

A network diagram background consisting of a complex web of thin grey lines connecting various colored dots (red, blue, grey, pink) scattered across the page. The dots represent nodes in a network, and the lines represent connections between them.

AN ECONOMIC ANALYSIS OF
**MOBILE WIRELESS
COMPETITION**
IN THE UNITED STATES

December 2023

An Economic Analysis of Mobile Wireless Competition in the United States¹

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December 11, 2023

¹ I have been asked by CTIA to perform an economic analysis of pricing and performance in the mobile wireless industry in the United States.

I. INTRODUCTION

1. This paper shows that the wireless industry is dynamic, and mobile network operators (MNOs) and mobile virtual network operators (MVNOs) have been making substantial investments year over year in network improvements and offering increasingly attractive and high-quality services at consistently declining prices, all of which generate significant benefits for U.S. consumers. The paper compares the state of the industry today to the state of the industry immediately following the passage of the Telecommunications Act of 1996, finding the industry has evolved substantially since that time.

2. Evaluating these data, the paper documents the extent of competition in the U.S. mobile wireless industry today. Economists evaluate competition by assessing a variety of economic indicators, including output, quality, price and the availability of different options to consumers. Assessing these metrics, I find the wireless industry to be highly competitive, indicating that utility regulation like that found in Title II of the Communications Act is both unnecessary and likely to be a harmful deterrent to future investment and industry performance due to imposed costs and diverted resources.

3. Key findings include:

- 1) *U.S. mobile wireless providers invested more \$364 billion in nominal dollars (\$434 billion in December 2022 dollars) between 2010 and 2022 to improve networks.*
- 2) *Capital investment in cell site densification and coverage increases network capacity and improves network quality.* This led to a 64 percent increase in the number of active cell sites over the past decade. Each of the three main facilities-based carriers offers wireless coverage accounting for at least 98 percent of the population.

- 3) *Providers are investing in deploying 5G quickly.* A recent report from Ookla found that the United States has the highest 5G availability in the world with approximately half of users on 5G-capable devices able to spend the majority of their time on 5G networks. This investment has made the 5G rollout in the United States about 40 percent faster than that of 4G and currently 330 million people are covered with 5G today.
- 4) *Investment also means speeds are up.* Median download speeds have quadrupled over the past seven years and have more than doubled in the past three years.
- 5) *Customers are also using more devices and more data every year.* Overall U.S. mobile wireless traffic grew at a compound annual rate of approximately 55 percent between 2010 and 2022 and overall U.S. mobile subscribers grew at a compound annual rate of approximately five percent between 2010 and 2022. Connected devices and data usage are projected to continue to grow in the years ahead with ongoing development of the Internet of Things (IoT).
- 6) *The price of wireless has been declining for over a decade.* The real (inflation-adjusted) wireless price indices published by the Bureau of Labor Statistics (BLS) have declined by 18 to 19 percent since 2017. Using data from the BLS, I find that the price of wireless has declined over the last 24-month period, while over the same period, once-in-a-generation inflationary pressures have raised the prices of other products by 12 percent.
- 7) *Output is up dramatically since the passage of the Telecommunications Act of 1996.* Since 1996, the number of subscribers has increased by more than 800 percent, substantially exceeding overall population growth. Wireless minutes of use (MOU) increased by more than 4,600 percent. The number of cell sites has increased by more

than 700 percent. All while the average revenue per user (ARPU) has declined by 58 percent over this time period (in real terms).

4. In the remainder of this report, I describe these findings in greater detail. Section II explains that investment and innovation in the industry have led to increasing network performance and increasing output. Section III explains that pricing for wireless plans has declined and a wide variety of pricing plans exist to serve customers with diverse preferences. Section IV explains that the wireless industry has evolved substantially since the passage of the 1996 Telecommunications Act in the presence of light-touch regulation. Finally, Section V explains that the strong industry performance has occurred in part due to the competitive structure of the industry.

II. INDUSTRY INNOVATION AND INVESTMENT HAVE LED TO INCREASING QUALITY AND RISING OUTPUT.

5. The U.S. mobile wireless industry is dynamic, characterized by substantial investment and innovation that have led to vastly improved products that generate greater benefits to users. As I explain below, this innovation and investment have led to decreasing prices, increasing quality, and increasing output. Intense competition between MNOs and from MVNOs is an important driver of these trends. Overall, I find that the wireless industry exhibits strong competitive performance as it features high levels of investment, service improvements (in terms of speed and coverage), declining prices, escalating usage, and expanding competition into new areas.

A. INVESTMENT

6. The provision of mobile wireless services is characterized by large investments necessary to maintain and expand the infrastructure supporting mobile wireless services. Among other

requirements, network operators must obtain licenses to use radio spectrum, build or lease cell sites, purchase the equipment necessary to operate the radio access network (RAN), and develop and maintain the core network.

7. As shown in Figure 1 below, U.S. mobile wireless providers invested a total of nearly \$364 billion in nominal dollars (\$434 billion in December 2022 dollars) between 2010 and 2022, which is an average investment rate of more than \$30 billion/year in nominal dollars (\$36 billion/year in December 2022 dollars) (see Figure 2).² Because these data exclude certain investments, including the costs of spectrum licenses as well as investments by third-party tower operations, backhaul providers, and utility providers, the figures reported here understate, likely substantially, the full amount of investment in the U.S. mobile wireless industry.³ For example, CTIA reports that winning bids on spectrum licenses totaled more than \$233 billion (in nominal dollars) as of year-end 2022.⁴ Similarly, FCC data indicate total cumulative spending on spectrum licenses at more than \$259 billion (in nominal dollars) as of 2022.⁵

² CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 14. See also FCC, “2022 Communications Marketplace Report,” December 31, 2022, FCC GN Docket No. 22-203 (hereinafter *FCC 2022 Communications Marketplace Report*), § III.A.5.a.

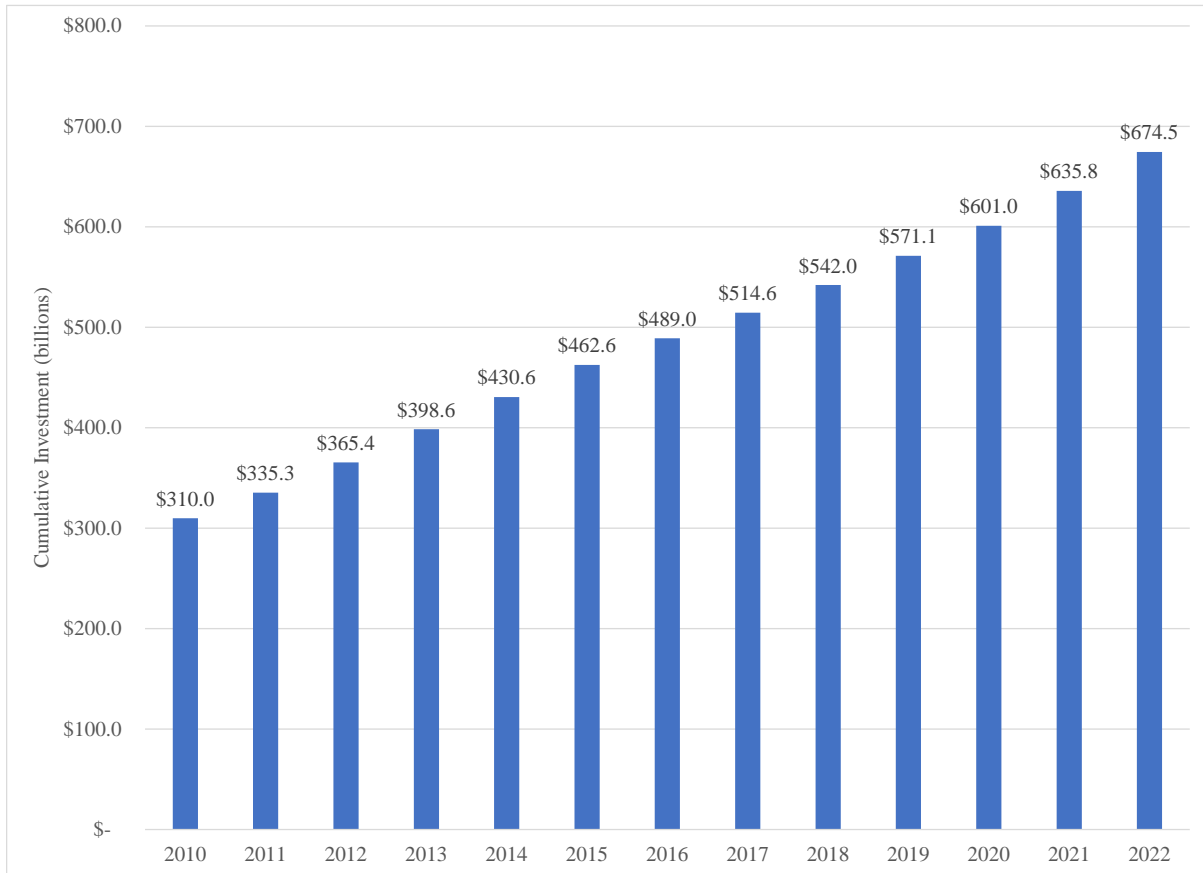
CTIA expresses the investment in nominal dollars.

³ CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, p. 47 (The CTIA data “excludes the cost of licenses used to deliver wireless service, whether acquired at private or public auctions, or via other acquisition processes.” In addition, “investment by third-party tower erectors, and non-carrier owners or managers of networks, is not tracked by or reflected in CTIA’s survey.”).

⁴ FCC, “Federal Communications Commission 2024 Budget-In-Brief,” March 2023, p. 37, available at <https://docs.fcc.gov/public/attachments/DOC-391614A1.pdf>.

⁵ FCC, “Auctions Summary,” September 14, 2022, available at <https://www.fcc.gov/auctions-summary>.

Figure 1: Mobile Wireless Investment (Cumulative) (2010-2022)



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 14.

Figure 2: Mobile Wireless Investment (Annual) (2010-2022)



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 16.

8. These large investments in part reflect the fact that mobile wireless networks are costly to deploy and maintain. But, as I explain further below, mobile wireless providers have not just *maintained* their networks, they have consistently *improved* the quality of their networks, in part due to competitive imperatives.⁶ They have done so both through investing in successive generations of technologies and through more incremental improvements such as densifying cell site networks in order to increase network capacity, resiliency, and performance. These

⁶ See, e.g., Linda Hardesty, “T-Mobile’s Mike Sievert updates on 5-year business plan,” December 7, 2022, available at <https://www.fiercewireless.com/wireless/t-mobiles-mike-sievert-updates-5-year-business-plan> (describing network quality competition between MNOs).

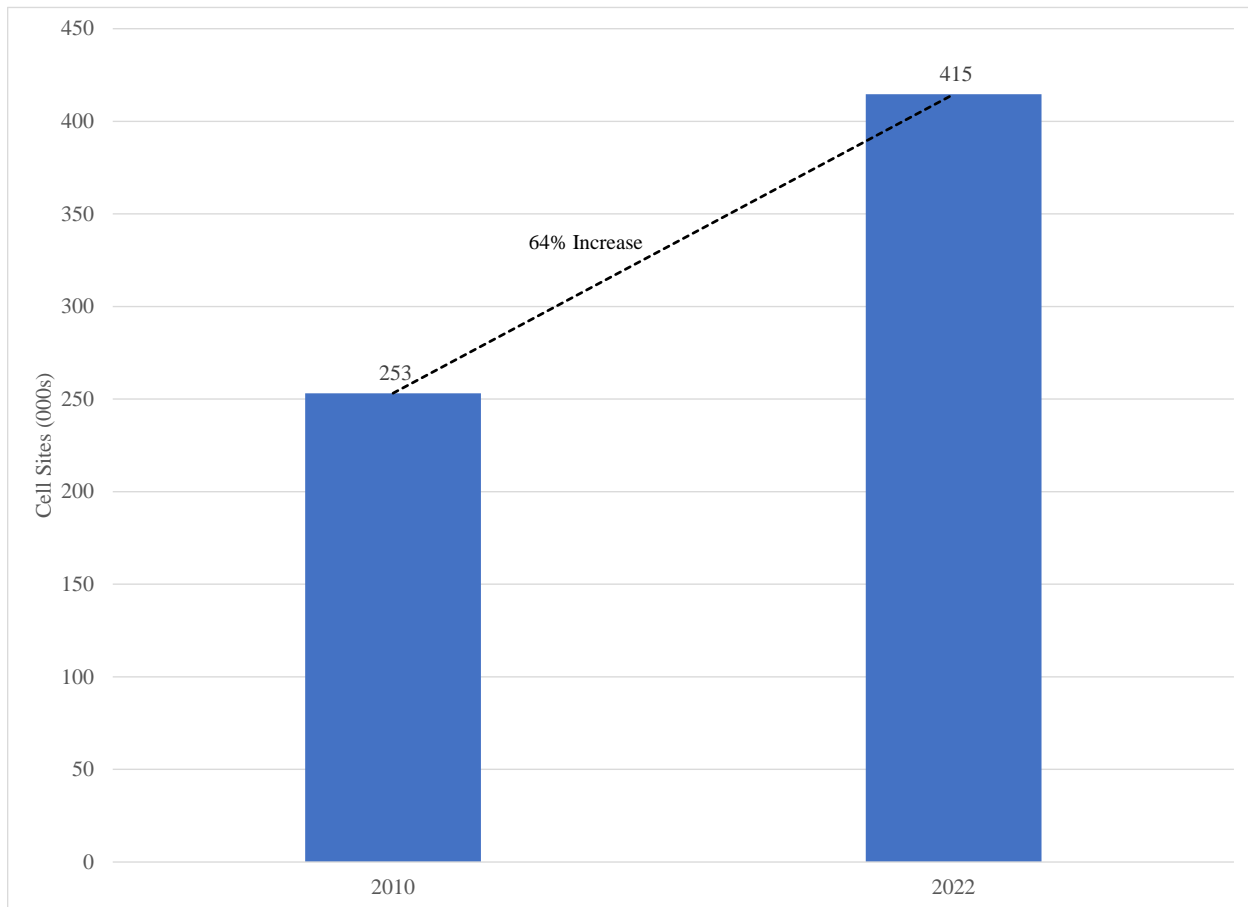
investments have led to the more efficient use of scarce resources. For example, wireless providers are using their spectrum assets more efficiently by “refarming” their spectrum—repurposing assets from older generations of wireless technologies to newer, more spectrally efficient generations of wireless technology.⁷

9. The substantial investment that mobile wireless carriers and other industry participants have made is reflected in the concrete expansion of networks. For example, as shown in Figure 3 below, investment in cell site densification and coverage, which increases network capacity and improves network quality, has led to a 64 percent increase in the number of active cell sites since 2010.⁸

⁷ For example, 5G is expected to be 23 times more spectrally efficient and 156,000 times faster than 2G. (CTIA, “What to Know About the Sunsetting of 2G/3G Networks in Preparation for 5G,” *available at* <https://www.ctia.org/what-to-know-about-the-sunsetting-of-2g-3g-networks-in-preparation-for-5g>.)

⁸ As described in note 3 above, because network operators typically lease cell sites and treat the associated costs as operating expenditures rather than capital expenditures, not all investment in cell sites is reflected in the numbers that I report above.

Figure 3: Cell Sites (2010-2022)



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Chart 19.

B. NETWORK EVOLUTION

10. Early mobile networks provided limited bandwidth and consequently could support only very basic talk and text services. For example, first-generation mobile networks offered speeds of less than five kbps. As networks expanded capacity, by adding new cell sites, additional spectrum, and more efficient technology, speeds improved. For example, 5G wireless networks are capable of delivering peak speeds up to 20 Gbps and average speeds of greater than 100 Mbps.⁹ Speeds of this magnitude are sufficient to accommodate a wide variety of services,

⁹ Qualcomm, “Everything you need to know about 5G,” available at <https://www.qualcomm.com/5g/what-is-5g>.

including the mobile web and a large assortment of mobile applications, which have created tremendous value for consumers and for the economy. By some estimates, the global mobile app economy has generated more than \$6 trillion dollars of value and approximately \$700 billion per year in revenue.^{10, 11}

11. Carriers' investments in network evolution, including stepwise improvements from generation to generation of wireless network technology, have allowed mobile network operators to make increasingly efficient use of scarce resources such as spectrum. For example, during the 4G Decade, spectral efficiency (measured as amount of data consumed per megahertz of licensed spectrum) increased by a multiple of 42.¹²

12. Wireless carriers are now investing heavily in the deployment of 5G technology, to complement their robust 4G networks. 5G network technology and related technologies such as Massive MIMO offer a variety of advantages over traditional 4G network technology, including greater spectral efficiency (and thus more efficient use of scarce resources), higher speeds, and lower latency. 5G networks also facilitate greater decoupling of network software and hardware through software-defined networks, network function virtualization, and virtualized RAN. These

¹⁰ "The State of the App Economy and App Markets in 2022," *42matters*, September 30, 2022, available at <https://42matters.com/blog/?p=the-state-of-the-app-economy-and-app-markets> (citing research by Statista).

¹¹ The smartphone app development industry has contributed an estimated combined total \$1.4 trillion in gross output in the US between 2011 and 2020. (Compass Lexecon, "The Importance of Licensed Spectrum and Wireless Telecommunications to the American Economy," December 7, 2022, available at <https://api.ctia.org/wp-content/uploads/2022/12/Compass-Lexecon-Licensed-Spectrum-Report.pdf>, p. 30.)

¹² CTIA, "Smarter and More Efficient: How America's Wireless Industry Maximizes Its Spectrum," July 2019, available at https://api.ctia.org/wp-content/uploads/2019/07/Spectrum_Efficiency.pdf, p. 3.

technologies enable the network simultaneously to optimize for multiple use cases with varying demands, thus making more efficient use of network resources and enabling new use cases.

13. Wireless carriers are in the midst of deploying 5G network assets. A recent report from Ookla found that the United States has the highest 5G availability in the world with approximately half of users on 5G-capable devices able to spend the majority of their time on 5G networks.¹³ Ongoing investment in 5G networks can be expected to increase both network coverage and performance. This investment has made the 5G rollout in the United States about 40 percent faster than that of 4G¹⁴ and 330 million people are covered with 5G today.¹⁵ By 2027, Ericsson projects that approximately 90 percent of mobile subscriptions in North America will be 5G capable.¹⁶

14. The enhanced performance that 5G technology enables can be expected to support further innovations in the wireless ecosystem that create value for consumers and society. For example, 5G technology is enabling new use cases in a variety of industries, including:¹⁷

¹³ Ookla, “Growing and Slowing: The State of 5G Worldwide in 2021,” December 20, 2021, *available at* <https://www.speedtest.net/insights/blog/state-of-worldwide-5g-2021/>.

¹⁴ CTIA, “Maintaining America’s 5G Leadership,” February 25, 2022, *available at* <https://www.ctia.org/news/maintaining-americas-5g-leadership>.

¹⁵ T-Mobile Press Release, “T-Mobile’s Ultra Capacity 5G Covers 300 Million People Months Ahead of Schedule,” October 24, 2023, *available at* <https://www.t-mobile.com/news/network/t-mobiles-ultra-capacity-5g-covers-300-million-people-months-ahead-of-schedule>. See also, *FCC 2022 Communications Marketplace Report*, § II.B.5.b.

¹⁶ Ericsson, “Ericsson Mobility Report,” June 2022, *available at* <https://www.ericsson.com/49d3a0/assets/local/reports-papers/mobility-report/documents/2022/ericsson-mobility-report-june-2022.pdf>, Figure 4.

¹⁷ CTIA, “The 5G Innovators: Entrepreneurs Leveraging 5G Platform.”

- **Agriculture:**¹⁸ crop management, irrigation, pest control, and soil analysis.
- **Education:** learning apps, augmented and virtual reality (AR and VR), and other immersive experiences.
- **Entertainment and Gaming:** AR and VR, live multi-player gaming, and live music and event streaming.
- **Healthcare:** wearable sensors, medical simulators, data and imaging analysis.
- **Manufacturing:** employee training, digital tracking, automated procedures, and environmental monitoring.
- **Office and Retail:** virtual meetings, contactless shopping, and facilitating operational efficiencies and customer experiences.
- **Public Safety:**¹⁹ safety equipment, threat detection, and VR training environments.
- **Smart Cites, Buildings, and Energy:** traffic flow and safety, use of drones in construction processes, and real-time monitoring of critical infrastructure.

¹⁸ See, for example, Verizon, “5G in agriculture: How smart farming is transforming the oldest industry,” March 3, 2022, *available at* <https://www.verizon.com/about/news/5g-in-agriculture-smart-farming-transforming-industry> (The higher speed and lower latency of 5G can enable near real-time data transfer, which helps to ensure the safe use of robotics to improve the efficiency of crop management. Paired with reliable cellular connectivity and IoT technology, 5G can help “agritech” achieve its ultimate goal—to make farmers’ work easier and more informed.”).

¹⁹ See, for example, 5G First Responder Lab, “Stories of Innovation: A new age of life saving capabilities,” *available at* <https://www.5gfirstresponderlab.com/5gimpact/> (“High bandwidth from 5G increases the quality of Asylon’s autonomous drone video streams, allowing system operators to gather actionable intelligence faster for improved threat detection & identification”; “Low latency from 5G allows PIXO to simultaneously train multiple people in a Virtual Environment from anywhere in the world; empowering complex life-saving operations.”).

- **Sports:** immersive experiences, smart sensors and wearables, and real-time analytics and visualizations.
- **Transportation and Logistics:** autonomous vehicles, fleet management, and vehicle connectivity.

15. A recent study by Accenture found that “5G-enabled use cases [are] projected to make up to a 20% contribution toward the country’s carbon emission reduction targets by 2025” by, among other things, improving efficiency in transportation, manufacturing, and building energy management.²⁰

C. NETWORK PERFORMANCE

16. One of the benefits of the mobile wireless industry’s substantial innovation and investments in mobile wireless networks and related technologies has been rapidly increasing realized speeds. As shown in Figure 4 below, median download speeds have approximately quadrupled over the past seven years and have doubled in the past three years.²¹ Higher speeds support enhanced user experience for existing applications (e.g., web pages load more quickly and files download faster) and facilitate new applications that were not previously feasible. Both generate tremendous value for consumers. For example, an academic study found that increases in download speeds of one Mbps increase consumer welfare by, on average, \$2 per customer per

²⁰ Accenture, “5G-Enabled Technologies Could Solve for One-Fifth of U.S. Climate Change Target by 2025, New Study Finds,” January 26, 2022, *available at* <https://newsroom.accenture.com/news/5g-enabled-technologies-could-solve-for-one-fifth-of-us-climate-change-target-by-2025-new-study-finds.htm>; Accenture, “5GConnectivity: A Key Enabling Technology To Meet America’s Climate Change Goals,” January 26, 2022, *available at* <https://www.ctia.org/news/5g-connectivity-a-key-enabling-technology-to-meet-americas-climate-change-goals>.

²¹ See also *FCC 2022 Communications Marketplace Report*, ¶ 141 (“the median 4G LTE download speed increased from 11.0 Mbps to 30.24 Mbps, an increase of approximately 176%” from 2014 to the first half of 2022).

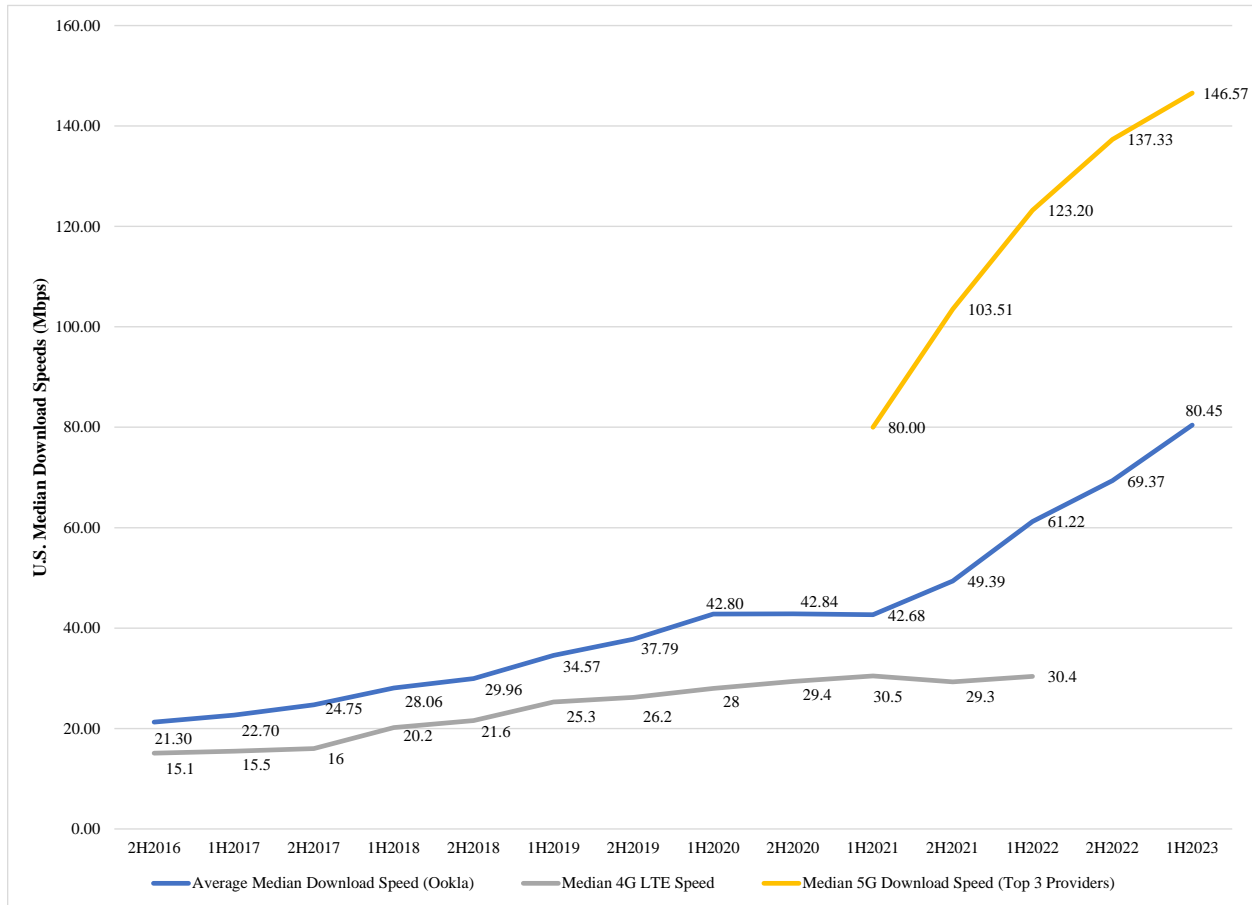
month.²² Increases in mobile wireless speeds over time have been much greater than one Mbps, indicating that network investment has created substantially more value. Today, 15 percent of Americans use mobile wireless as their only source of broadband. And, among those households that do not have home internet service, 45 percent say that their smartphone provides sufficient online access.²³ As providers continue to roll out 5G, they are starting to offer mobile speeds that rival traditional home broadband. For example, T-Mobile has announced that it has achieved download speeds in excess of three Gbps in a test environment.²⁴ As wireless network speeds continue to improve, wireless services will offer even greater competition for wireline networks and greater value for consumers.

²² Aviv Nevo, John L. Turner, and Jonathan W. Williams (2016), “Usage-Based Pricing and Demand for Residential Broadband,” *Econometrica*, **84**(2): 411-443, p. 434. Although the study is based on data for wireline networks, it illustrates the point that improvements in network speed create value for consumers.

²³ Andrew Perrin, “Mobile Technology and Home Broadband 2021,” *Pew Research Center*, June 3, 2021, available at <https://www.pewresearch.org/internet/2021/06/03/mobile-technology-and-home-broadband-2021/>.

²⁴ Deanna Ritchie, “3.3Gbps? T-Mobile’s 5G is Faster Than Your Home Internet,” *readwrite*, July 27, 2023, available at <https://readwrite.com/3-3gbps-t-mobiles-5g-is-faster-than-your-home-internet/>; *FCC 2022 Communications Marketplace Report*, ¶ 118.

Figure 4: Mobile Wireless Network Speeds



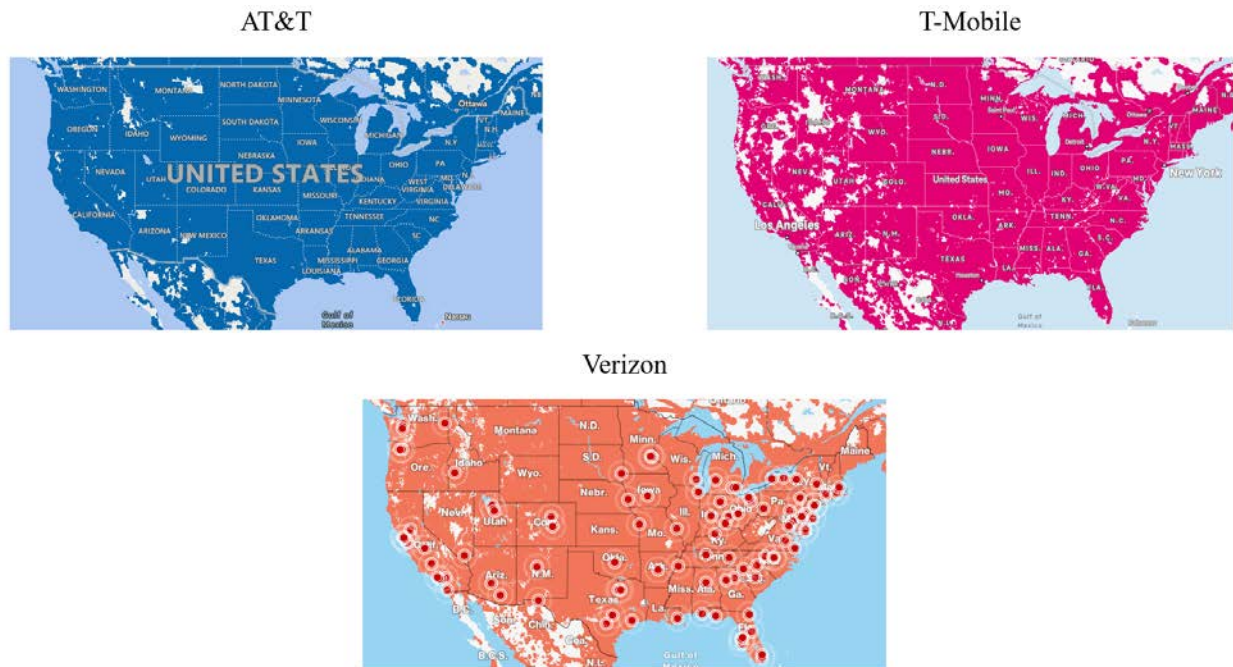
Sources: FCC, “2022 Communications Marketplace Report,” December 30, 2022, Figure II.B.30; Speedtest, “United States’ Mobile and Fixed Broadband Internet Speeds,” available at <https://www.speedtest.net/global-index/united-states?mobile#market-analysis>.

Notes: [1] 5G Median speeds are based on the quarterly average median speeds of the top 3 providers’ (AT&T, Verizon Wireless and T-Mobile) plans analyzed by Ookla. [2] The half-yearly values are based on the 6-month averages of the monthly median download speeds available in the Ookla data. [3] The “Average Median Download Speed (Ookla)” series is inclusive of 4G and 5G speeds and is based on US mobile download speeds available on Ookla. Historical data prior to 2H2022 is sourced from the internet archive. [4] Median 4G LTE Speed based on Figure II.B.30 of the FCC 2022 Communications Marketplace Report. [5] The 5G median download speeds for the top 3 providers are based on the medians provided in the “5G Performance” section of the US Mobile webpage on the Speedtest website. Historical data prior to 2H2022 is sourced from the internet archive.

17. Network coverage is an important aspect of availability. A high-quality network does consumers little good if they cannot access it. Increasing coverage requires investment in both spectrum and cell sites. As shown in Figure 5 below, the main facilities-based carriers have invested in nationwide coverage and now offer nearly ubiquitous coverage across the country.

Each of the three main facilities-based carriers offers wireless coverage accounting for at least 98 percent of the population.²⁵ DISH has also been actively building out its 5G network nationwide.

Figure 5: Mobile Wireless Coverage Maps



Sources: AT&T, “Wireless Coverage,” available at <https://www.att.com/maps/wireless-coverage.html>; T-Mobile, “5G & 4G Coverage map,” available at <https://www.t-mobile.com/coverage/coverage-map>; Verizon, “Explore Verizon 5G and 4G LTE network coverage in your area,” available at <https://www.verizon.com/coverage-map/>.

18. 5G rollout in the United States has been swifter than 4G deployment and has been associated with faster internet speeds and more subscriptions. Statistics from CTIA confirm that

²⁵ See e.g., T-Mobile, “5G & 4G Coverage map,” available at <https://www.t-mobile.com/coverage/coverage-map> (stating “98% of Americans have access to T-Mobile 5G today”); Verizon, “Explore Verizon 5G and 4G LTE network coverage in your area,” available at <https://www.verizon.com/coverage-map/> (“Our 4G LTE network covers more than 2.68 million square miles, 327 million people and over 99% of the U.S. population — and continues to expand”); CoverageMap.com, “AT&T Coverage Map,” November 20, 2023, available at <https://coveragemap.com/coverage-map/att> (“The AT&T 4G LTE network is the largest network in the United States, covering 57.0% of the land area in the country and over 99% of Americans”); Open Signal, “USA 5G Experience Report,” July 2023, available at <https://www.opensignal.com/reports/2023/07/usa/mobile-network-experience-5g..>

it took approximately 22 months for AT&T, T-Mobile, and Verizon to each cover approximately 200 million people with 5G compared to approximately 38 months with 4G—approximately 42 percent faster deployment.²⁶ Additionally, 5G’s speeds were 16 times faster than 4G’s speeds 16 months after launch. In terms of subscription quantity, 5G had about 50 million subscribers two years after its launch compared to 38.6 million 4G subscribers two years after 4G’s launch.²⁷ 5G currently covers an estimated 330 million people.²⁸

D. CONSUMPTION LEVELS

19. The enormous investments and resulting increases in mobile wireless quality have created the basis for an entire ecosystem, and the resulting innovation by platforms, app developers, and content creators has enabled and incentivized consumers to increase their data consumption, with large increases in subscribers and, especially, total traffic.

20. Perhaps the most striking feature of the recent history of the mobile wireless industry has been the tremendous growth in traffic volume. Figure 6 below shows that overall U.S. mobile wireless traffic grew at a compound annual rate of approximately 55 percent between 2010 and 2022.²⁹ Total mobile wireless traffic was more than 188 times greater in 2022 than in 2010.

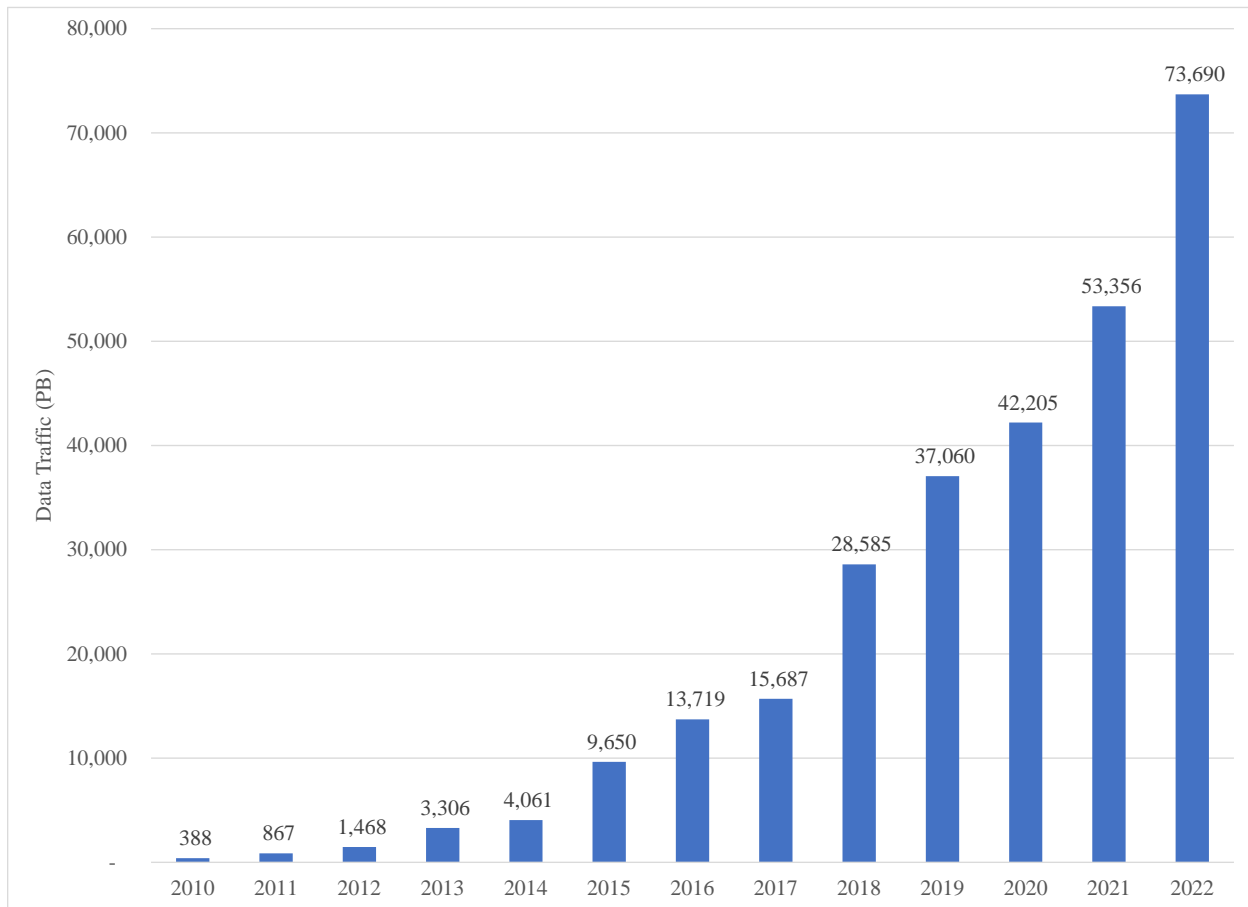
²⁶ CTIA, “5G Rollout Faster Than 4G.”

²⁷ CTIA, “5G Rollout Faster Than 4G.”

²⁸ T-Mobile Press Release, “T-Mobile’s Ultra Capacity 5G Covers 300 Million People Months Ahead of Schedule,” October 24, 2023, *available at* <https://www.t-mobile.com/news/network/t-mobiles-ultra-capacity-5g-covers-300-million-people-months-ahead-of-schedule>.

²⁹ CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Chart 1.

Figure 6: U.S. Mobile Wireless Traffic



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Chart 1.

21. This growth has been driven by both increases in the numbers of subscribers and by increases in usage per subscriber, although the importance of each component has changed over time. In the early years of the industry, much of the growth in traffic was due to increasing numbers of cell phone users. More recently, traffic growth has been driven by large increases in usage per subscriber.

22. Figure 7 below shows that overall U.S. mobile subscribers grew at a compound annual rate of approximately five percent between 2010 and 2022. Although penetration (devices per capita) exceeds 100 percent, this growth has continued as customers add more devices. For example, CTIA data shows that total wireless penetration (defined as the ratio of total wireless

subscriptions to population) was 155 percent and has been increasing at a steady rate for more than a decade.³⁰ Similarly, Cisco projected that mobile users as a percent of the population would increase from 87 to 89 percent between 2018 and 2023 and that the number of mobile devices per capita will increase from 1.7 to 3.4 over the same time period.³¹

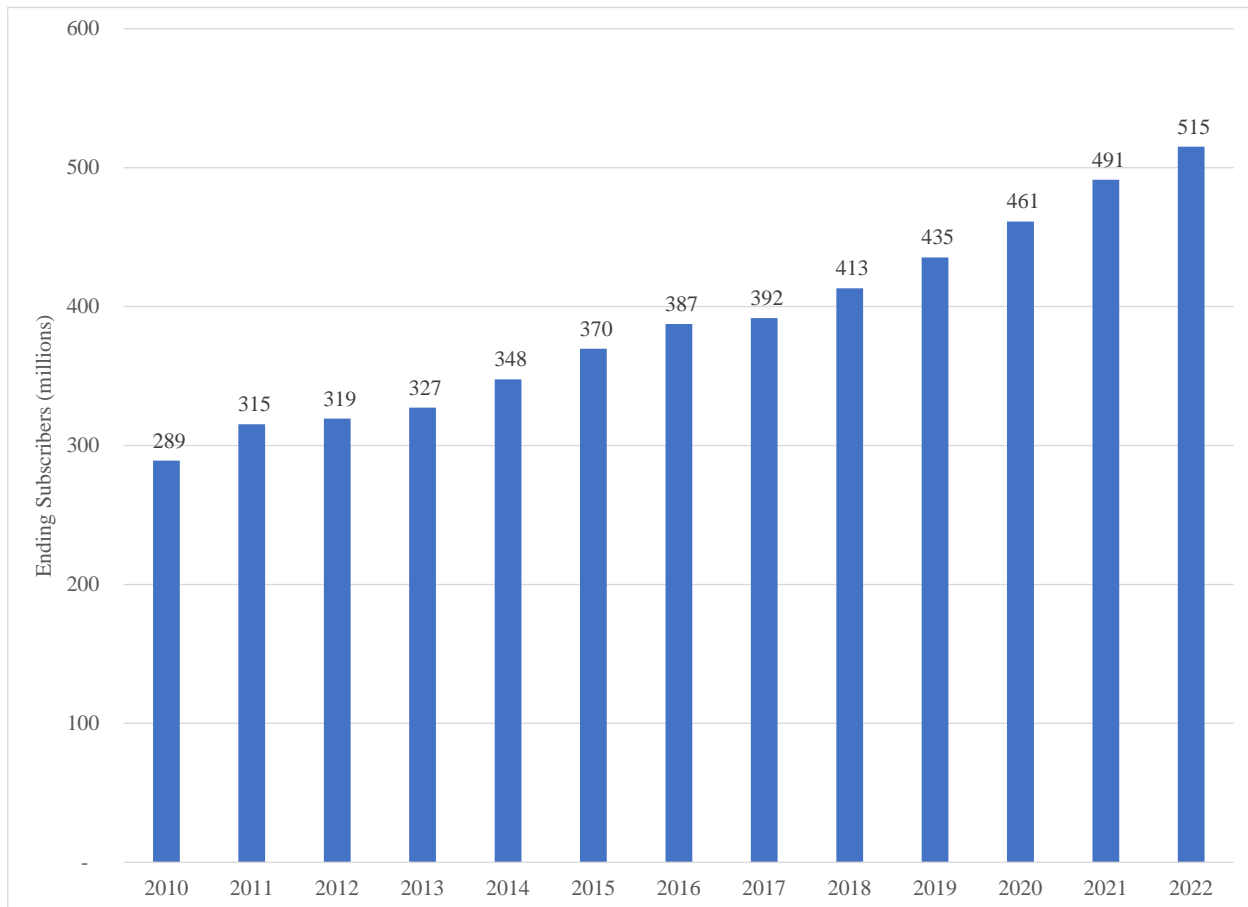
23. Enhanced mobile networks also facilitate the increasing use of IoT devices that facilitate machine-to-machine (M2M) communications. For example, Cisco projected that M2M devices would increase by nearly 250 percent between 2018 and 2023 and support applications such as connected homes (home automation, home security and video surveillance, connected white goods, and tracking applications), connected cars (fleet management, in-vehicle entertainment systems, emergency calling, internet, vehicle diagnostics and navigation), connected cities, and other applications such as smart meters, video surveillance, healthcare monitoring, transportation, and package or asset tracking.³²

³⁰ CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 6 and Chart 9.

³¹ Cisco, “Cisco Annual Internet Report Highlights Tool,” *available at* <https://www.cisco.com/c/en/us/solutions/executive-perspectives/annual-internet-report/air-highlights.html#> (estimating that “there will be 299.0 million total mobile users (89% of population) by 2023, up from 285.3 million (87% of population) in 2018” and that “there will be 3.4 mobile connected devices per capita by 2023, up from 1.7 per capita in 2018.”).

³² Cisco, “Cisco Annual Internet Report (2018–2023),” March 9, 2020, *available at* <https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html>, § 1.C.

Figure 7: U.S. Mobile Wireless Connections (Reported)

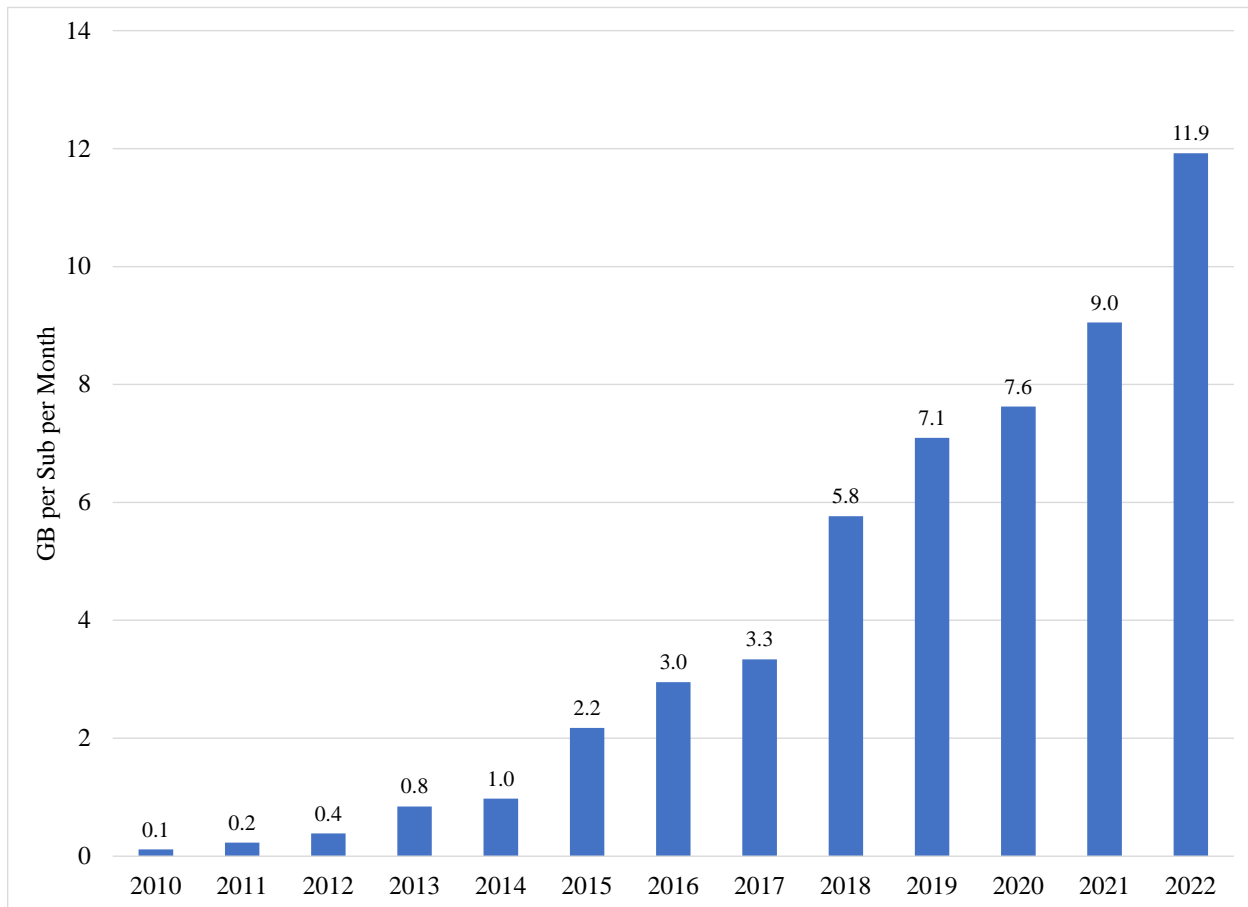


Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 2.

24. Evan as subscribers have increased, data usage per subscriber has grown much more quickly. Figure 8 shows that data usage per subscriber increased at a compound annual rate of 48 percent between 2010 and 2022. Moreover, increases in data usage are expected to continue. For example, Ericsson projects that mobile data traffic per smartphone is expected to grow at a compounded annual rate of 20 percent between 2022 and 2028.³³

³³ Ericsson, “Ericsson Mobility Report,” June 2023, available at <https://www.ericsson.com/49dd9d/assets/local/reports-papers/mobility-report/documents/2023/ericsson-mobility-report-june-2023.pdf>, Figure 20 (data for North America).

Figure 8: Data Usage per Subscriber (GB/Sub/Month)



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Chart 1 and Table 2.

E. FIXED WIRELESS ACCESS

25. Wireless providers are also making use of their competitive spirit and investment to introduce even greater competition into the home broadband industry by offering LTE- and 5G-based fixed wireless access (FWA) home broadband services. In particular, firms offering mobile data services (e.g., AT&T, T-Mobile, Verizon Wireless, DISH and UScellular) are also offering products specifically designed as replacements for wireline home internet services.³⁴ 5G

³⁴ *FCC 2022 Communications Marketplace Report*, ¶ 165 (“Technological advancements and entry from non-traditional providers of mobile broadband and fixed broadband could alter the relationship between fixed and mobile broadband services. Two such developments are the transition to 5G technologies and entry by cable companies into the mobile broadband market.”).

FWA is growing rapidly with fixed wireless services accounting for 90 percent of the broadband net adds in 2022 compared to only accounting for 20 percent of the net adds in 2021.³⁵ By some estimates, 5G FWA is already available to more than 98 million households.³⁶

26. As described above, all major U.S. mobile wireless carriers (including DISH³⁷) are in the midst of deploying 5G networks. Relative to LTE, 5G networks offer greater capacity, higher speeds, and lower latency.³⁸ These quality improvements promise to make wireless networks an even more robust competitor in home internet services.

27. T-Mobile sells a 5G-based, fixed wireless, home internet product. T-Mobile's 5G Home Internet product typically offers download speeds between 72-245 Mbps with no data usage caps for \$30-\$50/month (depending on what other products the customer purchases).³⁹ As of this writing, it is available to approximately 50 million homes in hundreds of cities and towns and has approximately 3.7 million customers.⁴⁰ This widespread availability of T-Mobile's fixed

³⁵ See, Leichtman Research Group Press Release, "About 3,500,000 Added Broadband From Top Providers in 2022," March 2, 2023, *available at* <https://leichtmanresearch.com/about-3500000-added-broadband-from-top-providers-in-2022/>.

³⁶ New Street Research, "The Fixed Wireless Broadband Footprint," July 23, 2023.

³⁷ Monica Allevan, "Dish gets FCC's blessing on 5G buildout commitments," October 2, 2023, *Fierce wireless*, *available at* <https://www.fiercewireless.com/5g/dish-gets-fccs-blessing-5g-buildout-commitments>.

³⁸ FCC, "5G FAQs," *available at* <https://www.fcc.gov/5g-faqs>.

³⁹ T-Mobile, "Home Internet," *available at* <https://www.t-mobile.com/isp>.

Customers ineligible for T-Mobile's 5G Home Internet may be able to access 4G LTE Home Internet.

⁴⁰ Trey Paul, "T-Mobile Home Internet: Can It Handle Your Home Broadband Needs," *CNET*, August 8, 2023, *available at* <https://www.cnet.com/home/internet/t-mobile-5g-home-internet-review/>; Geraldine Orentas, "T-Mobile Home Internet Review: Plans, Prices And Speed 2023," *Forbes*, July 11, 2023, *available at* <https://www.forbes.com/home-improvement/internet/t-mobile-home-internet-review/>; T-Mobile, "T-Mobile Delivers Industry-Leading Growth in Customers and Profitability in Q2 2023, Raises 2023 Guidance Again," July 27, 2023, *available at* <https://www.t-mobile.com/news/business/t-mobile-q2-2023-earnings>.

wireless product makes it the provider with the largest footprint of fixed broadband.⁴¹ Recent statements by T-Mobile executives indicate that it anticipates serving as many as seven to eight million customers by 2025.⁴² T-Mobile has also indicated that it can offer the service in many areas at very low incremental cost by utilizing otherwise-unused capacity created as part of its

⁴¹ *FCC 2022 Communications Marketplace Report*, ¶ 27. (“T-Mobile covered approximately 60% of the U.S. population through their fixed wireless technology, making it the provider with the largest footprint of fixed broadband.”)

⁴² T-Mobile US, Inc. (TMUS) CEO Mike Sievert on Q1 2022 Results, Earnings Call Transcript, April 27, 2022 (“... [B]ecause we're deployed nationally with fixed wireless, really the customers are coming from everywhere. You're seeing customers in top 100 where we are now providing a competitive choice to cable. You're seeing them in Smyrna, where oftentimes we're the only high-speed wireless alternatives in those communities. You're seeing good growth in business. So it's really across the board. And our growth is following the network expansion that Neville just talked about. So as the network expands and we have more capability, we have more sectors with capacity, we'll continue to see growth. All of that combined puts us on a really good trajectory to the 7 million to 8 million customers we talked about in 2025.”); T-Mobile, “T-Mobile Smokes the Competition, Reaching 1 Million Fixed Wireless Customers Just a Year After Commercial Launch,” April 20, 2022, *available at* <https://www.t-mobile.com/news/network/t-mobile-reaches-1-million-fixed-wireless-customers>.

mobile wireless network build-out.⁴³ T-Mobile offers fixed wireless service in rural, suburban, and urban areas.⁴⁴

28. Verizon is currently selling two wireless home internet products. Verizon's LTE Home Internet product offers 25-50 Mbps download speeds with no data usage caps for \$50/month with

⁴³ T-Mobile US, Inc. (TMUS) CEO Mike Sievert on Q1 2022 Results, Earnings Call Transcript, April 27, 2022 (“What’s fascinating about this business is we are able to offer it nationwide now across 40 million homes and compete in a relatively even basis in all parts of this country because our go-to-market plan is based on an excess capacity model. And so we aren’t dedicating large sums of capital to this business. Instead, our algorithms look at normal mobile usage that’s rapidly growing because of the strength of our 5G network and we expect will continue to rapidly grow. We also expect we will continue to take share. We model all that forward and find the pockets where even all those extra customers and all their extra mobile usage won’t soak up the capacity of this remarkable network. That’s where we approve applicants for 5G home broadband.”); T-Mobile US, Inc. (TMUS) Management Presents at Oppenheimer 5G Summit, Transcript, December 15, 2020 (Neville Ray (President of Technology) (“...the cost to go after that [5G, fixed wireless] space has very, very little incremental capital, because we’re building the network for that wireless need. And we have a surfeit of capacity in many areas that we can now purpose to new growth opportunities.”)); T-Mobile US, Inc. (TMUS) CEO Mike Sievert on Q3 2020 Results, Earnings Call Transcript, November 6, 2020 (“But you think about the capacity of this network that Neville is building, and the fact that all of the capital for that network is paid for by the mobile business, that means we have an ability to serve customers with 5G home Internet really cost-effectively because the network is basically already built. And there are places all across this country where no normal amount of mobile usage will soak up all of that massive capacity and that’s where we’ll be able to offer incredible deals on 5G-powered home Internet. And you don’t need a ditch dug to your house, you don’t need to use old DSL copper wires, you’re going to be able to experience 5G, which is many times faster than, for many people, in today’s home Internet connections even in well-served neighborhoods.”).

⁴⁴ T-Mobile US, Inc. (TMUS) CEO Mike Sievert on Q4 2021 Results, Earnings Call Transcript, February 3, 2022 (“So, I mean, the great thing about our position here and what Neville and his team have built is we’re all across the country in all different markets, all different types of markets. And we’re seeing wins -- customer wins across all of those. So, we’re certainly seeing a small percentage of people who have never had wireless before coming to us. And we certainly do very well. And as you would imagine, in rural and small-town America where they have either no or a choice and that choice isn’t very good, and so we’re doing well there. The thing that’s been also validating for us is that we are also winning well in urban and suburban markets. In fact, the majority of our customers come from suburban and urban markets, and the majority of those are coming from cable and fiber, and other things.”); T-Mobile US, Inc. TMUS.OQ - T-Mobile US Inc at UBS Global TMT Conference (Virtual), Edited Transcript, December 8, 2020 (Mike Sievert (CEO) (“And it’s something that our business plan is very focused on, both in suburban and rural areas. I can’t parse that one for you. The opportunity is really regardless of urbanicity. There will be places in urban markets where we play as well.”)).

AutoPay.⁴⁵ It is currently available in parts of over 200 markets in 50 states.⁴⁶ Reflecting the higher quality of 5G networks relative to LTE networks, Verizon’s 5G Home product offers download speeds up to 300 Mbps for \$50/month with AutoPay, and Verizon’s 5G Home Plus product offers download speeds of 300-1,000 Mbps for \$70/month with AutoPay.⁴⁷ Verizon is in the process of deploying its 5G Home Internet product, and it is currently available to more than 30 million households in approximately 900 cities.⁴⁸ As of the third quarter of 2023, Verizon has 1.64 million consumer fixed wireless connections and 1.03 million business fixed

⁴⁵ Verizon, “LTE Home Internet,” *available at* <https://www.verizon.com/home/lte-home-internet/>.

Verizon charges \$50/month to non-Verizon mobile customers enrolled in AutoPay and paper-free billing, \$25/month to Verizon mobile customers with select Verizon Mobile Unlimited plans and enrolled in AutoPay and paper-free billing, and \$40/month to Verizon mobile customers on any other Verizon Mobile plan of \$30/month or more and enrolled in AutoPay and paper-free billing. AutoPay and paper-free billing account for \$10/month savings.

⁴⁶ Joan Engebretson, “Verizon Fixed Wireless Starting to Get Into a Groove,” October 20, 2021, *Telecompetitor*, *available at* <https://www.telecompetitor.com/verizon-fixed-wireless-starting-to-get-into-a-groove/>.

⁴⁷ Verizon, “5G Home Internet,” *available at* <https://www.verizon.com/5g/home/>; Verizon, “Important Information About Verizon Wireless Broadband Internet Access Services,” January 5, 2022, *available at* <https://www.verizon.com/support/broadband-services/>.

Download speeds listed are for the 5G Internet Gateway. With the Verizon Internet Gateway, download speeds for 5G Home and 5G Home Plus are 85-300 Mbps (Verizon, “Important Information About Verizon Wireless Broadband Internet Access Services,” January 5, 2022, *available at* <https://www.verizon.com/support/broadband-services/>). Verizon charges \$50/month for 5G Home (\$70/month for 5G Home Plus) to non-Verizon mobile customers enrolled in AutoPay, \$25/month for 5G Home (\$35/month for 5G Home Plus) to Verizon mobile customers with select Verizon 5G Mobile plans and AutoPay, and \$40/month for 5G Home (\$50/month for 5G Home Plus) to Verizon mobile customers with any other Verizon Mobile plan of \$30/month or more and AutoPay. AutoPay accounts for \$10/month savings.

⁴⁸ Verizon, “Verizon’s wireless Internet service now covers 30+ million homes and 2+ million businesses,” February 14, 2022, Press Release, *available at* <https://www.verizon.com/about/news/homes-businesses-verizons-wireless-internet-services>; Trey Paul, “Verizon 5G Home availability expands to 900 cities,” January 25, 2022, *CNET*, *available at* <https://www.cnet.com/home/internet/verizon-5g-home-availability-expands-to-900-cities/>.

wireless connections.⁴⁹ Verizon has indicated that it expects to cover 50 million households with fixed wireless and to have four to five million total fixed wireless subscribers by the end of 2025.⁵⁰

29. Collectively, T-Mobile and Verizon have added millions of subscribers to their fixed broadband services in just two years. See Figure 9. Industry analyst MoffettNathanson also reports that “T-Mobile remains confident that they will meet or exceed their 2021 Analyst Day target of 7-8M customers by 2025...”⁵¹ This growth has largely come from wired broadband competitors such as cable providers. For example, whereas cable broadband used to account for approximately 100 percent of broadband net subscriber additions, fixed wireless is projected to account for approximately 90 percent of net subscriber additions over the next couple of years.⁵²

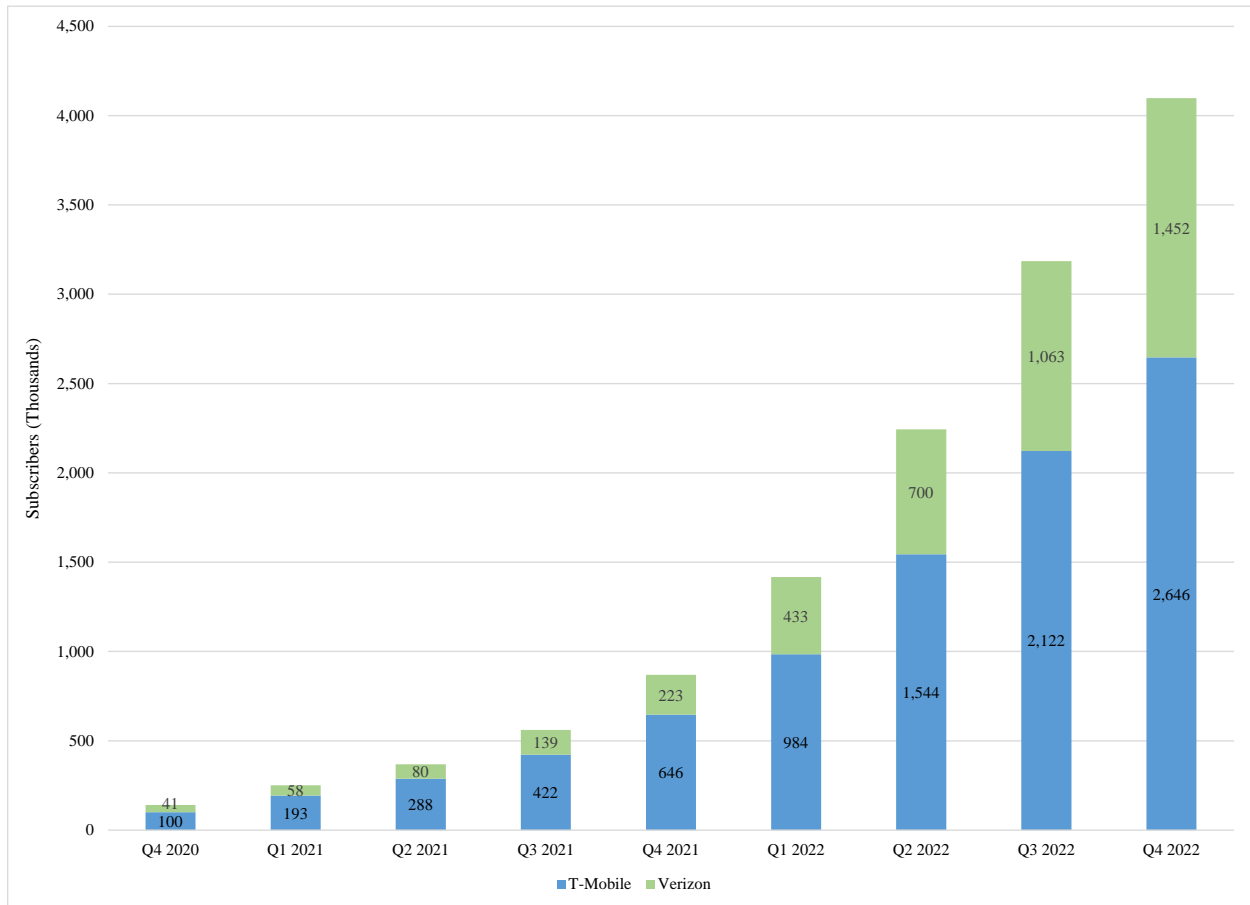
⁴⁹ Jeff Baumgartner, “Verizon tacks on another 384K FWA subs in Q3,” *LightReading*, October 24, 2023, available at <https://www.lightreading.com/fixed-wireless-access/verizon-tacks-on-another-384k-fwa-subs-in-q3>.

⁵⁰ Verizon Communications Inc. (VZ) CEO Hans Vestberg on Q1 2022 Results, Earnings Call Transcript, April 22, 2022 (“We feel confident that our C-Band network will cover at least 175 million POPs by the end of this year, and will cover 50 million household and 14 million businesses with fixed wireless access by the end of 2025.”); Monica Allevan, “Verizon beefs up C-band deployment to 175M by end of 2022,” March 3, 2022, *Fierce Wireless*, available at <https://www.fiercewireless.com/wireless/verizon-expects-cover-175m-ultra-wideband-5g-end-2022>.

⁵¹ MoffettNathanson, “Fixed Wireless Access: Where the Subscribers Are Coming From (An Update),” April 3, 2023, p. 4.

⁵² Mike Dano, “FWA to remain 'biggest disruptor' through 2024,” *LightReading*, June 29, 2023, available at <https://www.lightreading.com/fixed-wireless-access/fwa-to-remain-biggest-disruptor-through-2024>.

**Figure 9: T-Mobile and Verizon Fixed Wireless Broadband Subscribers
Q4 2020 – Q4 2022**



Source: Moffett Nathanson, “Fixed Wireless Access: Where the Subscribers Are Coming From (An Update),” April 3, 2023, Exhibit 1.

30. Other wireless providers similarly offer fixed wireless products. For example, AT&T recently announced that it is expanding its use of 5G for home internet.⁵³ Specifically, AT&T

⁵³ Erin Scarborough, “Say Hello to AT&T Internet Air! Plug-And-Play Home Wi-Fi Installed in Less Than 15 Minutes,” *AT&T Blog*, August 22, 2023 (updated September 6, 2023), available at <https://about.att.com/blogs/2023/internet-air.html>.

will offer its 5G-based “Internet Air” product in 20 new cities.⁵⁴ The Internet Air product will be available for \$55/month.⁵⁵

31. DISH designed and deployed a nationwide 5G network in just three years.⁵⁶ In June 2023, DISH announced that it had launched its 5G Open RAN network that provided 5G broadband access to over 70 percent of the U.S. population accounting for more than 240 million Americans.⁵⁷ The 5G network supports both home internet use and network-compatible devices, which are expected to increase in availability throughout the year.⁵⁸ DISH’s home internet product costs \$50/month and provides speeds up to 115 Mbps.⁵⁹

32. UScellular currently serves around 57,000 FWA customers on its 4G LTE network and has launched a new 5G mid-band network available to customers in 10 states.⁶⁰ UScellular

⁵⁴ Jeff Baumgartner, “AT&T extends reach of 'Internet Air',” *LightReading*, November 3, 2023, available at <https://www.lightreading.com/fixed-wireless-access/at-t-extends-reach-of-internet-air>.

⁵⁵ AT&T Internet Air is also eligible for the Affordable Connectivity Program (ACP) providing eligible households with a benefit of up to \$30 a month. (Erin Scarborough, “Say Hello to AT&T Internet Air! Plug-And-Play Home Wi-Fi Installed in Less Than 15 Minutes,” *AT&T Blog*, August 22, 2023 (updated September 6, 2023), available at <https://about.att.com/blogs/2023/internet-air.html>.)

⁵⁶ DISH Press Release, “The DISH 5G Network is Now Available to Over 70 Percent of the U.S. Population,” June 15, 2023, available at <https://ir.dish.com/news-releases/news-release-details/dish-5g-network-now-available-over-70-percent-us-population>.

⁵⁷ DISH Press Release, “The DISH 5G Network is Now Available to Over 70 Percent of the U.S. Population,” June 15, 2023, available at <https://ir.dish.com/news-releases/news-release-details/dish-5g-network-now-available-over-70-percent-us-population>.

⁵⁸ DISH, “The DISH 5G Network is Now Available to Over 70 Percent of the U.S. Population,” June 15, 2023, available at <https://about.dish.com/2023-06-15-The-DISH-5G-Network-is-Now-Available-to-Over-70-Percent-of-the-U-S-Population>.

⁵⁹ DISH, “5G Home Internet,” available at <https://www.dishpromotions.com/internet/5g-home-internet-service/>.

⁶⁰ Mike Dano, “UScellular’s FWA business pegged for growth by 2024,” *LightReading*, August 8, 2022, available at <https://www.lightreading.com/fixed-wireless-access/uscellular-s-fwa-business-pegged-for-growth-by-2024>.

expects that one million households will have access to its 5G mid-band network by the end of 2023 and that this number will grow to three million by the end of 2024.⁶¹

33. The growth in FWA creates strong intermodal competitive dynamics with FWA posing an increasing competitive constraint to wireline broadband networks. This can be seen in part from the fact that advertising increasingly focuses on the competition between wireline and fixed mobile broadband service.⁶² Similarly, convergence increases competition in the other direction as well. As discussed in greater detail below, cable MVNOs apply a competitive pressure to MNOs.

III. MOBILE WIRELESS PRICING HAS DECLINED

34. Even as quality has risen, mobile wireless prices have declined substantially over the past decade and continue to decline. Consumers are thus receiving higher quality (in the form of more generous data plans and higher quality networks resulting from substantial investment in those networks by mobile network operators) even as they pay less, and consumers have a broad range of pricing plans to choose from. The major providers and others in the industry have also shifted away from two-year contracts, lowering the instance of early-termination fees and making it easier for consumers to switch providers to take advantage of better offers, service, and

⁶¹ UScellular Press Release, “UScellular Launches 5G Mid-Band Network,” June 22, 2023, available at <https://newsroom.uscellular.com/uscellular-launches-5g-mid-band-network/>.

⁶² See, e.g., Sue Marek, “Comcast stokes competitive flames with T-Mobile 5G Home,” *Fierce Wireless*, October 18, 2022, available at <https://www.fiercewireless.com/5g/comcast-stokes-competitive-flames-t-mobile-5g-home-0/>; xfinity, “Xfinity vs T-Mobile 5G Home Internet,” available at <https://www.xfinity.com/compare/xfinity-vs-t-mobile-5g-home-internet/>; T-Mobile, “Comcast Raises Internet Prices AGAIN. T-Mobile Responds, Urging Fed Up Comcast Customers to “Make Xfinity Your Ex,” December 19, 2022, available at <https://www.t-mobile.com/news/offers/make-xfinity-your-ex>.

more. The wireless industry continues to be marked by intense competition and fierce price rivalry, unlocking and delivering substantial and increasing value to consumers.

A. PRICING TRENDS

35. A variety of public data sources on wireless prices exist, including plan-specific pricing details, FCC reports, pricing indices reported by the BLS, and reports from industry analysts. These data sources all demonstrate that mobile wireless prices are declining in nominal and real terms even as quality improves.⁶³

1. Plan Comparisons

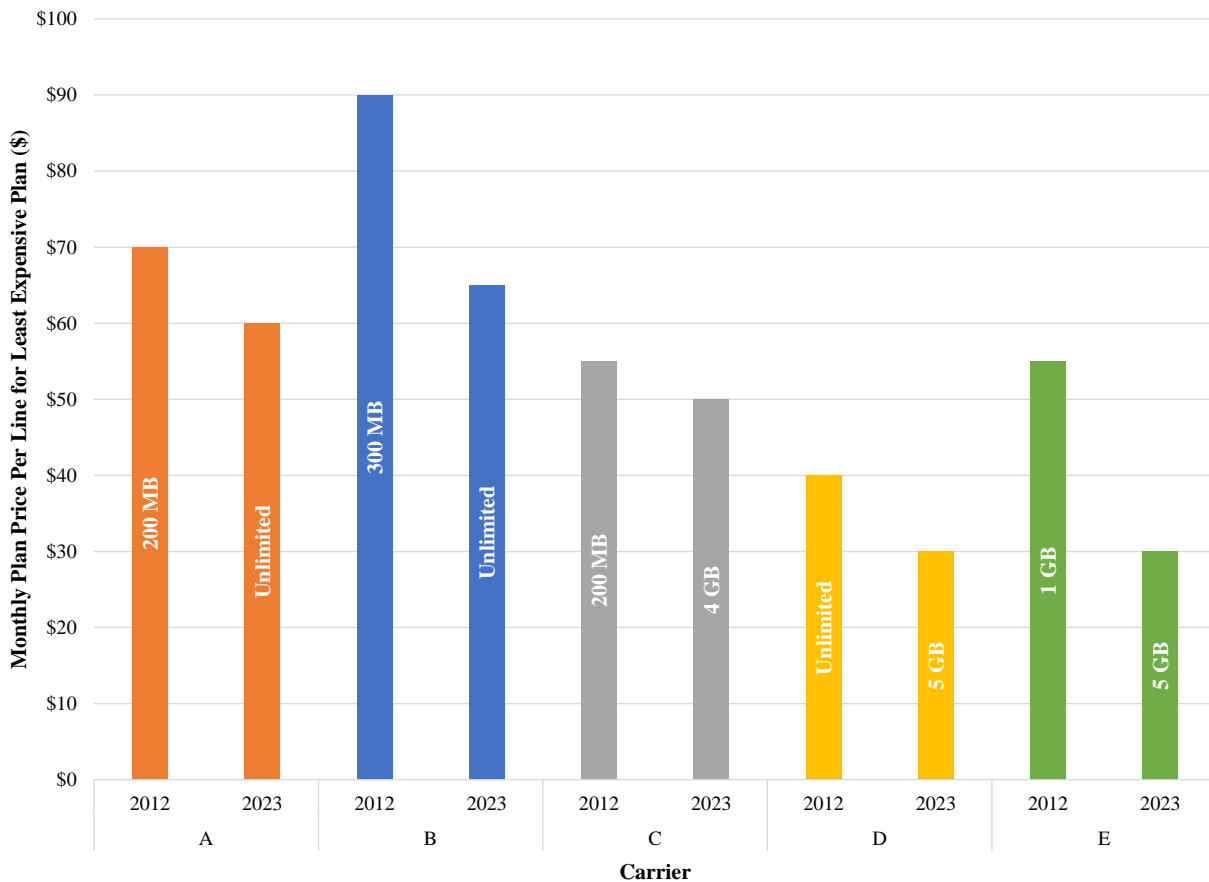
36. One particularly stark way to assess the evolution and decline of mobile wireless prices is to compare prices from ten years ago to current prices. Such a comparison makes clear the large reduction in mobile wireless plan costs even as service quality has improved substantially.

37. Figure 10 below compares the least expensive plan offered by several carriers in 2012 versus 2023.⁶⁴ As the figure makes clear, consumers today get much higher quality at lower prices than they did previously. And this trend is widespread, applying across carriers and plans, with percentage decreases in price ranging from two percent to 32 percent.

⁶³ As the FCC notes, “it is difficult to directly compare prices between providers or over time, because providers offer a variety of plans, frequently under multipart pricing and bundling schemes” and “[p]lans also vary in non-price terms and features, such as the consequences of reaching usage limits.” (FCC, “2022 Communications Marketplace Report,” December 31, 2022, FCC GN Docket No. 22-203, ¶ 106.) Nonetheless, as I explain below, the evidence conclusively shows that wireless prices have decline substantially over time.

⁶⁴ FCC, “Third International Broadband Data Report,” August 21, 2012, FCC GN Docket 11-121, Appendix B: Mobile Broadband Price Dataset, DA-12-1334A4.

Figure 10: Mobile Plan Prices Have Declined Substantially Since 2012



Sources: Carrier websites; FCC, “Third International Broadband Data Report,” August 21, 2012, FCC GN Docket 11-121, Appendix B: Mobile Broadband Price Dataset.

Notes: [1] Prices are for each carrier's least expensive smartphone plan. For T-Mobile, Verizon, and AT&T, prices are for the least expensive postpaid plan. Basic phone plans are excluded. [2] Prices are for a single line. 2023 prices account for autopay and paperless billing discounts but vary as to whether they include taxes and fees. [3] For carriers offering multiple 2012 plans for the same prices but differing in certain dimensions of quality, the higher quality plan is included. [4] For carriers offering multiple 2023 plans for the same prices but differing in certain dimensions of quality, the lower quality plan is included. [5] 2012 and 2023 plans generally also differ in terms of talk and text, technology, speeds, hotspot, video, etc.

2. Price Indices

38. An alternative way to evaluate trends in wireless prices over time is to use price indices that the BLS reports. Specifically, the BLS reports two price indices related to wireless communications: the wireless telephone services consumer price index (CPI) and the wireless telecommunications producer price index (PPI). Although the CPI and PPI differ in the specific

methodology for collecting data, both demonstrate that wireless prices have fallen substantially over time.⁶⁵

39. Since January 2000, the wireless CPI has declined by approximately 41 percent and the wireless PPI has declined by approximately 54 percent.⁶⁶ Relative to general inflation these price trends are even more favorable. Economy-wide prices as measured by the CPI-Urban (a measure of general price changes for all items that the BLS tracks) have increased by more than 81 percent. Thus, the real (inflation-adjusted) wireless price indices have declined by 67 to 74 percent since 2000.⁶⁷

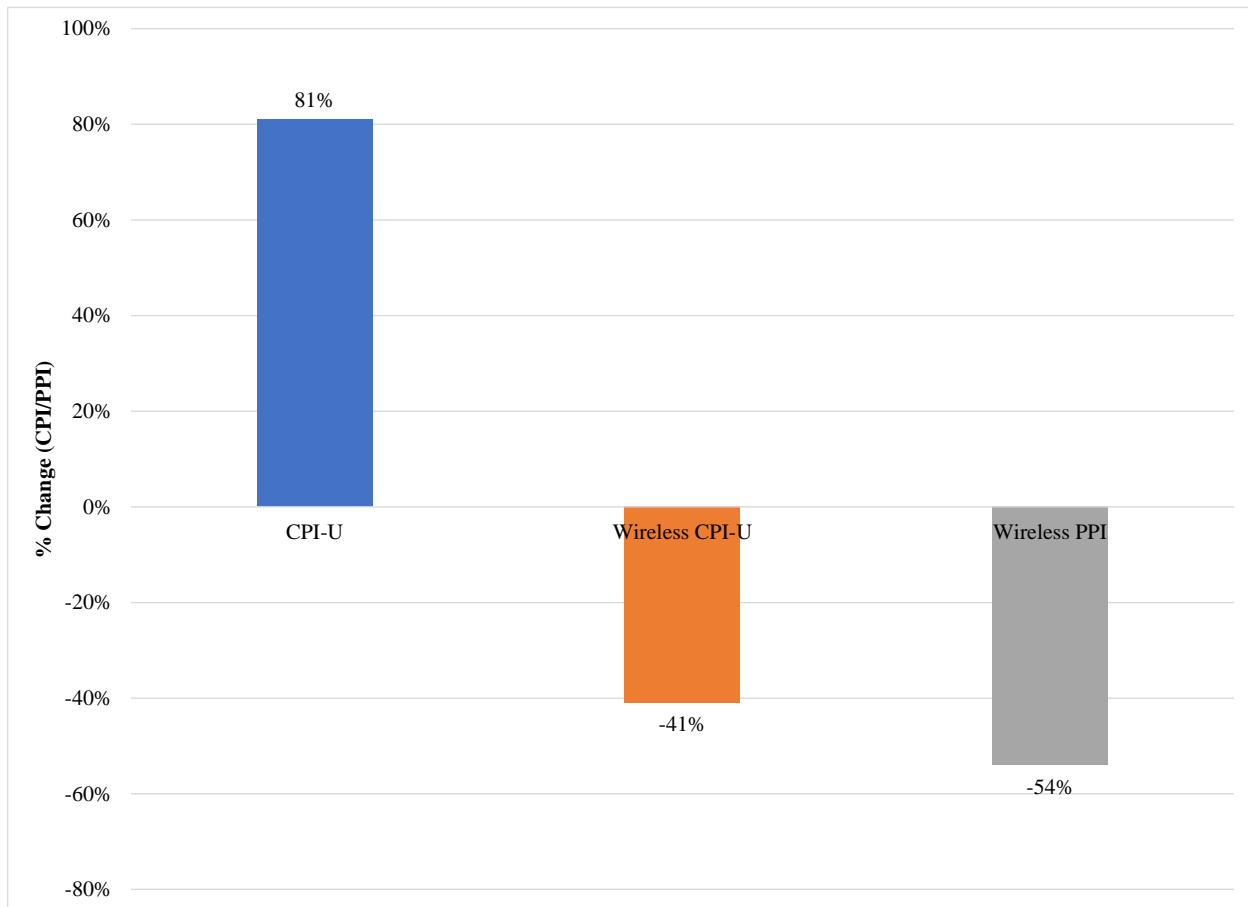
⁶⁵ In general, a PPI measures changes in prices received by producers and a CPI measures a change in prices paid by consumers. (See BLS, “Technical Notes,” *available at* <https://www.bls.gov/news.release/ppi.tn.htm>.) Specifically with respect to the wireless CPI and PPI, the CPI includes taxes whereas the PPI does not and the CPI uses data only from urban areas whereas the PPI uses data from urban and rural areas. (See BLS, “Producer Price Index for Wireless Telecommunications Carriers (NAICS 517312),” *available at* <https://www.bls.gov/ppi/factsheets/producer-price-index-for-wireless-telecommunications-carriers-naics-517312.htm>.)

⁶⁶ Mobile wireless price indices have also declined substantially if one uses 2012 as the starting point as I did in the prior section.

⁶⁷ BLS computes an aggregate price index by combining price changes in thousands of item-area combinations such as wireless products. Thus, the sub-indices are not themselves inflation adjusted, but instead reflect nominal changes in the prices of the relevant products. To compute changes in the wireless price indices relative to general inflation, I calculate the wireless and overall price indices for each time period t .

For a description of the calculation of price indices, see BLS, “Index Calculation,” *available at* <https://www.bls.gov/opub/hom/cpi/calculation.htm#index-calculation>.

Figure 11: BLS Price Indices are Declining (2000-2023)



Sources: BLS, Series ID CUUR0000SA0 (All items in U.S. city average, all urban consumers, not seasonally adjusted); BLS, Series ID CUUR0000SEED03 (Wireless telephone services in U.S. city average, all urban consumers, not seasonally adjusted); BLS, Series ID PCU517312517312 (PPI industry data for Wireless telecommunications carriers, not seasonally adjusted).

40. Although it is true that both the CPI and PPI have flattened since approximately 2017 in nominal terms, this fact does not imply that price competition has diminished. Indeed, as shown in Figure 12 below, the fact that wireless prices have remained flat recently is particularly notable in contrast to the high level of inflation in the overall economy over the past year and a half. For example, since January 2017, the cost of housing has increased by 30 percent and the price of food has also increased by 30 percent.⁶⁸ Adjusting for general inflation, the real wireless

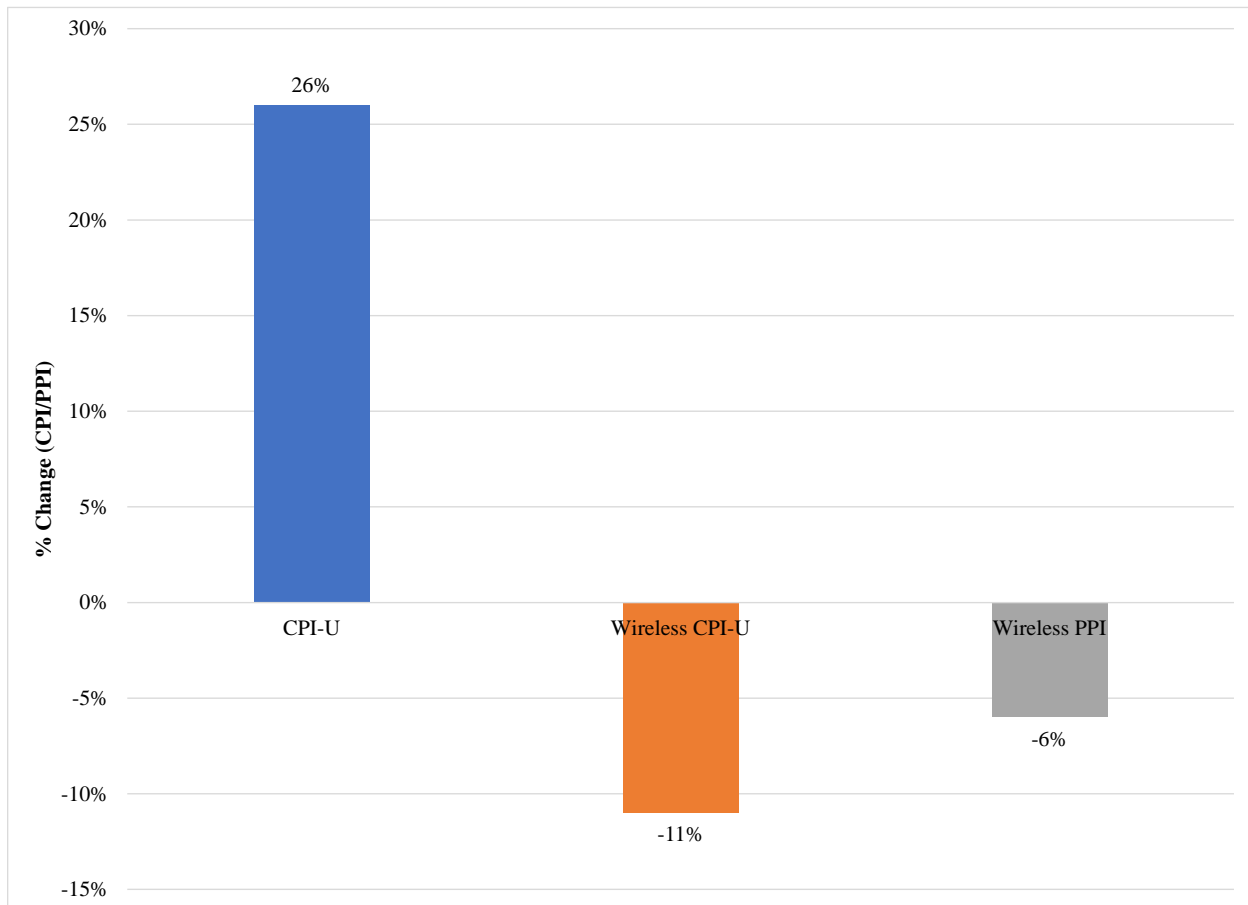
⁶⁸ I calculate these figures by using the BLS price indices for shelter and food, respectively.

price indices have declined by 18 to 19 percent since 2017. More recently, U.S. consumers faced a period of historic inflation between December 2020 to December 2021 where the prices of tracked goods and services increased by 94 percent (e.g., gasoline increased by 50 percent, new cars by 12 percent, food by 6 percent, electricity by 6 percent, etc.), while the prices for wireless devices/smartphones and plans decreased by 14 percent and 0.3 percent respectively.⁶⁹ Thus, the data demonstrate that wireless prices declined and have stayed low even as quality has improved and overall inflation has increased substantially.⁷⁰ This ongoing improvement in quality-adjusted prices since 2017 (and before) points to continuing intense competition in the industry.

⁶⁹ I calculate these figures by using the BLS price indices for Gasoline, New Cars, Food, Electricity, Wireless and Smartphones.

⁷⁰ Although the BLS attempts to adjust for changes in quality, such adjustments are likely to be imperfect. For example, although BLS collects data on 5G plans, it is still evaluating whether to implement a quality adjustment for 5G service. (See BLS, “Consumer Price Index,” January 27, 2022, *available at* <https://www.bls.gov/cpi/factsheets/telecommunications.htm>.)

Figure 12: Wireless Prices are Declining Relative to General Inflation (2017-2023)



Sources: BLS, Series ID CUUR0000SA0 (All items in U.S. city average, all urban consumers, not seasonally adjusted); BLS, Series ID CUUR0000SEED03 (Wireless telephone services in U.S. city average, all urban consumers, not seasonally adjusted); BLS, Series ID PCU517312517312 (PPI industry data for Wireless telecommunications carriers, not seasonally adjusted).

3. Average Revenue per User

41. Average revenue per unit (ARPU) is a commonly used proxy for price. Although industry commentators and analysts sometimes interpret ARPU as a price, it is not. Instead, it is only a proxy, which can provide a more or less precise estimate of price trends depending on underlying conditions. As its name indicates, it is based on average *revenue*, which reflects the quantities of services consumed and the price of those services, some of which are attributable to increases in quality. If the quantities of services consumed changed in fixed proportions over time, then ARPU could provide a reasonable proxy for nominal price trends. However,

customers shift across plans over time, meaning that ARPU reflects both price changes and mix effects. Moreover, the services included in the calculation of ARPU have changed over time. For example, starting in 2013, the industry shifted from bundling device costs into the monthly service fee to offering separate equipment installment plans (EIPs), with the result that ARPU fully captured device costs before 2013, but captured them only to a decreasing degree afterward as customers shifted to separate EIPs. Although ARPU is not a direct measure of price, it nonetheless provides additional information about general trends in the industry.

42. As part of its annual industry survey, CTIA reports data on ARPU with and without including equipment revenue.⁷¹ Consistent with the plan price and price indices data described above, ARPU is also declining. For example, CTIA data indicate that ARPU declined by 29 percent from 2012 to 2022 when excluding equipment revenue and by 16 percent when including equipment revenue (Figure 13). CTIA data also show declines in ARPU from \$38.66 in 2017 to \$34.56 in 2022 (a decline of approximately eleven percent) even as the BLS indices were approximately flat.⁷² Taking general inflation into account reveals even more favorable price trends: the real (as opposed to nominal) ARPU has declined by 45 percent since 2012 and by 26 percent since 2017.

⁷¹ CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, § 3.2.

The CTIA collects aggregate revenue data comprised of the following categories: activation charges, monthly service fees, usage-related charges, services such as voicemail, roaming, and data service revenues. When including publicly-reported equipment revenue, there is some ambiguity with respect to the treatment of equipment leasing. Thus, ARPUs based only on service revenue may provide a better basis for comparisons over time.

⁷² Including equipment revenue, the trends are similar.

Figure 13: Wireless ARPU is Declining⁷³



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Chart 17 and Table 13.

4. Average Revenue per GB

43. As I describe above, mobile data traffic has increased substantially over time. The decline in prices combined with the substantial increase in usage per device indicates that the amount that customers pay on a per-GB basis is also declining substantially.⁷⁴ Revenue per GB has declined by 98 percent since 2012 and by 75 percent since 2017.⁷⁵ Taking general inflation

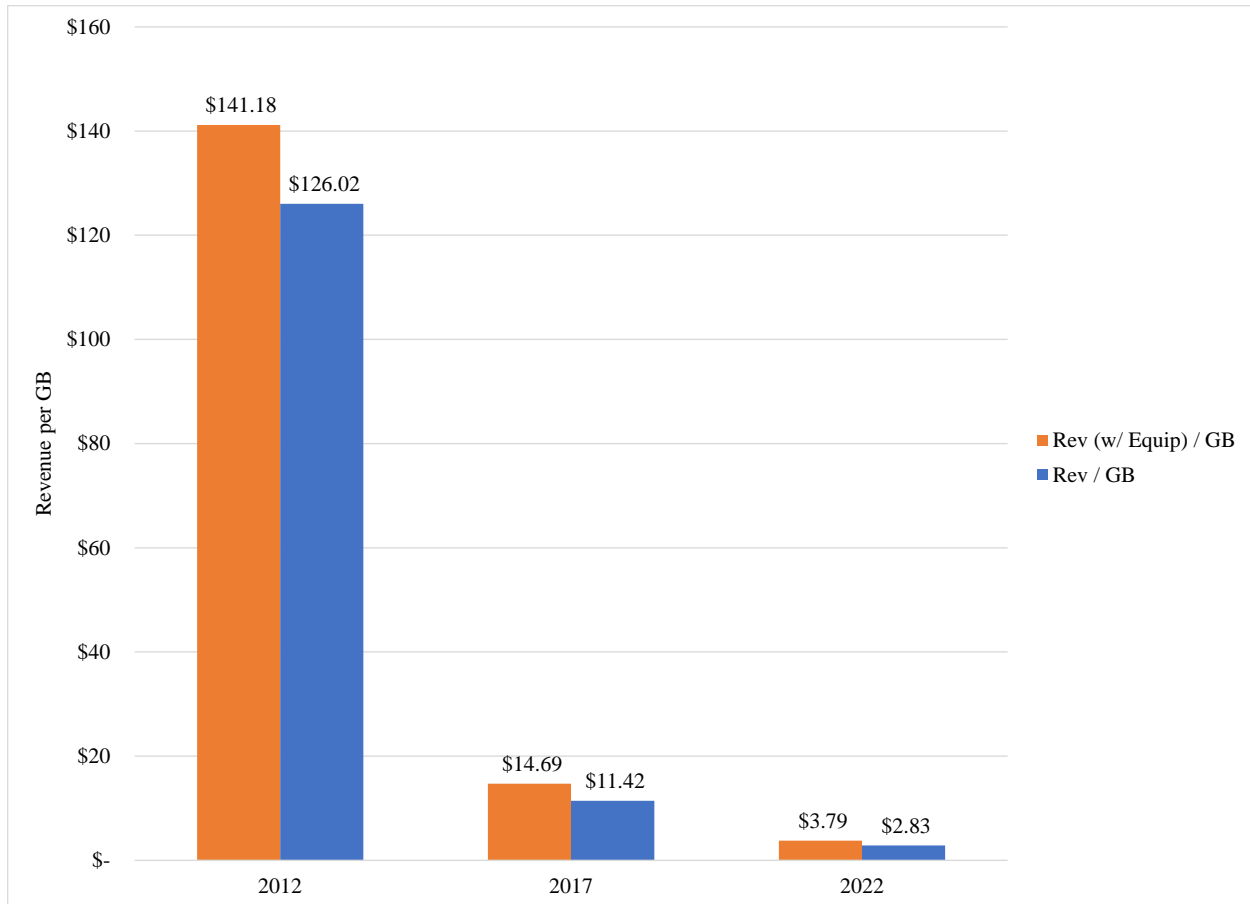
⁷³ CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Chart 17 and Table 13.

⁷⁴ Customers typically do not pay on a per-GB basis. Nonetheless, trends in average revenue per GB demonstrate that customers are getting more for their money over time.

⁷⁵ The calculation of wireless service revenues per GB is subject to the same caveats described above, including the fact that the services included in service revenues change over time.

into account reveals even more favorable price trends: the real (as opposed to nominal) revenue per GB has declined by 98 percent since 2012 and by 78 percent since 2017.

Figure 14: Average Revenue per GB is Declining⁷⁶



Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Tables 9 and 12 and Chart 1.

However, the downward trend in revenues per GB is so large that it is robust to accounting changes. For example, CTIA data show that the sum of service revenues and equipment revenues per GB has fallen every year since 2012 (when CTIA first started reporting data on equipment revenue). (CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Charts 14 and 23.)

⁷⁶ CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Tables 9 and 12 and Chart 1. See also *FCC 2020 Communications Marketplace Report*, Figure II.A.25.

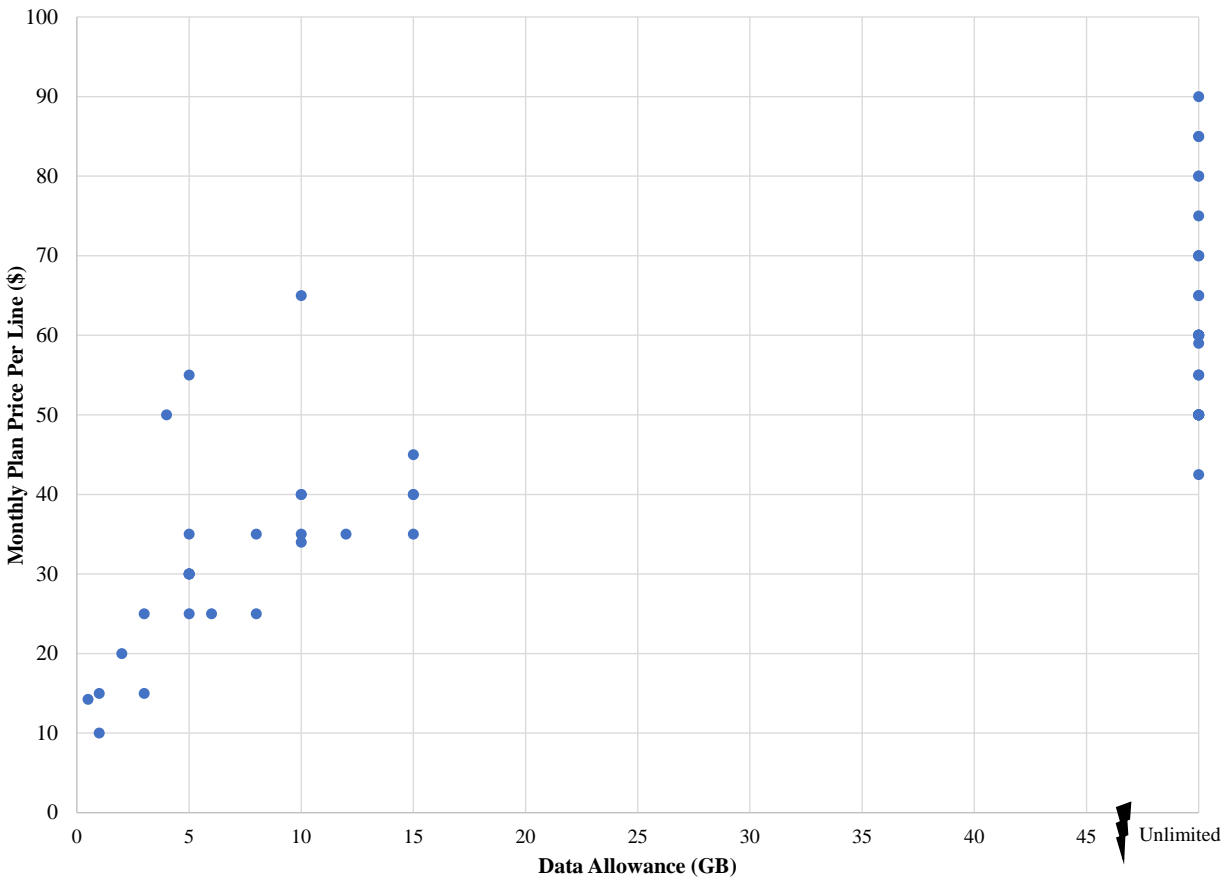
B. PRICE DISPERSION AND AFFORDABILITY

44. In the previous section, I demonstrated that wireless prices have declined substantially over the past decade and continue to decline in real terms. That analysis focused on average or median prices. However, it is also instructive to focus on the range of prices available to customers. As I show in this section, a wide variety of plans are available to customers at different levels of quality and price from entry-level plans to premium plans. This wide range of plans reflects a healthy and competitive marketplace that is meeting the needs of consumers. The wide range of plans available at different pricing points helps to ensure that plans are available at prices that households find affordable.

45. Figure 15 below shows the plans available to consumers from a selection of MNOs and MVNOs. As the figure makes evident, consumers can access both “unlimited” plans, which typically do not restrict the amount of data that users may consume although they may deprioritize traffic for high data users, and plans that have specific data allowances. Among unlimited plans, monthly prices range from approximately \$40 to \$90. Among plans with data allowances, monthly prices range from \$10 to \$65.⁷⁷

⁷⁷ Plans with data allowances typically allow unlimited talk and text.

Figure 15: A Range of Plan Options Are Available



Sources: Carrier websites.

Notes: [1] Verizon, T-Mobile, and AT&T data include postpaid and prepaid offerings, including Verizon shared data plans. [2] Prices are for a single line and account for autopay and paperless billing discounts. Taxes and fees are excluded for most plans. [3] Verizon prepaid plans with different pricing depending on the number of months the customer stays with Verizon are treated as separate plans.

46. The availability of a broad range of product offerings increases the availability of wireless plans to the public. In particular, it increases the likelihood that a consumer can find a plan that meets his or her needs at a price that he or she finds affordable. Analyses of pricing that focus on average or median prices, such as those described in the prior section, may obscure the variety of plans that are available to consumers.

47. Although the concept of affordability is not precisely defined, it commonly refers to a ratio of some measure of mobile wireless prices to some measure of household income. For example, a recent study by Oxford Economics found that, in the past three years, the price of entry-level wireless plans has declined by 44 percent as a percentage of household disposable income.⁷⁸ As Oxford Economics observes, “[t]he main driver for this improvement involved the 2021 introduction of a \$25/month pre-paid 12-month contract by one of the main providers, halving the cost for the lowest-cost plan from \$50/month.”⁷⁹

48. Mobile wireless penetration rates (e.g., the ratio of the number of households subscribing to mobile wireless to the total number of households within a certain geographic region) potentially provide an alternative measure of affordability. When deciding whether to purchase mobile wireless access, consumers can be expected to take into account both price and quality characteristics of available plans, among other factors. Hence, unlike price-to-income ratios, penetration rates capture differences in plan quality, consumers’ valuations of those differences, and the degree of plan availability. As I describe in Section II.D above, mobile wireless penetration rates in the United States are very high. Specifically, I show that U.S. mobile subscribers grew at a compound annual rate of approximately five percent between 2010 and 2022. Although mobile wireless penetration (devices per capita) exceeds 100 percent, this growth shows no signs of slowing as customers add more devices. For example, CTIA data finds that total wireless penetration (defined as the ratio of total wireless subscribership to

⁷⁸ Oxford Economics, “Unpacking the cost of mobile broadband across countries,” November 2022, available at <https://api.ctia.org/wp-content/uploads/2022/11/CTIA-Oxford-Economics-Report-Cost-of-Mobile-Broadband.pdf> (hereinafter *Oxford Economics Study*), § 2.3.

⁷⁹ *Oxford Economics Study*, n. 8.

population) was 155 percent and has been increasing at a steady rate for more than a decade.⁸⁰ Similarly, Cisco projected that U.S. mobile users as a percent of the population would increase from 87 to 89 percent between 2018 and 2023 and that the number of mobile devices per capita would increase from 1.7 to 3.4 over the same time period.⁸¹ These high mobile wireless penetration rates, combined with data showing that entry-level plans are widely available at relatively low prices supports the conclusion that customers in the United States find mobile wireless to be affordable.

IV. THE MOBILE WIRELESS INDUSTRY HAS CHANGED SUBSTANTIALLY SINCE THE PASSAGE OF THE 1996 TELECOMMUNICATIONS ACT

49. It is instructive to compare the current state of the industry to the state of the industry at the time of the passage of the Telecommunications Act of 1996 (the '96 Act). President Bill Clinton signed the '96 Act into law in February 1996. At the time of signing, it was the first major change to telecommunication law in more than six decades and it was designed to foster competition in the telecommunications industry.⁸²

50. At the time of its passage in 1996, the mobile wireless industry was in many ways a very different industry and delivered a fraction of the value that today's customers realize. In 1996, networks were based on 2G technology, mobile high-speed broadband did not exist, there was no app economy, devices were "candy bar" or flip phones with very basic user interfaces (the first

⁸⁰ CTIA, "CTIA's Wireless Industry Indices Report," July 2023, Table 6 and Chart 9.

⁸¹ Cisco, "Cisco Annual Internet Report Highlights Tool," *available at* <https://www.cisco.com/c/en/us/solutions/executive-perspectives/annual-internet-report/air-highlights.html#> (estimating that "there will be 299.0 million total mobile users (89% of population) by 2023, up from 285.3 million (87% of population) in 2018" and that "there will be 3.4 mobile connected devices per capita by 2023, up from 1.7 per capita in 2018.").

⁸² FCC, "Telecommunications Act of 1996," *available at* <https://www.fcc.gov/general/telecommunications-act-1996>.

iPhone was still more than ten years in the future), and there was no mobile streaming service. Mobile phones offered, in essence, a voice calling service and extremely limited texting features. Today's smartphones connected to 5G networks serve as pocket-sized computers with the ability to access the entire internet, stream video, and interact live with friends and colleagues through a variety of mediums.

51. As Table 1 below makes clear, on a variety of objective measures, the mobile wireless industry has evolved significantly compared to when Congress enacted the '96 Act.⁸³ For example, by any reasonable measure, output has increased substantially. The number of subscribers has increased by more than 800 percent, substantially exceeding overall population growth (the penetration rate has increased by more than 650 percent). Moreover, the intensity of usage has also increased, with wireless minutes of use (MOU) increasing by more than 4,600 percent. Because mobile data was largely non-existent in 1996, growth rates in data usage are even higher. Increases in output were driven in part by increasing quality and decreasing prices, both of which came about because of substantial investment in networks. This investment led to networks that were both denser and offered greater coverage. For example, the number of active cell sites has increased by more than 700 percent. Similarly, the prices that customers pay for mobile wireless services have declined substantially. Expressed in December 2022 dollars, the ARPU has declined by 58 percent over this time period.

⁸³ The CTIA's first industry report was published in 1997 and I use data from that report for purposes of comparison.

Table 1: Comparison of Selected Industry Statistics Between 1997 and 2021

		YE 1997	YE 2022	% Change
	Total Subscribers [Mn]	55.3	523.0	845%
Output	Subscriber Penetration	20%	155%	685%
	Wireless MOU [Bn]	52.0	2,474.0	4661%
Network	Cell Sites [000s]	52	415	703%
ARPU	ARPU [Dec. 2022 Dollars]	\$85.37	\$35.74	-58%

Source: CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023; CTIA, “A Comprehensive Report on CTIA’s Semi-Annual Data Survey Results,” 1997.

Notes: [1] Subscribers based on CTIA estimates of total subscribers; [2] Wireless MOU as of YE 1996 rather than YE 1997.

V. THIS STRONG INDUSTRY PERFORMANCE OCCURRED IN PART DUE TO EVOLUTION IN THE STRUCTURE OF THE INDUSTRY.

52. The mobile telecommunications industry is relatively young, with the first commercial services introduced in 1983.⁸⁴ The industry has evolved over time to the current structure, which sees competition from nationwide providers, regional providers (that also offer nationwide footprints), and MVNOs.

53. Today, the U.S. has three highly competitive mobile service providers that provide nationwide coverage using their own network facilities, but it is important to recognize that AT&T, T-Mobile, and Verizon are not the only firms to offer mobile wireless services to consumers nationwide, nor are they the only firms that offer wireless services that provide a subscriber with nationwide coverage. For example, DISH announced in June 2023 that it had satisfied its 5G FCC buildout commitments by launching over 15,000 5G sites and now offering 5G broadband service nationwide to over 70 percent of the US population.⁸⁵

⁸⁴ CTIA, “History of Wireless Communications,” *available at* <http://undistracteddrivingadvocacy.net/historical-timeline-of-cellular-telecommunications/>.

⁸⁵ DISH Press Release, “The DISH 5G Network is Now Available to Over 70 Percent of the U.S. Population,” June 15, 2023, *available at* <https://ir.dish.com/news-releases/news-release-details/dish-5g-network-now-available-over-70-percent-us-population>.

54. Several mobile wireless service providers operate local or regional networks.⁸⁶ The largest of these regional MNOs is UScellular, which operates its own network in part of 23 states and serves approximately five million customers.⁸⁷ C Spire is the fifth-largest MNO and provides service to approximately one million customers in several Southeastern states.⁸⁸ In addition, dozens of smaller MNOs provide service on their own networks in more limited, often rural, geographic areas.⁸⁹

55. Mobile wireless service providers that operate their own networks within relatively small geographic footprints often supplement the coverage of their network through roaming agreements with other network operators. Under a roaming agreement, one MNO pays a second MNO in return for which customers of the first MNO are allowed to connect to and use the network of the second MNO. Roaming agreements allow firms that have less-than-nationwide footprints (such as UScellular and C Spire) to compete for customers who desire nationwide—or even broader—geographic coverage.

56. Another class of service providers, known as MVNOs, do not operate their own networks, but instead compete for retail subscribers by purchasing wholesale network access from MNOs and reselling that access to retail customers. MVNOs design their own retail rate plans and conduct their own marketing.

⁸⁶ *FCC 2022 Communications Marketplace Report*, ¶ 64.

⁸⁷ U.S. Cellular, “Company Information and Facts,” *available at* <https://newsroom.uscellular.com/uscellular-company-information-and-facts/>.

⁸⁸ *FCC 2022 Communications Marketplace Report*, ¶ 64.

⁸⁹ *FCC 2022 Communications Marketplace Report*, ¶ 64. For specific examples, see *FCC 2022 Communications Marketplace Report*, note 141.

57. An MVNO may switch among MNOs as it seeks to obtain wholesale access on more favorable terms. An MVNO may also purchase wholesale network access from multiple MNOs simultaneously and switch traffic among them to take advantage of that most favorable available terms. The ability of MVNOs to shift traffic volume among MNOs (e.g., channeling traffic to those MNOs that offer more attractive wholesale prices or better network quality) creates competitive pressure on MNOs supplying wholesale services.

58. Competition between MNOs and MVNOs, especially those associated with cable broadband providers such as Xfinity Mobile and Spectrum Mobile, has intensified in recent years. Cable MVNOs are planning to one day operate hybrid networks that consist of primary reliance on wholesale network access agreements and offloading of traffic to their Wi-Fi networks, and eventual, gradual deployment of some of their own spectrum.⁹⁰ Although cable has not yet deployed their own wireless infrastructure on a broad scale (other than WiFi), the operation of such hybrid networks will provide cable MVNOs the ability to minimize costs, rely on wholesale network access only where necessary, and bundle wireless service with existing wireline products.

59. Customers have the ability to switch between mobile wireless providers and many do every year. On an annual basis, approximately 18 percent of mobile wireless customers change providers.⁹¹ In 2022 alone, 92 million subscribers disconnected their mobile wireless service in

⁹⁰ *FCC 2022 Communications Marketplace Report*, ¶ 66 (“In recent years, cable providers have also entered the mobile wireless market through MVNO arrangements, as well as beginning to deploy their own facilities-based networks. These service offerings rely on combining the mobile networks of facilities-based partners with hotspot or small-cell networks that send traffic through the cable provider’s infrastructure.”).

⁹¹ This is equivalent to a monthly average churn rate of 1.53 percent. (CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 8. See also *FCC 2022 Communications Marketplace Report*, ¶ 79.)

the United States.⁹² Competition for these switching customers is intense, with that competition benefiting all subscribers including those that choose not to switch.

60. The ability to switch mobile wireless providers is demonstrated by the fact that churn is an important strategic focus in the industry. This is evident in providers' efforts to induce subscribers to switch from rivals and focus on retaining their own customers.⁹³ This is competition in action; the ability to switch leads firms to offer substantial inducements to stay, as well as substantial inducements to persuade customers to switch.

61. The fact that consumers have—and can make use of—a credible threat to switch mobile wireless providers is well-recognized in the industry. For example, Consumer Reports has for years advocated for consumers to switch (or threaten to switch) in order to obtain discounts for mobile wireless service.⁹⁴ The credibility of a threatened switch is demonstrated by the success of those who do switch. A recent survey by Consumer Reports found that more than half of consumers that switched providers paid lower prices.⁹⁵ Again, this is competition in action: If a consumer is unhappy with the cost or characteristics of the service they are receiving, they are motivated to switch providers, and providers are incented to keep customers happy and switching losses low. Finally, search costs are very low in this industry. As the FCC has recognized,

⁹² CTIA, “CTIA’s Wireless Industry Indices Report,” July 2023, Table 8.

⁹³ See, e.g., AT&T, “See how we stack up against the competition,” *available at* <https://www.att.com/wireless/switch-and-save/>; T-Mobile, “T-Mobile has options for everyone. Switch and get more for less on America’s Largest 5G Network.” *Available at* <https://www.t-mobile.com/switch/free-cell-phone-with-plan>; Christine Canencia, “T-Mobile CEO Sees AI as Way to Help Reduce Churn Rate,” TmoNews, May 31, 2023, *available at* <https://www.tmonews.com/2023/05/t-mobile-ceo-sees-ai-as-way-to-help-reduce-churn-rate/>.

⁹⁴ See, for example, Consumer Reports, “Cell Phone Service Buying Guide,” updated February 3, 2023, *available at* <https://www.consumerreports.org/electronics-computers/cell-phones-services/buying-guide/>.

⁹⁵ Consumer Reports, “Cell Phone Service Buying Guide,” updated February 3, 2023, *available at* <https://www.consumerreports.org/electronics-computers/cell-phones-services/buying-guide/>.

mobile wireless providers have also invested in extensive marketing campaigns designed to highlight each provider's differentiated product offerings.⁹⁶

62. This industry structure has led to intense competition characterized by increasing quality and decreasing prices as described in Section II above. Moreover, technological advances in both wireless and wireline networks have put wireless and wired broadband providers in increasingly direct competition with each other. As described above, improvements in wireless networks have led to high-quality fixed wireless product offerings that are competing for subscribers directly with wired broadband providers. Conversely, wireline broadband providers are increasingly investing in wireless MVNO offerings that compete with wireless providers.⁹⁷

63. In summary, the mobile wireless industry has evolved to a structure in which MNOs with local, regional, and nationwide networks, and MVNOs all compete to sell retail mobile wireless services through a variety of differentiated offerings that serve the diverse needs and preferences of consumers and enterprise customers, with the competition between service providers to serve these needs driving technological and service innovation, just as the early advocates of a competitive market structure for the wireless industry conceived.

64. The wireless industry is highly competitive, having grown since its infancy under a long bipartisan history of light-touch, market-oriented policies. Those light-touch policies have

⁹⁶ *FCC 2022 Communications Marketplace Report*, ¶ 133 (“Mobile wireless providers also compete for customers through extensive advertising and marketing campaigns. Service providers’ marketing campaigns often focus on aspects such as network quality, 5G capabilities, price differences, differentiating services, and device promotions.” [internal cites omitted])

⁹⁷ Mike Dano, “FWA to remain 'biggest disruptor' through 2024,” *LightReading*, June 29, 2023, available at <https://www.lightreading.com/fixed-wireless-access/fwa-to-remain-biggest-disruptor-through-2024> (“Indeed, the US cable industry accounted for nearly 75% of total wireless phone net customer additions in the first quarter of 2023, according to a recent MoffettNathanson report.”).

successfully encouraged large, sunk cost investments in expensive infrastructure and dynamic competition. Today, technological improvements and dynamic competition allow for increasingly direct competition between the cable and wireless industry for both mobile and fixed customers, making the wireless industry more intensely competitive than ever. Invoking Title II is not necessary to create or intensify competition, and in fact, may stifle the very investment that has led the industry to this point of widespread availability, low prices, diversity in plans and offerings, and flourishing innovation.

About the Author

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Dr. Keating was supported during this engagement by Rudra Ramchandran (Senior Analyst; Bachelor of Arts, Economics, University of Chicago), Philipp Eibl (Senior Analyst; Bachelor of Arts, Economics, Columbia University), and Lauren Lau (Analyst; Bachelor of Arts, Economics, Pomona College), with additional consulting support from Gloriana Alvarez (Vice President; Master of Science, Applied Economics, Johns Hopkins University).