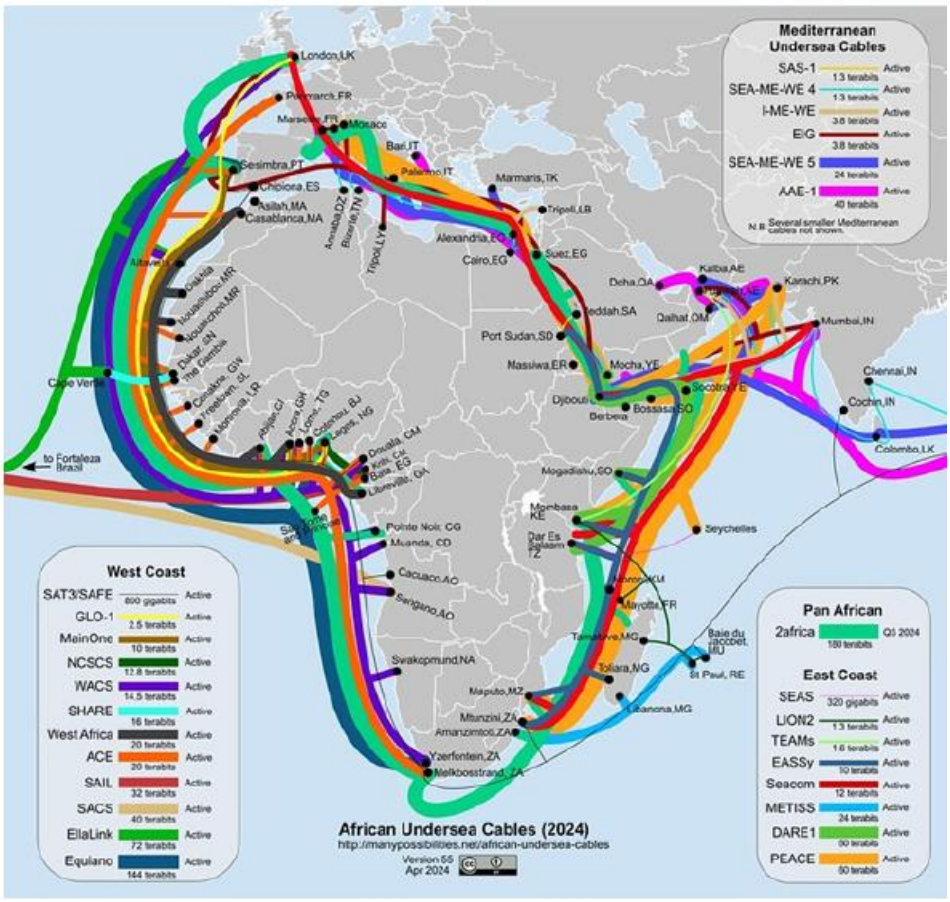
Skills and digital literacy represent a third demand-side dimension that has received less policy attention than connectivity and devices. The empirical literature (Section 2.2) indicates that the realisation of employment and welfare gains from digital infrastructure depends on the skill profile of the population, with the Azam et al. (2024) Indian evidence suggesting that the absence of complementary skills can mute the labour-market effects of expanded ICT access. The South African policy framework, including the Department of Basic Education's digital learning strategy, the Skills Development Act, and the Universal Service and Access Fund's mandate, provides institutional tools for skills investment, but the integration of skills policy with connectivity policy has been uneven. The reform options in Section 4 discuss this integration explicitly.

1.5 Adjacent infrastructure layers: a brief context

Three adjacent infrastructure layers warrant a brief mention as context for the analysis below, though their detailed treatment is outside the scope of this paper.

International connectivity. South African submarine cable capacity has expanded substantially with the recent landings of 2Africa and Equiano, supplementing the existing WACS, SAT-3, ACE, EASSy, and SEACOM systems. Figure 9 shows the network of submarine cables connecting Africa to the broader internet infrastructure, with the concentration of landings around the South African coast (Cape Town, Yzerfontein, and Mtunzini) visible at the bottom of the map. Commissioned impact assessments suggest GDP contributions in the range of 0.4–0.6 percent within two to three years of 2Africa operations (RTI International, 2023), though such assessments should be interpreted with caveats appropriate to their commissioning context. The academic evidence is more conclusive: Hjort and Poulsen (2019) document employment effects from earlier submarine cable arrivals in sub-Saharan Africa, and Goldbeck and Lindlacher (2024) estimate that early submarine cable arrival raised nighttime-light intensity in mid-sized sub-Saharan African towns by 10 percent.

Figure 9: Submarine cable network in the Africa region.



Source: https://www.submarinenetworks.com/. TeleGeography submarine cable map. Cable landings around the South African coast are visible at the lower right of the map.

Data centres and digital public infrastructure. The South African data centre sector has expanded rapidly, with Teraco operating approximately 189 MW of critical IT load across four campuses as of end-2025 (TechCentral, 2025). Three hyperscale cloud regions (AWS Cape Town, Azure South Africa North and West, Google Cloud Johannesburg) are operational. Digital public infrastructure is at an earlier stage of development; PayShap, launched in March 2023, had processed approximately ZAR 100 billion across 136 million transactions and registered about 4.5 million ShapIDs by mid-2025, but per-capita transaction volumes remain below those observed in Brazil (PIX) or India (UPI).

Energy. The 2020–2024 load shedding episode imposed substantial operating cost shocks on the digital infrastructure sector. Operator disclosures indicate combined load-shedding-related expenditure of the order of ZAR tens of billions, with documented effects on capital allocation and the displacement of investment from 5G and rural coverage to backup-power infrastructure (TechCentral, 2023; Engineering News, 2023). The episode has eased in 2024–2025, but the legacy capital expenditure and structural exposure to grid reliability persist. The energy constraint is addressed in more detail in Section 3.6.

2. Literature Review and International Lessons

This section reviews the empirical literature on the relationship between digital infrastructure and economic outcomes, with particular attention to the employment, firm-performance, and regional-development effects. The literature has matured substantially over the past decade, with more credible identification strategies, a much greater focus on developing-country contexts, and a more detailed treatment of the channels through which connectivity affects economic activity. The section then summarises selected international experience with policy interventions relevant to the South African case.

2.1 Broadband, mobile and economic outcomes: the macro view

Early cross-country evidence on broadband and growth, most prominently Czernich et al. (2011), which estimated that a 10 percentage point increase in broadband penetration was associated with a 0.9–1.5 percentage point increase in annual per capita GDP growth in OECD countries, suffered from substantial identification difficulties and limited applicability to lower-income contexts. The literature has since shifted toward identifying specific channels using credible quasi-experimental variation and toward developing-country settings that are more relevant to the South African case.

The recent survey of Hjort and Tian (2025) synthesises this evolution. The authors conclude that the economic impacts of internet connectivity in developing countries are sizeable in many, though not all, settings, with improvements in firm productivity, worker wages, and aggregate employment all documented across different country contexts. They emphasise that the empirical estimates vary substantially depending on the identification strategy, the country context, the technology generation, and the outcome measure, and they caution that difference-in-differences and synthetic-control designs do not always cleanly separate aggregate gains from spatial reallocation effects. For South African policy, headline elasticities from earlier cross-country studies should not be treated as precise structural parameters. Policy design should focus instead on the channels through which digital infrastructure affects growth, and on the complementary inputs needed to make those channels effective.

2.2 Employment effects: the sub-Saharan African evidence

A growing body of empirical work documents the channels through which digital infrastructure affects employment, firm performance, and regional economic development.

Employment effects of submarine cable arrival. Hjort and Poulsen (2019) provide what is now the canonical sub-Saharan African evidence on the employment effects of digital infrastructure. Using the gradual arrival of submarine cables in sub-Saharan Africa between 2000 and 2010 as quasi-experimental variation, and combining three datasets covering 12 African countries, the authors estimate that fast internet arrival produced large positive effects on employment rates, including for less-educated workers, with little or no displacement across space. Firm-level data document that increased firm entry, productivity, and exporting contribute to higher net job creation, and average incomes rise. The identification strategy uses the rollout sequence of cables and the geographic distance from terrestrial fibre to instrument internet penetration. The estimated effects are large: a connected location experiences employment growth of approximately 6.9 percent relative to comparable unconnected locations.

Mobile internet and employment in developing countries. Chiplunkar and Goldberg (2022) extend this analysis from the submarine cable channel to the mobile internet channel. Examining 14 developing countries across Asia, Africa, and Latin America, the authors find that the expansion of 3G mobile internet significantly increases labour-force participation among women and the employment rates of both men and women. The paper documents a distinct gender dimension: men transition out of unpaid agricultural work into operating small agricultural enterprises, while women take more unpaid jobs (especially in agriculture) and operate more small businesses across all sectors. Both genders move into wage employment in services. The findings are relevant to the South African policy debate, which has emphasised women's labour-force participation as a development priority.

Welfare effects of mobile broadband: the Tanzanian evidence. Bahia et al. (2023) use Tanzanian household-survey panel data combined with geospatial 3G-rollout maps in a difference-in-differences design. The headline finding is that being covered by 3G networks has a large positive effect on total household consumption and poverty reduction, driven by positive impacts on labour-market outcomes. Working-age

adults in covered areas see increases in labour-force participation, wage employment, and non-farm self-employment, alongside a decline in farm employment. The Tanzanian evidence is the closest African comparator to South Africa for which household-level welfare effects of mobile broadband expansion have been credibly estimated.

The companion study Bahia et al. (2024) applies the same research design to Nigeria, the largest economy and mobile broadband market in Africa, integrating three waves of a nationally representative longitudinal living-standards survey with operator data on 3G and 4G deployment between 2010 and 2016. The estimates again show large and positive impacts of mobile broadband coverage on household consumption, increasing over time, though at a decreasing rate, and a reduction in the proportion of households below the poverty line driven by higher food and non-food consumption in rural households. As in Tanzania, the effects operate mainly through increased labour-force participation and employment, particularly among women. The Nigerian and Tanzanian studies provide the strongest available quasi-experimental evidence on the household-welfare effects of mobile broadband in large African economies. They are also the most relevant comparison for assessing the likely effects of closing South Africa's rural coverage and quality gaps.

Structural transformation and skills in Rwanda. Caldarola et al. (2023) combine GSMA network-coverage maps with Rwandan census and labour-force surveys at district level over 2002–2019. The paper documents that mobile internet coverage both raises employment opportunities and reshapes the composition of the labour market, areas with higher coverage shift towards higher-skilled, higher-value-added activities. Education, migration, and demand shifts are the proposed mechanisms. The Rwandan evidence parallels the Sub-Saharan African pattern of skill-biased structural transformation that digital infrastructure may catalyse.

ICT skills and labour market outcomes in India. Azam et al. (2024) provide a useful counterpoint. Using the 2020 Indian Multiple Indicators Survey and instrumental-variables estimation that exploits cell-tower rollout across India's telecom circles, the authors find no significant effects at the extensive margin (labour-force participation and employment are unchanged) but positive effects at the intensive margin (hours, occupational quality, household expenditure). The paper challenges the widespread assumption that ICT-skill diffusion mechanically raises employment rates and underscores the heterogeneity of effects across contexts and identification strategies. For South Africa, the lesson is not that connectivity alone will generate employment, but that its labour-market effects depend on whether workers and firms have the skills, electricity, and institutional support needed to use it productively.

The earlier mobile-phone evidence. The canonical pre-broadband evidence on mobile-phone effects on agricultural markets provides useful context. Jensen (2007) documents that mobile phone adoption by Indian fishermen and wholesalers between 1997 and 2001 produced a dramatic reduction in price dispersion, the elimination of waste, and near-perfect adherence to the Law of One Price, with both consumer and producer welfare rising. Aker (2010) documents in Niger that the introduction of mobile service explains a 10–16 percent reduction in grain price dispersion across markets, with larger effects for market pairs separated by higher transport costs. The broader survey of Aker and Mbiti (2010) synthesises this first wave of African evidence, setting out the channels, reduced search and communication costs, improved market integration, new platforms for service delivery, through which mobile telephony affects economic development, and provides the conceptual framing within which the later broadband and mobile-money literatures developed. These mechanisms, reducing search costs and improving market integration, continue to operate in the contemporary mobile-broadband context and are particularly relevant for rural and informal-sector activity in South Africa.

The South African evidence. The South African evidence parallels the broader sub-Saharan African pattern. Grzybowski and Patel (2023) use South African longitudinal panel data to estimate the effect of mobile-phone ownership on transitions in employment status. The paper finds that mobile phones facilitate transitions

from unemployment and inactivity into employment, with the effects particularly pronounced in rural and lower-income segments where job-search information frictions are most pronounced. This finding maps closely onto the broader empirical literature on the labour-market matching channel through which digital infrastructure affects employment.

The South African results are consistent with the gendered patterns documented by Chiplunkar and Goldberg (2022) across 14 developing countries, with women's labour-force participation showing positive responses to mobile internet access. They are also consistent with the structural transformation pattern documented by Caldarola et al. (2023) for Rwanda, in which higher mobile internet coverage is associated with shifts toward higher-skilled and higher-value-added activities. The combined message from the South African and sub-Saharan African evidence is that digital infrastructure expansion can deliver employment gains, but the realisation of these gains depends on the broader complementary inputs (skills, electricity, market institutions) that condition productive use of the available infrastructure.

2.3 Firm performance and regional development

A complementary literature documents the firm-level and regional development channels. Digital infrastructure and local economic development. Goldbeck and Lindlacher (2024) provide some of the most credible recent evidence on the regional development channel in sub-Saharan Africa. Using a difference-in-differences design that exploits the staggered arrival of submarine internet cables and the rollout of national fibre backbones across the region, the authors document that for mid-sized incidentally connected towns, early basic-speed internet availability raised nighttime-light intensity by approximately 10 percent. The increase in employment is the main proposed channel, with effects concentrated in towns that were close to but not on the path of the original infrastructure rollouts. The paper provides quasi-experimental evidence for the proposition that digital infrastructure investment can have local development effects beyond direct user benefits.

Skill complementarity at the firm level. Earlier work in OECD settings provides complementary firm-level evidence. Akerman et al. (2015), using Norwegian administrative data, identify skill-biased patterns in the effects of broadband adoption on firm-level productivity and labour-market outcomes consistent with broadband as a complement to higher-skilled workers. The applicability of OECD firm-level evidence to South African conditions is uncertain, but the mechanism, broadband as a productivity-enhancing input that interacts with worker skill, is consistent with what has been documented in the South African and Indian settings.

Trade facilitation channel. Improved bilateral digital connectivity is associated with increased participation of firms in export markets, with implications for the structural diversification objective that is central to the South African growth agenda. The trade-facilitation channel is potentially important for South Africa, given the country's reliance on commodity exports and the structural diversification imperative. Direct evidence on the international-connectivity channel for sub-Saharan Africa is provided by Cariolle (2021) who uses the staggered arrival of submarine cables across the region in a difference-in-differences design and finds that the SEACOM and EASSy landings of 2009–2010 raised internet penetration in Eastern and Southern Africa by several percentage points relative to the rest of the continent. This corroborates the submarine cable mechanism documented by Hjort and Poulsen (2019) and Goldbeck and Lindlacher (2024) and is relevant to the assessment of South Africa's own international-connectivity investments (the recent 2Africa and Equiano landings) discussed in Section 1.6.

2.4 Mobile market structure and competition: the modern literature

A strand of the empirical literature addresses the relationship between mobile market structure and investment, prices, and welfare. The findings are relevant to the assessment of the Vodacom–Maziv transaction and to broader questions about competition policy in the South African telecommunications sector.

Cross-country evidence on consolidation. Genakos et al. (2018) use a panel of mobile operators across 33 OECD countries over 2002–2014 to document that more concentrated markets lead to higher end-user prices and that they also lead to higher investment per operator, though the effect on total industry investment is inconclusive. The paper has become the standard empirical reference in mobile-merger policy debates and is cited in the recent European debate over the Draghi (2024) report.

The Draghi debate and the recent European evidence. The Draghi report (Draghi, 2024) reopened the European policy debate on telecom market structure by proposing that further consolidation could be welfare-improving when paired with investment commitments. The academic response was substantial. Duso et al. (2024), in a VoxEU column responding directly to the Draghi report, drew on Genakos et al. (2018) and on a fresh 29-country empirical study commissioned by the European Commission (Lear, E.CA Economics, Fideres, Prometeia, University of East Anglia, and Verian, 2024) to argue against Draghi's call for in-country mobile consolidation. The headline empirical numbers from Lear et al. (2024), that one additional mobile network operator is associated with a 7 percent reduction in average revenue per user across the 29-country sample (9 percent in Europe alone), and a 9 percent increase in total investment, suggest that the welfare effects of additional consolidation in already-concentrated European markets would be unfavourable. The South African mobile market, with its declining HHI and the entry of Telkom Mobile and Rain, has moved in the opposite direction from European consolidation; the empirical evidence suggests this evolution has been welfare-improving.

Modern structural evidence on mobile market structure. Elliott et al. (2025) develop a structural model of price and infrastructure competition in mobile telecommunications that incorporates economies of scale in spectrum and data transmission. Estimating the model on French data, the authors find that while prices decrease with the number of firms, so do delivered download speeds, because economies of scale in network deployment are substantial. Consumer surplus is maximised at a moderate (not maximal) number of firms; the social value of an additional unit of spectrum is roughly five times an individual operator's willingness to pay for it in spectrum auctions. The consequence is that the optimal market structure trades off the price-reducing effect of additional competitors against the quality-reducing effect of fragmentation across scale-sensitive infrastructure. The South African market, with its three to four competitors, sits within the range that structural estimates suggest is consistent with welfare-improving outcomes.

The disciplining effect of new entry. Bourreau et al. (2021) study Free Mobile's 2012 entry into France's three-incumbent mobile market. The authors find that incumbents' introduction of fighting brands following Free's entry is difficult to rationalise as unilateral best responses, but fits a breakdown of tacit semi-collusion: pre-entry coordination on restricted product variety became unsustainable post-entry as business-stealing incentives intensified. Consumers gained substantially from added variety and to a lesser extent from price responses. The implication for South African policy is that entry, where commercially viable, can generate welfare gains through both direct competition and the disruption of tacit coordination that may exist among incumbent operators.

Competition in network industries: the Rwandan evidence. Björkegren (2022) uses a structural model of supply and demand in Rwanda's mobile market that allows for network effects across rival operators. The counterfactual simulations show that adding a second operator earlier could have reduced prices and

increased incentives to invest in rural towers, increasing welfare by the equivalent of approximately 1 percent of GDP. The earlier Björkegren (2019) paper in the *Review of Economic Studies* uses a structural model on Rwandan transaction records to show that regulatory requirements to serve rural areas lowered operator profits but increased net social welfare, that mobile-phone taxes imposed a welfare cost up to 3.11 times the revenue raised once network effects are accounted for, and that shifting from handset to usage taxes would have increased the surplus of poorer users by at least 26 percent. The Rwandan evidence is particularly relevant for South Africa because it documents the importance of network effects and demand-side heterogeneity in mobile markets at similar income levels.

Infrastructure sharing. Houngbonon et al. (2025), in their most recent CEPR Discussion Paper, compile 107 tower-sharing deals across 28 low-income countries from 2008 to 2020. Using staggered difference-in-differences estimation, the authors find that two years after a transaction covering over 1,000 towers, the PPP-adjusted mobile-price index falls by approximately USD 1.60 from a baseline of USD 3.16, and data prices fall by USD 1.00 from a baseline of USD 3.41 per GB. Mobile connections rise, rural internet access rises by approximately 4.7 percentage points, female-headed-household connectivity by 3.6 percentage points, and product-market competition (measured by HHI) increases. This evidence supports a more active use of infrastructure sharing in South Africa, especially in rural and lower-income areas where stand-alone network deployment is commercially difficult.

The South African evidence on regulation versus competition. Hawthorne and Grzybowski (2021) provide what is probably the most policy-relevant South African study on the regulation-versus-competition trade-off. Using six waves of the AMPS consumer survey covering more than 134,000 individuals from 2009 to 2014, the authors estimate a discrete-choice demand model with individual-specific price responsiveness and then simulate a demand-supply equilibrium with and without market entry and with and without regulation of mobile termination rates (MTRs). The headline finding is that MTR regulation has delivered larger consumer surplus gains than market entry, and that the gains have been skewed toward higher-income consumers and metropolitan dwellers rather than the lower-income and rural segments that the policy framework has historically targeted. The implications for South African policy are substantial: continued regulation of wholesale prices may deliver more inclusive welfare gains than reliance on new market entry alone, and complementary measures may be needed to ensure that the gains from competition reach lower-income and rural users.

The international evidence on termination-rate regulation provides important context for the South African MTR debate. Genakos and Valletti (2011) document a “waterbed” effect across a panel of 27 countries: a 10 percent cut in mobile termination rates was associated with an approximately 5 percent rise in retail prices, as operators recovered lost termination revenue from their own subscribers. The follow-up study Genakos and Valletti (2015) revisits this relationship over a longer horizon and finds that the waterbed effect, initially present, weakened and effectively disappeared after the mid-2000s as mobile penetration approached saturation and mobile-to-mobile traffic grew; crucially, the authors also find that MTR regulation did not reduce operator profits or investment. For South Africa, where MTR regulation has been a central and contested instrument, and where Hawthorne and Grzybowski (2021) attribute large consumer-surplus gains to it, this evidence suggests that the distributional benefits of wholesale-price regulation need not come at the expense of investment, but that the magnitude of pass-through to retail prices is contingent on the maturity and competitive structure of the market.

Fixed-line unbundling and access regulation. On the fixed-broadband side, Nardotto et al. (2015) study local-loop unbundling (LLU) in the United Kingdom using a detailed panel of local exchanges over 2005–2009. They find that mandated access to the incumbent’s network raised broadband penetration only in the early years and not once the market matured, but that it had a persistent positive effect on service quality, as entrants differentiated their products upward. Inter-platform competition from cable, which is not subject to access

regulation, raised both penetration and quality. The findings are relevant to the South African debate over access regulation of Telkom's Openserve wholesale arm and the broader question of functional versus structural separation discussed in Sections 3.3 and 4.2: access regulation can be an effective instrument for quality and entry, but its penetration benefits are concentrated in the build-out phase, and facilities-based (inter-platform) competition is a powerful complement.

2.5 Digital divide, financial inclusion, and the role of mobile money

A complementary literature addresses the demand-side dimensions of digital infrastructure, including the digital divide, financial inclusion through mobile money, and the substitutability between fixed and mobile broadband.

The South African digital divide. Grzybowski and Hawthorne (2025) study the substitution and complementarity between fixed and mobile broadband services in South Africa using approximately 134,000 individual-level survey observations from 2009 to 2014. The discrete-choice model accommodates fixed and mobile voice/data as either substitutes or complements. The paper identifies that fixed and mobile broadband function as substitutes for lower-income households and as complements for digitally engaged higher-income users, with implications for the design of inclusion policy. This suggests that fibre deployment alone is unlikely to close the digital divide; mobile broadband affordability and quality remain the principal levers for inclusion at the lower end of the income distribution. The earlier Grzybowski (2015) uses a discrete-choice model with network effects to identify operator-specific complementarities in mobile-phone adoption in South Africa; pricing and subsidy policies that exploit network effects can substantially expand adoption among low-income consumers.

Demand-side adoption programmes. Hauge and Prieger (2010) provide a survey of demand-side broadband adoption interventions, including digital-literacy training, community technology centres, and subsidies. The authors argue that balanced portfolios combining supply-side and demand-side measures are more likely to deliver positive outcomes than supply-only spending, and they call for rigorous cost-benefit analysis tied to ultimate policy goals (welfare, growth) rather than programme-implementation metrics. The implication for South Africa is that the supply-side coverage focus of SA Connect Phase 2 should be complemented by demand-side instruments addressing affordability, devices, and skills.

Mobile money and financial inclusion. The economics of mobile money has, over the past decade, become one of the most developed empirical literatures in development economics, and it is relevant to the South African PayShap agenda discussed in Section 3.5. The foundational contribution is Jack and Suri (2014) who exploit the rapid expansion of the M-PESA agent network in Kenya, identifying effects through households' changing proximity to agents. They find that, in the face of negative income shocks, the consumption of non-user households falls by approximately 7 percent, while the consumption of mobile-money users is left unaffected, evidence that mobile money enables more complete informal risk-sharing by sharply lowering the transaction costs of remittances. Suri and Jack (2016), in *Science*, extend this to long-run effects, estimating that access to M-PESA lifted approximately 194,000 Kenyan households (around 2 percent) out of extreme poverty, with effects concentrated among female-headed households and associated with a shift of roughly 185,000 women out of subsistence agriculture into business and retail occupations. The survey by Suri (2017) synthesises this body of work, setting out the mechanisms, risk-sharing, savings, the reallocation of labour and consumption, through which mobile money affects welfare in developing countries.

Subsequent work has examined the consumption-smoothing and remittance channels in a wider set of African contexts. Riley (2018) uses Tanzanian household panel data and finds that, following village-level rainfall shocks, only mobile-money users can fully smooth consumption, with no spillover to non-using households in the same village, suggesting that mobile money enables risk-sharing with networks beyond

the village but may, in doing so, weaken traditional within-village insurance. Munyegera and Matsumoto (2016) use a panel of 846 rural Ugandan households and find that mobile-money adoption raises per capita consumption, with the effect operating through an increased likelihood, frequency, and value of remittances received. Experimental evidence from beyond East Africa points in the same direction while adding nuance: Batista and Vicente (2025) report a cluster-randomised introduction of mobile money in rural Mozambique that increased remittances received and improved consumption-smoothing against floods and idiosyncratic shocks, but also increased out-migration and reduced on-farm investment, a reminder that the general-equilibrium effects of digital financial infrastructure can include spatial reallocation. Aker et al. (2016) use a randomised cash-transfer experiment during a Niger drought and find that delivering transfers via mobile money (rather than manual cash) raised household dietary diversity and shifted intra-household decision-making toward women, partly through the time savings and privacy of the mobile channel. These studies show that mobile money improves welfare mainly by making remittances and informal insurance cheaper, faster, and more reliable. The gains are concentrated among poorer, rural, and female users, which makes the evidence directly relevant to South Africa's financial-inclusion agenda.

The author's own research, drawing on multiple sub-Saharan African contexts, has documented the role of mobile money in expanding financial inclusion. Grzybowski and Mothobi (2017) establish that the main reasons for low formal-bank-account penetration in sub-Saharan Africa are infrastructure deficits, physical inaccessibility, and financial illiteracy, and that mobile money adoption is highest in areas with poor banking infrastructure, i.e., that mobile money substitutes for, rather than complements, traditional banking in infrastructure-poor environments. Grzybowski et al. (2023a) use 12,735 individual survey responses across nine sub-Saharan African countries merged with geo-located mobile towers and bank branches. A two-stage model has individuals choose a feature phone versus a smartphone in stage 1 and mobile-money use in stage 2. Network coverage significantly raises phone adoption; mobile money is mainly used by the young and relatively richer to send money, while the elderly and the poor predominantly use it to receive remittances, confirming a remittance channel for financial inclusion among older and rural recipients. Grzybowski et al. (2023b) examines how Tanzania's policy permitting mobile-money agents to serve multiple operators (agent interoperability) affects consumer choice of network operator. Interoperability weakens the lock-in power of dominant operators by lowering the effective switching cost associated with losing access to a specific agent network. The implication for South Africa is that PayShap, the recently launched real-time payment system, is likely to deliver financial inclusion gains, but that interoperability mandates and supportive regulatory frameworks are necessary to ensure that the benefits accrue to the population segments most in need.

Two further contributions refine the interoperability and demand-side stories above. Economides and Jeziorski (2017) study the transaction behaviour of approximately 1.4 million Tigo customers in Tanzania and document a striking pattern: more than 35 percent of funds entering the mobile money network are not transferred between people but used either as short-distance "money transport" (with the median trip between cash-in and cash-out of 5–6 km) or as short duration storage. Estimating consumer willingness-to-pay from responses to a price change, the authors find that urban Tanzanian consumers will pay on average 1.52 percent of value per kilometre of transport and approximately 0.8 percent per day for storage, with implied willingness-to-pay reaching 7 percent of transaction value when the alternative is theft or robbery during physical cash transport. The finding, that mobile money functions in part as "theft insurance" and "portable safety deposit" rather than purely as a transfer mechanism, has implications for how PayShap and similar systems should be designed and priced in markets with weak property-rights enforcement and limited household financial infrastructure.

Brunnermeier et al. (2023) address the interoperability question directly. Using a newly assembled dataset of mobile money fees scraped from operator websites over time via the Wayback Machine, merged with network-coverage and operator-financial data, the authors exploit the staggered introduction of platform

interoperability across African operators and countries. They find that interoperability lowers mobile money fees and reduces their dispersion across operators, a pro-consumer outcome consistent with the standard interoperability case. However, these gains are partly offset by a reduction in mobile-tower investment and network coverage in rural and poor districts, with the net effect being lower financial inclusion in precisely the population segments that interoperability is intended to benefit. The authors show that combining interoperability mandates with subsidies for rural telecommunications infrastructure can deliver lower fees without the coverage reduction. The implication for South African policy is that interoperability mandates, whether for PayShap rails, mobile money agents, or fixed broadband wholesale access, are not unambiguously welfare-improving on their own; they should be paired with complementary measures to maintain investment incentives in marginal coverage areas. This finding adds a nuance to the more positive interoperability story from Grzybowski et al. (2023b) on Tanzania and reinforces the case made in this paper for an integrated reform programme that combines competition-enhancing measures with targeted rural-coverage support.

Political and governance effects. A related strand of research has documented effects of digital infrastructure on political participation and governance outcomes. Manacorda and Tesei (2020) provide the broadest African evidence: using georeferenced data on mobile coverage matched to surveys and protest event data across the continent over 1998–2012, they document that mobile phone coverage causally increases political mobilisation, with the effect concentrated in economic downturns and operating principally through coordination rather than information channels. Donati (2023) exploits the staggered introduction of 3G mobile internet across South African municipalities to identify causal effects on political outcomes. The paper finds that in 2016 mobile internet availability caused a 2 percentage point increase in voter turnout and a 3 percentage point reduction in the vote share of the ruling party, with main opposition parties gaining. The number of parties running for election and the number of protests both increased. Suggestive evidence points to both information mechanisms (about municipal corruption) and coordination mechanisms (lower costs of organising protest activity). The Donati findings for South Africa are consistent with the broader continental pattern documented by Manacorda and Tesei (2020): digital infrastructure affects political accountability through both information and coordination channels, with effects that are particularly pronounced where existing accountability mechanisms are weak. The implication for the digital infrastructure policy debate is that the benefits of expanded connectivity include not only direct economic gains but also governance-related spillovers that may amplify the long-term welfare effects.

State aid and crowding out. A direct policy-relevant contribution is Bourreau et al. (2026). Estimating a fibre-entry model on more than 34,000 French municipalities from 2014 to 2019, the authors find that in approximately 36 percent of cases public subsidies were allocated to municipalities where private entry would have occurred within three years. The authors estimate that approximately €902 million of the total €2,203 million in subsidies disbursed by end-2019 may have crowded out private investment, while also accelerating fibre coverage in subsidised municipalities in the early stages of deployment. The implications for the design of South African universal service architecture are substantial: state aid programmes that are not carefully targeted at underserved areas can crowd out the private investment they are intended to stimulate. The reform options in Section 4 draw on this finding.

2.6 International policy experience: selected cases

Four international cases may be instructive for the South African policy debate.

Brazil's 2021 5G spectrum auction. Brazil's November 2021 5G auction, conducted by Anatel, raised total commitments of BRL 46.79 billion (approximately USD 8.44 billion), of which approximately BRL 42 billion was channelled into investment and coverage obligations rather than fiscal revenue (Anatel, 2021; Teleco, 2021). Coverage obligations included 5G service in all 5,570 Brazilian municipalities by December 2029, fibre

backhaul to 530 municipal seats by 2026, BRL 3.1 billion in public-school connectivity, and a secure federal government private network. By July 2024, 815 Brazilian municipalities had 5G service. The Brazilian case illustrates how spectrum-auction design can be used to convert a substantial share of licence value into legally enforceable infrastructure and coverage commitments. Compared with Brazil, South Africa's 2022 spectrum auction placed relatively greater emphasis on direct fiscal revenue generation.

UK Openreach legal separation. Following Ofcom's March 2017 decision to require the legal separation of Openreach from BT Group, Openreach was incorporated as a distinct legal entity with an independent board and strengthened governance obligations. The 2021 Wholesale Fixed Telecoms Market Review subsequently established a long-horizon regulatory framework intended to support investment in full-fibre infrastructure. FTTP coverage increased rapidly, rising from roughly 6 percent in 2019 to approximately 74 percent by mid-2025, alongside annual industry fibre investment estimated at several billion pounds per year. Openreach reached 17 million UK premises in January 2025 and 21.75 million (65.1%) by March 2026, with a commercial target of 25 million by end-2026 and an ambition of up to 30 million by 2030 (Ofcom, 2024; Openreach, 2025). The UK experience suggests that legal separation combined with a predictable long-term access pricing framework can support substantial fibre investment and network expansion.

Mexico's 2013 telecom reform. Mexico's 2013 constitutional telecommunications reform created the autonomous Instituto Federal de Telecomunicaciones (IFT) and introduced measures aimed at reducing the market dominance of the América Móvil group. These measures included functional separation obligations imposed on Telmex and Telnor in February 2018, alongside the establishment of the wholesale-only Red Compartida network. According to IFT reporting subsequently summarised in OECD and industry analyses, the reform period was associated with substantial reductions in telecommunications prices, rapid growth in mobile broadband subscriptions, major reductions in interconnection charges, and significant increases in internet access during 2013–2016 (Oxford Business Group, 2018; OECD, 2018). The Mexican experience suggests that constitutionally anchored regulatory independence can strengthen policy stability in telecommunications reform, while wholesale-only network models may improve coverage expansion but continue to face important commercial viability challenges.

Kenya: dominance and mobile money. Safaricom provides an important contemporary African comparator. The company held roughly 63 percent of Kenya's mobile subscriber market in early 2025 and continues to dominate mobile money through M-Pesa. The Kenyan experience illustrates that markets characterised by a dominant incumbent can nevertheless achieve broad network coverage and substantial digital-financial inclusion when combined with credible regulatory oversight and sustained infrastructure investment. At the same time, interoperability reforms and reductions in inter-network transaction costs have been important in supporting competitive entry and reducing switching frictions. The Kenyan experience should, however, be interpreted alongside the cautionary evidence from Brunnermeier et al. (2023) discussed in Section 2.5: interoperability may reduce consumer fees while simultaneously weakening incentives for rural infrastructure investment, implying that its net effect on financial inclusion in marginal coverage areas depends on the availability of complementary infrastructure subsidies or universal-service mechanisms. The Kenyan case is particularly relevant for the South African debate around digital payments infrastructure, including PayShap, and for the broader question of whether market dominance can function as a transitional rather than permanent feature of digital-platform development.

Three broad patterns emerge across the comparator cases. First, spectrum-auction frameworks that incorporate substantial coverage and investment obligations tend to achieve more rapid and inclusive network rollout than approaches focused primarily on short-term fiscal revenue generation. Second, some degree of separation between wholesale infrastructure and retail services—whether legal, functional, or structural—is common among jurisdictions that have achieved extensive FTTH coverage, particularly where open-access models have supported downstream retail competition. Third, the effectiveness of digital

infrastructure policy depends not only on regulatory design but also on the state's capacity to implement, monitor, and enforce policy over time.

2.7 Synthesis of the literature for South African policy

The literature reviewed above supports six observations relevant to the South African policy debate.

First, the employment effects of digital infrastructure expansion in developing-country settings are substantial and operate through multiple channels including firm entry, productivity, exporting, labour-market matching, and gender-specific transitions into wage employment. The estimates in Hjort and Poulsen (2019), Chiplunkar and Goldberg (2022), Bahia et al. (2023), and Caldarola et al. (2023) suggest that South African digital infrastructure investment in underserved areas can deliver employment gains; the Grzybowski and Patel (2023) evidence indicates that this pattern also holds within South Africa.

Second, the welfare effects of digital infrastructure are heterogeneous across population groups, with effects typically larger for lower-income and rural households where the marginal returns to additional connectivity are highest. The Tanzanian evidence in Bahia et al. (2023), the Rwandan evidence in Björkegren (2019) and Caldarola et al. (2023), and the South African evidence in Hawthorne and Grzybowski (2021) and Grzybowski and Hawthorne (2025) all point in the same direction.

Third, the relationship between mobile market structure and welfare is non-monotonic. The cross-country evidence in Genakos et al. (2018) and Lear, E.CA Economics, Fideres, Prometeia, University of East Anglia, and Verian (2024) indicates that more concentrated markets have higher prices, while the structural evidence in Elliott et al. (2025) indicates that there are scale economies that limit the welfare benefits of additional fragmentation. The South African market, with its deconcentration documented in Figure 2 and the entry of Telkom Mobile and Rain, has moved toward the welfare-improving end of the structure spectrum.

Fourth, infrastructure sharing and wholesale-access regulation can improve coverage and reduce consumer prices in lower-income telecommunications markets by lowering the cost of network deployment. Recent empirical evidence, including Houngbonon et al. (2025), provides quantitative support for these effects. South Africa's widespread use of tower-sharing arrangements and wholesale open-access fibre models is consistent with this evidence. However, outcomes depend heavily on regulatory design, particularly the calibration of wholesale access prices and the geographic scope of sharing obligations.

Fifth, state aid for digital infrastructure can produce crowding out of private investment when not carefully targeted at underserved areas, as Bourreau et al. (2026) document for the French market. The implication for the design of South African universal service architecture is that the geographic and technological targeting of public expenditure matters substantially for efficiency.

Sixth, mobile money and digital financial inclusion operate principally through the remittance channel and depend on supportive regulatory frameworks, including interoperability, as documented across multiple sub-Saharan African contexts in Grzybowski and Mothobi (2017), Grzybowski et al. (2023a), and Grzybowski et al. (2023b). The canonical evidence from Jack and Suri (2014), Suri and Jack (2016), and the survey of Suri (2017), reinforced by Riley (2018) and Munyegera and Matsumoto (2016), establishes that the welfare gains operate through cheaper and more reliable risk-sharing and remittances, concentrated among poorer, rural, and female users.

The recent evidence from Economides and Jeziorski (2017) on the "money transport" and storage uses of mobile money, and from Brunnermeier et al. (2023) on the interoperability–coverage trade-off, qualifies the unambiguously positive framing of interoperability: mobile money fulfils functions beyond pure transfer, and interoperability mandates should be paired with measures that preserve operator incentives to invest in

marginal coverage areas. The South African PayShap system has the potential to deliver inclusion gains, conditional on the regulatory design supporting interoperability and accessible pricing. These observations contribute to the diagnosis in Section 3 and inform the reform recommendations in Section 4.

3. Diagnosis of Growth and Employment Constraints

This section identifies the principal constraints on the contribution of the South African telecommunications sector to growth and employment. The diagnosis is organised around five clusters, consistent with the OECD's "Foundations for Growth and Competitiveness" framework, which emphasises the importance of input markets, competition, regulation, infrastructure, and complementary inputs to overall productivity. The analytical synthesis in Section 4 builds on the diagnosis to develop reform recommendations.

The constraints documented below are not independent of one another. Affordability constraints interact with infrastructure deployment gaps because the geographic areas with the highest affordability barriers are also typically those with the most limited supply-side capacity. Market structure considerations interact with regulatory frameworks because competition outcomes depend on the design of access regulation and the broader licensing framework. The energy constraint cuts across all of the other diagnostics by raising the cost of supplying coverage, particularly in rural and lower-density areas. The integrated treatment of these constraints in Section 4 reflects their interdependence. To avoid duplicating the descriptive material in Section 1 and the evidence reviewed in Section 2, this section states each diagnostic point once and cross-refers to the relevant figures, tables, and studies rather than restating them.

3.1 Affordability and the demand-side constraint

Affordability remains one of the main obstacles to effective use of digital infrastructure among lower-income households. While aggregate price declines have been substantial (Tables 1 and 2), distributional pricing patterns persist: higher effective per-megabyte prices for the small prepaid bundles preferred by lower-income consumers. The Competition Commission's 2020 settlements with Vodacom and MTN narrowed the spread but did not eliminate it. The welfare gains from aggregate price reductions are therefore unevenly distributed; the instruments that might address this distributional gap are considered in Section 4.

The affordability constraint operates jointly with the complementary-input constraints—devices, electricity, and skills—set out in Section 1.5. The central implication is that single-instrument interventions addressing connectivity alone are unlikely to close the divide; the energy and skills dimensions are taken up as complementary constraints in Section 3.6.

Two findings from the literature reviewed in Section 2 bear directly on this constraint. The fixed–mobile substitution result (Section 2.5) implies that mobile-broadband affordability remains the principal lever for inclusion, because even where fibre is available, lower-income households continue to rely on mobile networks. And the finding that wholesale-price (MTR) regulation delivered larger, but less progressively distributed, consumer-surplus gains than entry (Section 2.4) implies that the distribution of gains, and not only their magnitude, should weigh in the welfare assessment of the Vodacom–Maziv conditions, future spectrum design, and universal-service architecture.

3.2 Infrastructure deployment gaps and regional inequality

Notwithstanding aggregate coverage gains, deployment gaps persist with implications for inclusive growth and regional economic development. The geographic distribution of coverage and quality maps onto the broader spatial inequalities of the South African economy. Urban metropolitan areas are well-served by

mobile and fibre; rural areas, townships, and former homeland regions exhibit substantially lower quality and capacity. The fibre coverage metropolitan vs. non-metropolitan gap is particularly pronounced.

The literature reviewed in Section 2.3 implies that these gaps have direct consequences for employment and economic activity in underserved areas, with localised development effects that can be substantial. Reduced digital connectivity reinforces the disadvantage of peripheral location and limits the structural diversification potential of the regional economy.

The Vodacom–Maziv conditions include explicit rollout commitments in low-income reach areas and represent the most consequential recent intervention targeting the spatial dimension of digital infrastructure. The international evidence on infrastructure sharing (Section 2.4) indicates that sharing arrangements of the type already embedded in the South African market through tower-company structures can contribute to expanded rural coverage when paired with appropriate regulatory oversight. The monitoring of these merger commitments and the role of infrastructure sharing in the rural rollout agenda are taken up in Section 4.

3.3 Market structure and competition

The South African mobile market has deconcentrated over the past two decades (Figures 1 and 2; Section 1.3). It now supports meaningful retail competition among four operators, although the degree of underlying infrastructure independence varies across them—a qualification that is central to the diagnosis below.

The evidence reviewed in Section 2.4 indicates that this structure now lies within the range that international experience associates with welfare-improving outcomes: more concentrated markets tend to have higher prices, but scale economies limit the gains from further fragmentation. The South African pattern of progressive entry and declining ARPU (Figure 3) is consistent with the cross-country relationship between operator numbers and prices.

Several features suggest that competitive pressure remains uneven. The substantial coverage and quality differential between Vodacom/MTN on one hand and Cell C, Telkom Mobile, and Rain on the other (Figure 4) limits the substitutability of operators from the perspective of higher value customers. The reliance of Cell C and Telkom Mobile on roaming and infrastructure-sharing arrangements with the larger operators means that the nominal four-to-five operator structure understates the degree of underlying infrastructure consolidation. As noted in Section 3.1, the evidence that wholesale-price (MTR) regulation delivered larger consumer-surplus gains than entry suggests that wholesale-price regulation remains an important policy lever even in a deconcentrated market.

The fixed broadband market exhibits a different structural pattern, with infrastructure-based competition in urban areas under the open-access wholesale model. The Vodacom–Maziv transaction has altered this structure by combining Vodacom's mobile capabilities and retail customer base with Maziv's fibre infrastructure. The conditional remedies imposed by the Competition Appeal Court (Section 1.4) include open-access wholesale obligations, rollout commitments, and broader investment commitments, designed to mitigate the risk of vertical foreclosure and to extract pro-competitive coverage commitments. The effectiveness of these remedies will be observable only with several years of post-merger conduct data; the international comparator evidence (Section 2.6) suggests that behavioural remedies are typically less effective than structural separation in delivering open-access outcomes, though calibrated access pricing can produce substantial investment.

The structural relationship between Telkom and Openserve deserves attention. Telkom remains the historical fixed-line incumbent, while Openserve operates as its wholesale infrastructure arm, providing access to much of the legacy copper and fibre network. Although South Africa's regulatory framework incorporates elements of functional separation and wholesale-access regulation under the oversight of the Independent Communications Authority of South Africa (ICASA), Openserve has not been legally separated from Telkom in the manner of the UK's Openreach. The international comparator evidence discussed in Section 2.6 suggests that legal separation, when combined with predictable long-term access pricing and credible regulatory enforcement, can support fibre investment and downstream competition rather than necessarily discouraging investment incentives.

The combined effects of the Vodacom–Maziv transaction and the existing Telkom/Openserve structure produce a fixed broadband market that is structurally similar to a regulated duopoly in many geographic areas, with Maziv (Vumatel) and Openserve as the two principal wholesale providers and multiple internet service providers competing at the retail level. The question is whether this structure delivers effective competition for the marginal user, particularly in lower income segments where price elasticity is high and where the substitution to mobile broadband (Section 2.5) is strongest. This question, and the monitoring needed to answer it, is taken up in Section 4.

3.4 Regulatory and institutional constraints

The Electronic Communications Act (ECA) of 2005 remains South Africa's principal communications statute. It was drafted for the technological and market structure of the mid-2000s, and increasingly fits the contemporary digital economy only imperfectly. The Act was drafted in an environment dominated by traditional mobile and fixed-line telecommunications operators and does not naturally accommodate several categories of market participant that have subsequently become important, including low-earth-orbit (LEO) satellite operators, hyperscale cloud and data-centre infrastructure providers, and foreign-owned multinational infrastructure operators operating under globally standardised ownership structures. In particular, the ECA's ownership provisions, including the historically disadvantaged group (HDG) ownership requirements associated with Section 9(2)(b), reflect a transformation-oriented regulatory design whose application to multinational digital infrastructure operators has become increasingly contested.

The most active recent regulatory issue concerns the interaction between Section 9(2)(b), ICASA's ownership regulations, and the use of Equity Equivalent Investment Programmes (EEIPs) as an alternative to direct equity participation for foreign-owned licensees. The Minister's Policy Direction of 12 December 2025 instructed ICASA to consider recognising EEIPs within the ICT ownership framework (Minister of Communications and Digital Technologies, 2025). ICASA's subsequent response in May 2026 indicated, however, that the existing ECA continues to require minimum HDG ownership for individual licence holders and that full implementation of EEIPs as a substitute for direct equity ownership would likely require amendment of the underlying statute (Independent Communications Authority of South Africa, 2026). The Electronic Communications Amendment Bill therefore becomes a central institutional issue for the future structure of the sector, particularly for foreign participation in satellite, cloud, and digital infrastructure investment.

ICASA's technical and operational capacity has itself become a recurring topic of policy discussion. Over the past two decades the regulator's mandate has expanded substantially, encompassing spectrum management, competition remedies, wholesale-access regulation, consumer protection, content regulation, and increasingly the governance challenges associated with digital convergence. This expansion in responsibility has not always been matched by commensurate growth in institutional capacity or technical resources. This suggests that implementation capacity and regulatory enforcement may themselves constitute constraints on improved sectoral outcomes. The international comparator evidence discussed

earlier suggests that regulatory credibility and sustained implementation matter at least as much as formal policy design in determining long-run investment outcomes.

Administrative friction in network deployment remains an additional constraint on rollout speed and investment efficiency. Rights-of-way approvals, municipal permitting, environmental authorisations, access to public infrastructure, and inconsistent local administrative procedures continue to increase deployment costs and delay network expansion. The Rapid Deployment Policy and Guidelines have sought to reduce these frictions through greater standardisation of approval processes and infrastructure-access rules, but implementation across municipal jurisdictions has remained uneven. In this respect, the local-government reform agenda incorporated into Operation Vulindlela Phase II is relevant to the digital infrastructure agenda, since municipal administrative performance affects the cost and pace of fibre and mobile network deployment.

The public-subsidy framework for universal connectivity also warrants careful attention, particularly in the context of a potential successor to SA Connect Phase 2. The evidence reviewed in Section 2.5 indicates that subsidy programmes can crowd out commercially viable private investment where they are not carefully targeted at genuinely underserved areas. The implication for South African policy is that the geographic and technological targeting of universal service expenditure matters substantially for the efficient use of public funds. Public-subsidy programmes that are not carefully focused on underserved areas risk displacing private investment rather than complementing it.

3.5 Mobile money, PayShap, and the financial inclusion gap

A specific area where the South African digital infrastructure agenda intersects with broader inclusion objectives is mobile money and digital payments. The PayShap real-time payment system, whose scale and launch are described in Section 1.6, represents a significant institutional investment in digital financial infrastructure, comparable in concept to Brazil's PIX system (launched in 2020 and now used by approximately 175 million Brazilians) and India's UPI system (around 491 million users in 2025–26).

The per-capita transaction volume of PayShap remains substantially below that observed in the Brazilian and Indian comparators, however. The question is whether the gap reflects the early stage of the South African system, structural features of the South African financial sector, or both. The mobile-money evidence reviewed in Section 2.5 suggests several relevant observations. First, mobile money adoption in South Africa has historically been substantially lower than in East African comparators (Kenya, Tanzania), reflecting the relative strength of formal banking infrastructure in South Africa. Second, the remittance channel through which mobile money supports financial inclusion, with the elderly and poor predominantly receiving rather than sending, suggests that PayShap's expansion into lower-income segments depends on the willingness of higher-income senders to use the system, which in turn depends on transaction fees and ease of use. Third, agent interoperability (Section 2.5) is a critical regulatory feature; the equivalent question for South Africa concerns the interoperability between PayShap, traditional bank infrastructure, and emerging fintech platforms.

Two findings reviewed in Section 2.5 sharpen this diagnostic. The evidence that a large share of mobile-money activity in comparable markets is short-distance "money transport" and short-term storage rather than interpersonal transfer suggests that the South African PayShap design should consider not only the transfer use case but also the storage and intra-personal value-movement functions that are particularly relevant for the unbanked or partially-banked population. And the evidence that interoperability lowers fees but can reduce rural network investment when not paired with connectivity subsidies implies that PayShap interoperability mandates—between bank-led PayShap and any future mobile-money-led rails, or between

PayShap and emerging fintech platforms—should be designed jointly with measures that preserve operator and bank incentives to extend physical and digital infrastructure to marginal areas.

The way PayShap is governed, priced, and connected to banks and fintech platforms will determine whether it can deliver the financial-inclusion gains observed in Brazil and India; the specific instruments—fee design, integration with social-transfer payments, and interoperability mandates—are set out in Section 4.

3.6 Energy as an input to telecommunications

Energy reliability is the most prominent of the complementary, or "analogue," constraints—alongside skills (Section 1.5) and institutional capacity (Section 3.4)—that condition whether the digital infrastructure described above translates into growth and employment. It is treated at greater length here because, unlike the others, it generated a direct and quantifiable cost shock to the sector over 2020–2024.

The mobile sector has been particularly exposed to electricity supply disruption because mobile networks depend on a dense distribution of base stations, each requiring continuous power. South African mobile operators have provided detailed disclosures of the costs and mitigation measures associated with load shedding. Vodacom Group disclosed total electricity expenditure of approximately ZAR 4.7 billion in the 2024 financial year, up from ZAR 3.8 billion in the previous year, a 23 percent year-on-year increase attributed to higher tariffs, expansion, 5G rollout, and load shedding (TechCentral, 2024). The company disclosed cumulative spending of approximately ZAR 4 billion on batteries and generators between 2020 and 2023. MTN South Africa disclosed monthly diesel consumption of approximately 400,000–450,000 litres at Stage 5 and Stage 6 load shedding, operated more than 2,000 generators across its base station network, and reported approximately ZAR 640 million in foregone service revenue attributable to load shedding in 2022 (Engineering News, 2023; TechCentral, 2023). The Association of Comms and Technology estimated aggregate industry diesel expenditure of approximately ZAR 1.1 billion in 2023 (News24, 2023).

These figures, while self-reported and not independently audited, indicate the order of magnitude of the cost shock and have implications for capital allocation. Industry executives have stated publicly that the redirection of capital toward battery and generator deployment has displaced investment in 5G rollout and rural coverage expansion (TechCentral, 2023). Smaller operators with more limited financial flexibility have faced a more acute version of the constraint, contributing to the widening of the coverage and quality gap between incumbents and smaller competitors visible in Figure 4.

The relationship between digital infrastructure and the broader electricity reform agenda is bidirectional. Digital infrastructure depends critically on grid reliability, while the rapid expansion of data centres and cloud infrastructure represents a growing source of industrial electricity demand, with some projections approaching 1,000 MW by 2030. The first-order response to electricity unreliability lies outside the digital infrastructure policy domain itself, in broader electricity-sector reform: additional generation capacity, transmission expansion, market liberalisation, and tariff reform. The role of digital infrastructure policy is therefore primarily complementary. Regulatory frameworks governing network deployment, universal service obligations, infrastructure permitting, and corporate renewable-energy procurement should reinforce rather than impede the broader electricity reform agenda.

4. Opportunities for Growth, Job Creation and Reform

This section develops the reform recommendations that follow from the diagnosis. The recommendations are organised by policy horizon (short-term: 0–24 months; medium-term: 2–5 years; long-term: 5–10 years) and within each horizon are grouped around the issues identified in Section 3.

4.1 Short-term: regulatory and operational reforms (0–24 months)

Spectrum. The disposition of the unsold IMT800 lot from the 2022 auction provides an opportunity to reconsider spectrum-assignment design in favour of stronger coverage obligations. Rather than a simple revenue-maximising re-auction on the original terms, the spectrum could be allocated through a framework similar to the Brazilian 2021 model, under which licence awards are linked to measurable rollout obligations in underserved areas. Such obligations could include population-coverage targets, municipal-level deployment commitments, and quality-of-service benchmarks implemented over a three- to five-year horizon. The fiscal revenue foregone relative to a purely revenue-maximising allocation may be justified by the documented social returns to rural connectivity expansion, including the welfare gains from rural mobile-network access documented by Björkegren (2019) for Rwanda, the labour-market effects identified by Hjort and Poulsen (2019) and Bahia et al. (2023), and the more recent infrastructure-sharing evidence in Houngbonon et al. (2025). Future spectrum decisions—including 6 GHz, mmWave, and any further 3.5 GHz assignments—could incorporate similar coverage-oriented design principles. The structural evidence in Elliott et al. (2025), which suggests that the broader social value of spectrum may substantially exceed operators' private willingness to pay, further strengthens the case for incorporating public-interest rollout obligations into spectrum-assignment design.

EEIP resolution. The regulatory tension between Section 9(2)(b) of the ECA and the December 2025 Ministerial Policy Direction on EEIPs is unlikely to be definitively resolved without statutory amendment, an issue more appropriately addressed within the medium-term reform horizon discussed below. In the interim, a pragmatic approach would be for ICASA to issue clarifying regulations or guidance under the existing statutory framework establishing criteria for EEIP-based licensing applications, while recognising that such arrangements may remain subject to judicial review. Simultaneously, the Department of Communications and Digital Technologies could advance the Electronic Communications Amendment Bill to provide a more durable legislative basis for EEIP recognition. Such an approach would improve near-term regulatory certainty while facilitating progress on the licensing of satellite and other foreign-owned digital infrastructure operators.

Vodacom–Maziv implementation. The Competition Commission and Competition Tribunal should develop a rigorous monitoring framework for the Vodacom–Maziv conditions, with quarterly reporting on rollout commitments, school and health-facility connectivity, open-access wholesale obligations, and broader commitments. Public reporting of monitoring outcomes is essential to credibility. The Commission should also signal clearly the consequences of non-compliance, including potential modification of conditions or referral for further structural remedies.

Infrastructure sharing and rapid deployment. ICASA should pursue more aggressive regulatory facilitation of passive and active infrastructure sharing, particularly in rural and underserved areas where commercial deployment economics are marginal. The evidence from Houngbonon et al. (2025), that infrastructure sharing in 28 low-income countries reduced mobile and data prices by approximately 30 percent and raised rural internet access by 4.7 percentage points, provides a quantitative basis for prioritising sharing in the South African rural rollout agenda. The cautionary finding from Brunnermeier et al. (2023) should be taken into account in the design of sharing obligations: pro-competition policies that lower retail prices can also dampen operator investment incentives in marginal areas, so sharing mandates should be paired either with explicit rural rollout obligations or with targeted infrastructure subsidies for the relevant geographies.

4.2 Medium-term: statutory and structural reforms (2–5 years)

Electronic Communications Amendment Bill. The Bill provides an opportunity to address several interrelated weaknesses in South Africa's communications regulatory framework through a comprehensive rather than narrowly targeted amendment process.

The reform package should address four issues. First, it should recognise Equity Equivalent Investment Programmes (EEIPs) as an alternative compliance mechanism for foreign-owned licensees subject to ownership and control requirements under section 9(2)(b) of the ECA and associated ICASA regulations. Second, it should modernise licensing and regulatory classifications for emerging infrastructure and platform operators, including LEO satellite providers, hyperscale cloud infrastructure, and content delivery networks. Third, it should clarify the relationship between Ministerial policy direction-setting and ICASA's regulatory independence. Fourth, it should delineate more clearly the boundary between ICASA's sector-specific authority and the Competition Commission's general competition oversight.

Universal service architecture. The successor to SA Connect Phase 2 should be designed around competitive reverse-auction mechanisms in which operators bid on the level of subsidy required to provide service in specified underserved areas. This approach is consistent with the international evidence on the relative efficiency of state-led versus market-led delivery and addresses the documented underperformance of the legacy SA Connect model. The geographic and technological targeting must be tight: the Bourreau et al. (2026) evidence from France indicates that approximately 36 percent of subsidised municipalities would have received private fibre investment within three years in the absence of subsidy, with approximately €902 million of public funds crowding out private investment. The implication for South Africa is that universal service expenditure should be confined to areas where commercial deployment is unlikely on a credible time horizon, identified through transparent commercial-availability assessments rather than political negotiation.

The reverse-auction approach should incorporate the following design elements. First, the geographic areas should be precisely specified through transparent assessments of commercial deployment likelihood, with the burden of proof on the public authority to establish that commercial coverage will not occur on a credible time horizon. Second, the auction should be technology-neutral. Operators should be free to bid using any combination of fibre, fixed wireless, satellite, or other technologies that meet the quality benchmarks. Third, the subsidy ceiling should be set at a level that reflects realistic deployment costs, drawing on international benchmarks for similar geographic and demographic conditions. Fourth, the auction should be repeated periodically (perhaps every two to three years) for unallocated areas, allowing for technology and market changes. Fifth, the public reporting of auction outcomes, subsidy levels, and coverage delivery should be transparent and standardised, supporting both accountability and learning across rounds.

The reverse-auction approach should be complemented by demand-side instruments, specifically, targeted connectivity vouchers for the lowest-income households in covered areas, to address the affordability dimension of the digital divide. The Hauge and Prieger (2010) survey of demand-side interventions provides a framework for designing such instruments.

Access regulation on Openserve. The diagnosis in Section 3.3 identified the structural relationship between Telkom retail and Openserve wholesale as a candidate area for further reform. Drawing on the UK Openreach legal separation model, the medium-term recommendation is for ICASA to strengthen functional separation requirements within Telkom Group, combined with geographic-specific access regulation in districts identified as lacking effective infrastructure-based competition. Full legal separation is a possible further step if the functional separation does not deliver effective open access; the international evidence (UK Openreach post-2017) suggests that legal separation is investment-enabling under the right access pricing regime.

Spectrum programme. A multi-year spectrum roadmap should be published, setting out the bands to be released over a 5–7 year horizon with indicative auction timing, lot configurations, and design parameters. The roadmap should incorporate the coverage-obligation design philosophy across all future auctions and should reserve specific lots for new entrants and for specific operator categories (satellite, fixed-wireless specialists).

4.3 Long-term: structural and strategic reforms (5–10 years)

Workforce and human capital integration. The long-term contribution of digital infrastructure to growth and employment depends critically on complementary investments in human capital, digital literacy, and institutional capability. Recent empirical work on the heterogeneous labour market effects of digital connectivity, particularly Azam et al. (2024) for India and Caldarola et al. (2023) for Rwanda, suggests that the employment and productivity gains associated with digital infrastructure expansion are conditional on the educational and skills profile of the population. The long-term policy implication is that digital skills and workforce-development components should be integrated more systematically into licensing frameworks, merger remedies, spectrum-allocation processes, and universal-service programmes, building on recent South African precedents, including elements of the Vodacom–Maziv remedy package. The broader integration of digital capabilities into the basic, vocational, and post-school education systems lies outside the telecommunications policy domain, but constitutes a complement to the effectiveness of digital infrastructure investment.

Mobile money and digital financial inclusion. The author's research on mobile money in sub-Saharan Africa (Grzybowski and Mothobi, 2017; Grzybowski et al., 2023a,b) indicates that mobile money's contribution to financial inclusion operates principally through the remittance channel and depends on agent interoperability across operators. The complementary evidence from Economides and Jeziorski (2017) on the money-transport and storage uses of mobile money, and from Brunnermeier et al. (2023) on the interoperability–coverage trade-off, suggests that PayShap's long-term design should explicitly support these non-transfer functions and that any interoperability mandates should be paired with measures preserving rural infrastructure investment. The PayShap real-time payment system, launched in March 2023, provides the institutional tool for South African digital financial inclusion. The long-term recommendation is for the South African Reserve Bank, the Department of Communications and Digital Technologies, and the National Treasury to coordinate on the architecture and pricing of PayShap to support its expansion into lower-income segments. The international evidence from Brazil (PIX) and India (UPI) indicates that fee-free or low-fee public real-time payment infrastructure can deliver substantial financial inclusion gains within five to seven years of launch.

Regional and continental integration. South Africa's position as a regional digital infrastructure hub provides the basis for a long-term strategy of regional integration. The principal opportunities concern cross-border data infrastructure, spectrum, and interconnection harmonisation with SADC partners, and the development of regional digital public infrastructure standards. These opportunities depend on diplomatic and political conditions outside the digital infrastructure policy domain, but shape the long-term structural opportunity facing the South African sector.

5. Conclusion

Digital infrastructure is an enabling input for inclusive growth in South Africa, though not a sufficient condition in itself. The empirical literature reviewed in this paper, substantially expanded and strengthened by recent developing-country evidence including Hjort and Poulsen (2019), Chiplunkar and Goldberg (2022), Bahia et al. (2023), Caldarola et al. (2023), Azam et al. (2024), Goldbeck and Lindlacher (2024), Houngbonon et al. (2025), and the recent survey by Hjort and Tian (2025), indicates that the relationship between digital

infrastructure and economic growth, employment, firm performance, and regional development is consistent across a wide range of methodological approaches and country contexts. The evidence suggests that improvements in coverage, adoption, affordability, and effective use can generate substantial aggregate economic effects. The South African experience over the past decade has been consistent with these findings, with documented effects on consumer welfare, market entry, and competition. The evolution of the policy debate itself reflects this progress: the constraints have shifted increasingly from basic supply-side coverage toward affordability, adoption, institutional capability, and the regulatory framework governing digital infrastructure markets.

The literature on market structure and competition in telecommunications has also advanced over the past decade. The structural evidence in Elliott et al. (2025), the analysis of entry and tacit coordination in Bourreau et al. (2021), the recent European policy debate involving Duso et al. (2024) and Lear, E.CA Economics, Fideres, Prometeia, University of East Anglia, and Verian (2024), and the South African evidence in Hawthorne and Grzybowski (2021) and Grzybowski and Hawthorne (2025) together provide a richer empirical basis for assessing South African telecommunications markets than was available even a decade ago. The deconcentration of the South African mobile market over the past two decades, visible in Figures 1 and 2, appears, on balance, to have been welfare-improving. The contemporary market structure, characterised by four retail operators and a moderately concentrated market, lies within the range that recent structural estimates suggest is compatible with favourable consumer and investment outcomes.

This paper has outlined a reform programme aimed at addressing the remaining constraints through a coordinated policy approach. The principal recommendations, coverage-obligation spectrum design, comprehensive reform through the proposed Electronic Communications Amendment Bill, rigorous implementation and monitoring of the Vodacom–Maziv remedies combined with strengthened wholesale-access regulation for Openserve, and a competitive reverse-auction successor to SA Connect informed by the Bourreau et al. (2026) evidence on crowding out, are interdependent and require sustained institutional coordination, including through Operation Vulindlela Phase II.

The decisions taken over the next several years—on spectrum, fibre access, universal-service funding, EEIP recognition, and digital payments—will shape South Africa's digital economy for at least the next decade. The objective of this paper has been to inform those decisions by synthesising the international empirical literature, the South African evidence base, and relevant international policy experience. The paper identifies practical reforms that can help digital infrastructure contribute more effectively to South Africa's growth, inclusion, and employment objectives.

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