Internet Adoption Trends during COVID-19

Amaglobeli, David and Gu, Mengfei and Moszoro, Marian and Zhou, Yue and Escalante, Patricia

International Monetary Fund, George Mason Univeristy, SGH Warsaw School of Economics

March 2023

IMF

NOTES

Internet Adoption Trends during COVID-19

David Amaglobeli, Mengfei Gu, Mariano Moszoro, Yue Zhou, and Patricia Escalante

NOTE/2023/001

Internet Adoption Trends during COVID-19

NOTE/2023/001

David Amaglobeli, Mengfei Gu, Mariano Moszoro, Yue Zhou, and Patricia Escalante *

RECOMMENDED CITATION: Amaglobeli, David, Mengfei Gu, Mariano Moszoro, Yue Zhou, and Patricia Escalante. 2023. "Internet Adoption Trends during COVID-19" IMF Note 2023/001, International Monetary Fund, Washington, DC.

ISBN:	979-8-40023-885-7 (Paper) 979-8-40023-893-2 (ePub) 979-8-40023-895-6 (PDF)
JEL Classification Numbers:	L16, L86
Keywords:	Internet; Digitalization; COVID-19
Authors' email addresses:	DAmaglobeli@imf.org MGu@imf.org MMoszoro@imf.org YZhou4@imf.org PEscalante@imf.org

* The authors gratefully acknowledge Ookla for providing their data for this research. Data were obtained through the Development Data Partnership, a collaboration between international organizations and private sector companies to facilitate the efficient and responsible use of third-party data in international development. The authors thank Angham Al Shami, Josh Aslett, Nina Budina, Pavis Devahasadin, Almudena Fernandez, Davide Furceri, Ed Hearne, Purva Khera, Andja Komso, Jocelyn Koussere, Paolo Mauro, Giovanni Melina, Manabu Nose, Myrto Oikonomou, Rumit Pancholi, and Pierre Adrien Wandja for valuable comments.

Internet Adoption Trends during COVID-19

David Amaglobeli, Mengfei Gu, Mariano Moszoro, Yue Zhou, and Patricia Escalante

March 2023

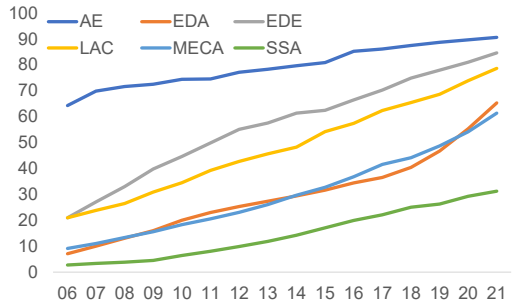
This paper examines the common perception that internet adoption accelerated globally during the COVID-19 pandemic. The data show little evidence of a faster expansion of access to internet (extensive margin) across all country income groups but strong evidence of acceleration in the improvement in the quality of connectivity (intensive margin). The data also support that, despite a decline in internet prices over the past decade, affordability of digital services remains a concern for low-income developing countries.

I. Broad Trends in Digitalization

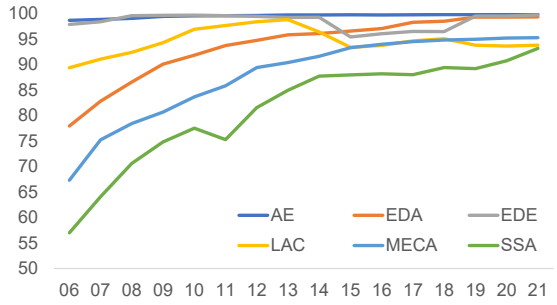
Access to internet has been expanding in most regions—but at different paces.[1] Internet users per 100 inhabitants reached 91 in advanced economies in 2021 (Figure 1.1). However, only 61 and 31 percent of the populations in the Middle East and Central Asia and in sub-Saharan Africa, respectively, had internet access. Despite the near convergence in mobile signal coverage—including 3G to 5G—across regions (Figure 1.2), mobile cellular subscription lagged considerably in Middle East and Central Asia and in sub-Saharan Africa (Figure 1.3). High-speed LTE[2] network coverage, which is important for effective internet adoption, also shows a large discrepancy across regions (Figure 1.4).

Figure 1. Developments in Internet Access

1. Internet Users, Percent of Population



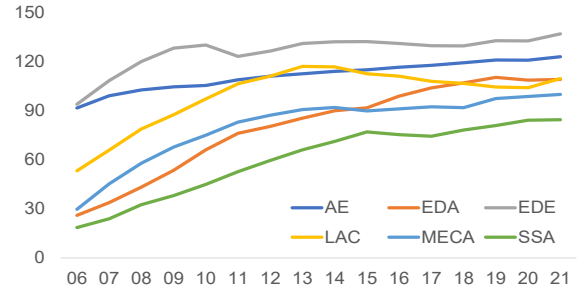
2. Signal Coverage, Percent of Population



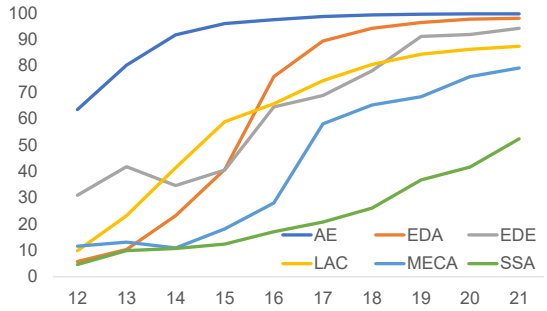
[1] Digitalization has important macroeconomic implications. For example, Jaumotte and others (forthcoming) show that during the pandemic the acceleration of digitalization at the firm level—measured as the share of workers using a computer with internet access—shielded productivity and hours worked in digitalized entities during the crisis.

[2] LTE stands for Long-Term Evolution and is sometimes referred to as 4G LTE. It is a standard for wireless data transmission that allows to download data much faster than you could with the previous technology, 3G.

3. Mobile Cellular Subscription, Percent of Population



4. LTE Coverage, Percent of Population



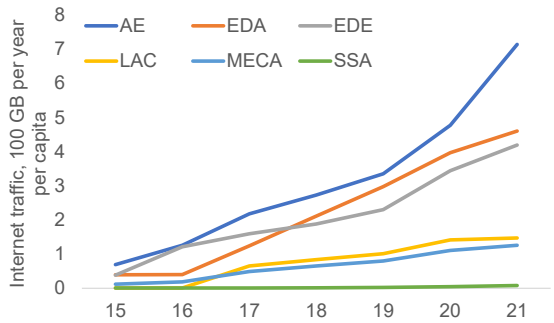
Sources: ITU and IMF staff calculations.

Note: Internet users are individuals who have used the internet in the past three months via both computer and mobile phone. Population weighted average is used. AE = advanced economies; EDA = emerging and developing Asia; EDE = emerging and developing Europe; LAC = Latin America and the Caribbean; MECA = Middle East and Central Asia; SSA = sub-Saharan Africa.

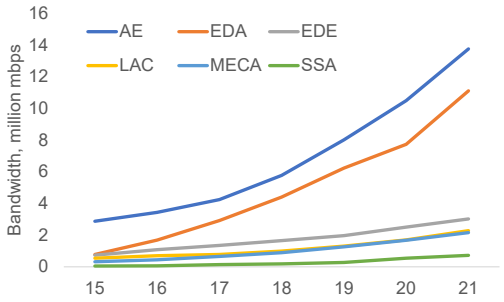
Broadband traffic per capita and the quality of internet continued to rise at different speeds across regions.[3] Fixed broadband traffic per capita has been growing fast in advanced economies, emerging and developing Asia, and emerging and developing Europe compared with other regions (Figure 2.1), and international internet bandwidth has significantly improved in advanced economies and emerging and developing Asia (Figure 2.2).[4] Although the adoption of 5G is expected to be the main driver of mobile technology development and faster broadband speed growth in the coming years, subscription of 5G-using mobile devices was small but growing fast (Figure 2.3), with around 160 million in 2020 mainly clustered in northeast Asia (Figure 2.4).[5]

Figure 2. Developments in the Quality of Internet

1. Broadband Traffic (100 GB per person)



2. Bandwidth (Million Mbps)

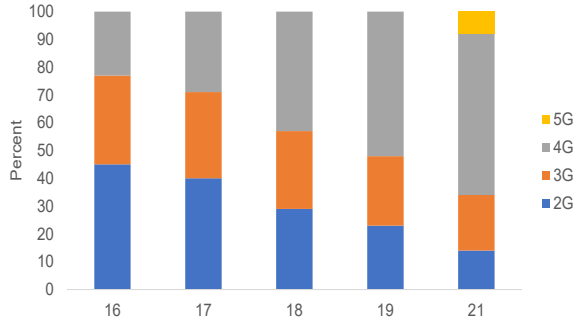


[3] Internet quality is generally assessed by a collection of metrics that measure different facets of connectivity—for example, outages, latency, throughput, jitter, and packet loss; these metrics should also include bandwidth. In isolation, bandwidth may best be considered a measure of capacity rather than quality. This note focuses on internet speed, which ultimately results from several of these facets of connectivity.

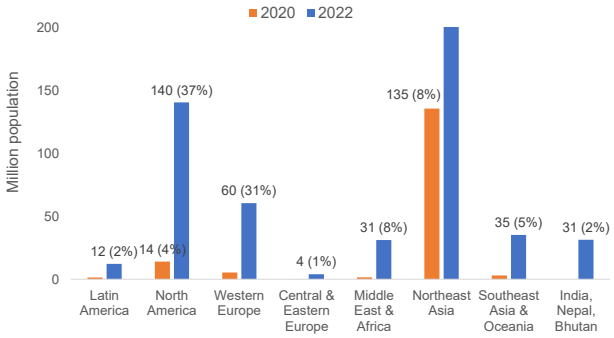
[4] The term *international internet bandwidth* refers to the total used capacity of international internet bandwidth in megabits per second (Mbit/s). It is measured as the sum of used capacity of all internet exchanges (locations where internet traffic is exchanged) offering international bandwidth.

[5] Path dependence may explain the high number of mobile subscriptions in emerging and developing Europe with those in advanced economies. Although advanced economies had fixed lines in the past, fast-growing emerging and developing Europe chose mobile connection instead.

3. Worldwide Mobile Technologies, by Generation, Percent of Total



4. 5G Mobile Subscriptions, by Region, in Million (left axis) and as Percent of the Population (in-graph label in bracket)



Sources: ITU, GSMA Intelligence, Ericsson, Statista, and IMF staff calculations.

Notes: Data traffic is 100 GB per year per person, including both fixed and mobile data. Data traffic in China in 2017–2019 was interpolated. Population-weighted average is used. AE = advanced economies; EDA = emerging and developing Asia; EDE = emerging and developing Europe; GB = gigabytes; LAC = Latin America and the Caribbean; mbps = megabits per second; MECA = Middle East and Central Asia; SSA = Sub-Saharan Africa.

II. Developments during COVID-19

Contrary to popular expectations, internet access does not appear to have accelerated much during the COVID-19 pandemic (Figure 3.1)**.** The annual growth of internet users accelerated only in emerging market economies during the pandemic (Figure 3.2),[6] driven mainly by the rapid internet adoption in India, which had started before the outbreak of the pandemic.[7] Digitalization in advanced economies and low-income developing countries remained at the historical trend since the outbreak of COVID-19.[8]

Instead, the largest improvement in digitalization during the pandemic was the leap in internet speed among existing users.[9] The average download/upload speed since the outbreak of COVID-19 accelerated considerably across all income groups (Figure 3.3).[10] The improvement in internet speed probably reflects the fact that existing internet users started to upgrade their internet packages as most work- and household-related activities shifted online.

Ookla data, which rely on self-administered internet speed tests, offer several advantages over advertised speeds used in other data sets.[11] Advertised speeds can be misleading and do not always reflect

[6] The average annual growth of internet users per 100 inhabitants in emerging market economies was 4.6 percentage points between 2019 and 2021, compared with 8.4 percentage points between 2017 and 2019. The coefficient of variation (that is, mean over standard deviation) of internet users in advanced economies and emerging market economies is low (below 30 percent). In low-income developing countries, the coefficient of variation is around 50 percent but declining over time.

[7] In 2015 India launched the "Digital India" campaign, targeting faster and more inclusive economic growth by pushing government and banking services online and by investing in technology.

[8] Internet users per 100 habitants in the US grew from 74.5 in 2015 to 85.5 in 2016, leading to the hike of internet access in advanced economies in 2016.

[9] This section uses Ookla Speedtest Intelligence® data, which provide aggregated measurements on internet performance collected through Speedtest®, a web and app consumer-initiated testing tool. A snapshot of the internet is taken for a specific time, place, device, and network each time a user initiates a Speedtest. A statistical sampling methodology is then employed to identify and remove tests that could intentionally or unessentially bias the results and account for outliers or short-term fluctuations in service or user behaviors. However, Ookla's estimates may have wider confidence intervals in countries with low internet access, due to a limited number of observations.

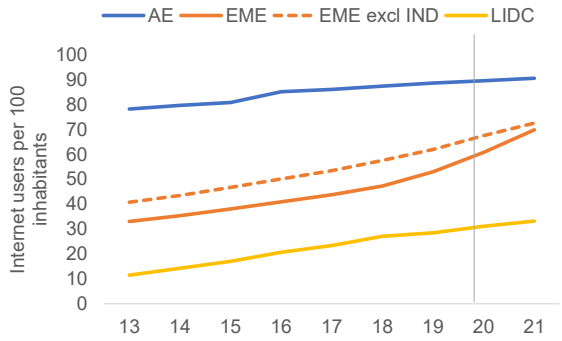
[10] The likelihood-ratio (LR) test for whether there is a structural break in April or May 2020 (H_0: no structural break) is 9.1775 (prob = 0.0102) for advanced economies, 5.4734 (prob = 0.0648) for emerging market economies, and 4.7477 (prob = 0.0931) for low-income developing countries.

[11] A variety of recent studies (Gozzi and others 2022; European Commission, Joint Research Centre; Proietti, Sulis, Perpiña and others 2022; University of Chicago 2022) have used Ookla data See also other user cases highlighted at https://www.ookla.com/articles/archive (accessed March 1, 2023).

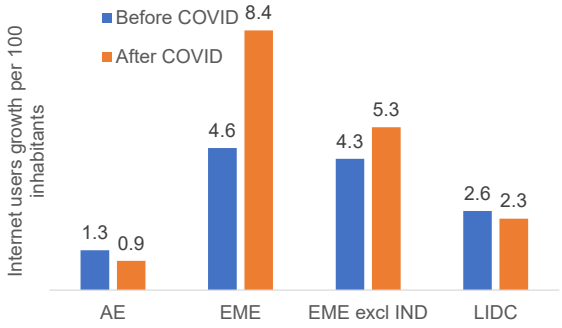
the actual internet speeds that users experience. In contrast, self-administered tests, because they are based on actual user experiences, provide more accurate and reliable measurements of internet performance. Additionally, self-testing allows researchers to gather data on internet speeds across a wider range of locations, devices, and times, permitting a more comprehensive understanding of internet performance.

Figure 3. Trends in Digitalization after the Start of the COVID-19 Pandemic

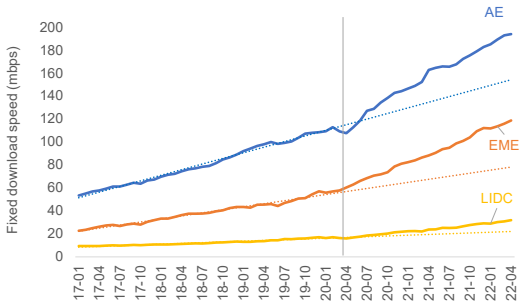
1. Internet Users per 100 Inhabitants



2. Internet User Growth, Before and After COVID-19



3. Download Speed, Mbps



Sources: ITU, Ookla, and IMF Staff calculations.

Notes: Download speed is the fixed band average download speed. Internet users' access and download speed is weighted by population. The data before COVID-19 cover January 2017 to February 2020; data after the start of the COVID-19 pandemic cover March 2020 to April 2022. The gray line in Figures 3.1 and 3.3 refers to March 2020, when the World Health Organization declared COVID-19 a global pandemic. The dashed line in Figure 3.3 is the fitted trendline without structure break. AE = advanced economies; EME = emerging market economies; IND = India; LIDC = low-income developing countries; mbps = megabits per second.

III. Price and Affordability of Broadband Services

Despite a continued decline in internet prices—a key factor for digital adoption—affordability remains a major concern in low-income developing countries.[12] Data-only mobile-broadband basket prices have dropped by more than 50 percent since 2015—to less than $5 per month in 2021 in emerging market economies and low-income developing countries (Figure 4.1). In advanced economies, mobile-broadband prices spiked recently, an increase that likely reflects internet users upgrading their data packages as data-unit prices continue to decline (Figure 4.2).[13] However, relative to per capita gross income, a better metric of

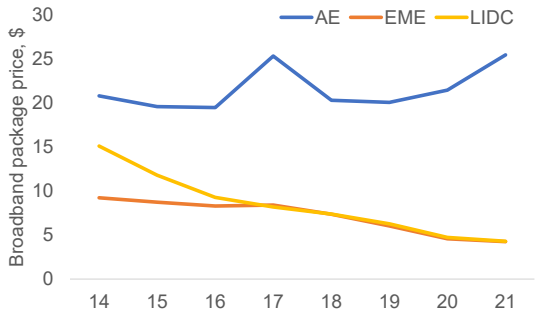
[12] The kink of broadband price in 2017 is driven by the US, whose data package price increased from $16 in 2016 to $33 in 2017 before dropping back to $22 in 2018.

[13] There are at least three explanations for higher internet prices in advanced economies. On the supply side, labor costs related to digitalization are higher in advanced economies than in emerging market economies and low-income developing countries. Also, the quality of service (for example, broadband) is higher in advanced economies. On the demand side, the willingness to pay is higher in advanced economies than in emerging market economies and in low-income developing countries, given that internet is a more essential service in advanced economies.

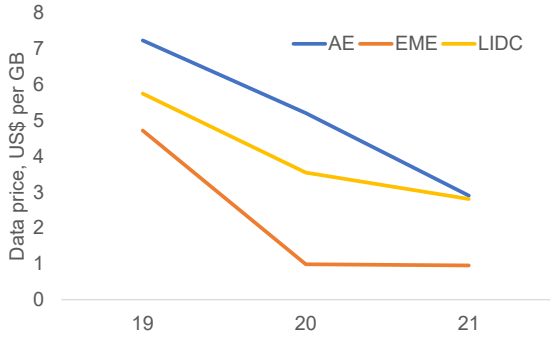
affordability, the average mobile-broadband basket price is nine times higher in low-income developing countries than in advanced economies (Figure 4.3), making it even more difficult for low-income developing countries to bridge the gap in internet access.[14]

Figure 4. Trends in Internet Affordability

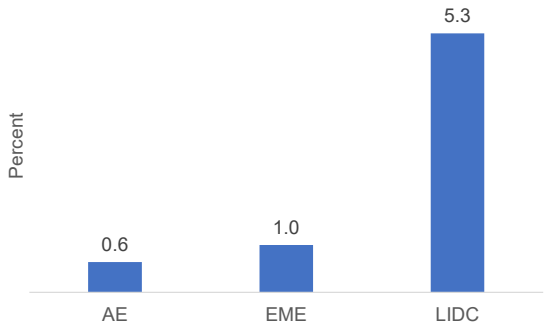
1. Mobile Broadband Price, by Income Group, US Dollars per Month



2. Average Price of 1GB Data, US Dollars



3. **Mobile Broadband Price, by Income Group, Percent of Monthly GNI per Capita (2020)**



Sources: ITU, Cable.co.uk (https://www.cable.co.uk/broadband/pricing/worldwide-comparison/), and IMF staff calculations.

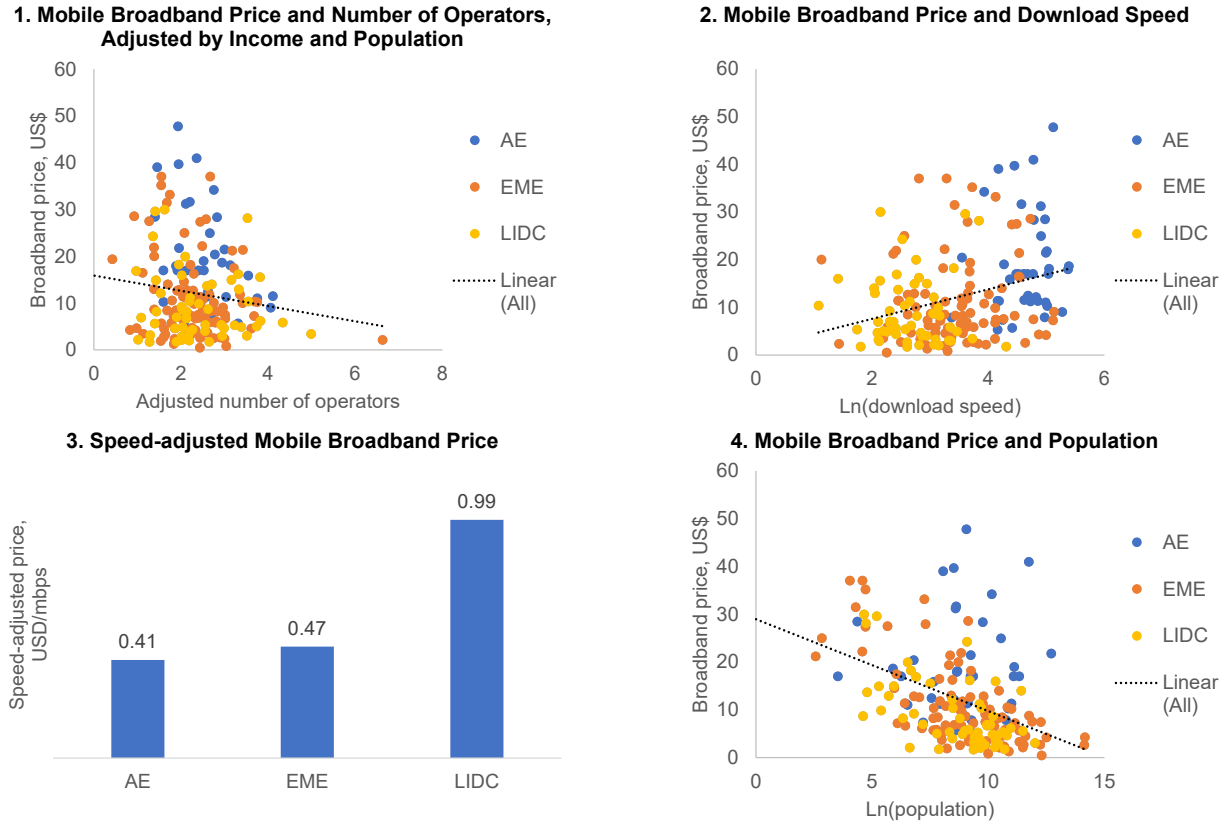
Notes: Information and communications technology prices based on current and historical basket definitions in USD purchasing power parities (PPP) 2020 and as a percent of monthly GNI per capita. Population-weighted average is used. AE = advanced economies; EME = emerging market economies; LIDC = low-income developing countries; GB = gigabytes; GNI = gross national income.

Internet prices appear to be affected by the market structure, the quality of internet services, and the economies of scale.

- *Market structure*. A more concentrated telecom market, rather than a more competitive one, allows broadband service providers to exploit their market power and charge higher prices (Figure 5.1).
- *Quality of internet services.* Nominal prices on broadband are positively correlated with internet quality measured by the download speed (Figure 5.2). The average nominal cost of a broadband package is still significantly higher in low-income developing countries even after adjusting for internet speed (Figure 5.3). As noted above, the difference in prices between low-income developing countries and the other countries is even more pronounced when they are considered relative to average income levels.
- *Economies of scale*. The marginal cost of telecom service tends to decrease with the number of consumers, which implies that a larger market should help lower the internet broadband prices. A negative correlation between the size of population and broadband package prices likely reflects the economies of scale in the sector (Figure 5.4).

[14] Internet prices display a high variation across countries. Future work could investigate the drivers of these cross-country variations.

Figure 5. Internet Prices and Its Correlates, 2020



Sources: ITU, Cable.co.uk (https://www.cable.co.uk/broadband/pricing/worldwide-comparison/), and IMF staff calculations.

Notes: The adjusted number of operators in Figure 5.1 is the residual from the regression of the number of operators on GDP per capita and the log form of population; the constant term is added to the residual. The lines represent the Ordinary Least Squares best fit for 170 countries. AE = advanced economies; EME = emerging market economies; LIDC = low-income developing countries.

IV. Conclusions

The findings here demonstrate that during the COVID-19 pandemic, there was little acceleration in growth in internet access (extensive margin) across all income groups, but improvements were observed in internet speed (intensive margin) for existing users. Additionally, these findings highlight that the affordability of digital services remains a concern for low-income developing countries, even as internet prices decline. This is particularly evident when comparing the average mobile-broadband basket price between low-income developing countries and advanced economies, where the former is substantially higher than the latter. Consequently, low-income developing countries face even greater challenges in addressing the gap in internet accessibility.

Fiscal policy has an important role to play in promoting internet adoption at the individual level and preventing widening of the digital divide (Kumar and others 2023). These policies include, but are not limited to, providing and financing digital infrastructure, subsidizing internet adoption directly and indirectly, and supporting programs for digital literacy.

References

European Commission, Joint Research Centre, Paola Proietti, Patrizia Sulis, Carolina Perpiña Castillo, and others. 2022. "New Perspectives on Territorial Disparities: From Lonely Places to Places of Opportunities." Report JRC126033, Publications Office of the European Union, Luxembourg City.

Gozzi, Nicolò, Niccolò Comini, and Nicola Perra. 2022. "The Adoption of Non-pharmaceutical Interventions and the Role of Digital Infrastructure during the COVID-19 Pandemic in Colombia, Ecuador, and El Salvador." *arXiv.* Accessed February 14, 2023.

Jaumotte, Florence, Longji Li, Andrea Medici, Myrto Oikonomou, Carlo Pizzinelli, Ippei Shibata, Jiaming Soh, and Marina M. Tavares. 2023. "Digitalization during the COVID-19 Crisis: Implications for Labor Markets and Productivity in Advanced Economies." IMF Staff Discussion Note 23/03, International Monetary Fund, Washington, DC.

Kumar, Utkarsh, David Amaglobeli, and Mariano Moszoro. 2023. "Determinants and Social Dividends of Digital Adoption." IMF Working Paper 23/065, International Monetary Fund, Washington, DC.

University of Chicago. 2022. "Internet Equity Initiative." Data Science Institute. Accessed February 28, 2023.

PUBLICATIONS

Internet Adoption Trends during COVID-19

NOTE/2023/001