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Exhibit No.:	Joint Applicants-
Hearing Date:	
Witness:	Mark A. Israel
ALJ:	Karl Bemesderfer
Commissioner:	Clifford Rechtschaffen

REBUTTAL TESTIMONY OF MARK A. ISRAEL

ON BEHALF OF JOINT APPLICANTS

JANUARY 29, 2019

—PUBLIC VERSION—

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ATTACHMENTS

I. WITNESS IDENTIFICATION

Q: Please state your name, occupation, and business address.

A: My name is Mark A. Israel. I am a Senior Managing Director at Compass Lexecon, an economic consulting firm where I have worked since 2006. My business address is 555 12th Street, NW, Washington, DC 20004.

Q: Please describe your professional qualifications and experience.

A: I received my Ph.D. in economics from Stanford University in 2001. From 2000 to 2006, I served as a full-time member of the faculty at Kellogg School of Management, Northwestern University. I continue to do some executive MBA teaching for Kellogg.

I specialize in the economics of industrial organization as well as applied econometrics. At Northwestern (Kellogg) and Stanford, I taught graduate-level courses covering topics including business strategy, industrial organization economics, and econometrics. My research on these topics has been published in leading peer reviewed economics journals including the American Economic Review, the Rand Journal of Economics, the Review of Industrial Organization, the Review of Network Economics, and the Journal of Competition Law and Economics.

My work at Compass Lexecon has focused on the application of economic theory and econometric methods to competitive analysis of the impact of mergers, antitrust issues including a wide variety of single-firm and multi-firm conduct, class certification, and damages estimation. I have analyzed these competition issues on behalf of a wide range of clients, including private companies and government entities including the US Federal Trade Commission. I have testified in Federal court, multiple state courts, and in many regulatory and arbitration proceedings in the U.S. and around the world. I have presented my findings to both US competition agencies on dozens of occasions. I have also submitted expert reports, declarations, and affidavits to government agencies and Federal and state courts. Included in this work are well over a dozen merger, arbitrations, and regulatory proceedings in mobile wireless communications and media/telecommunications more generally.

Attachment A contains my CV.

II. PURPOSE OF TESTIMONY

Q: Are you generally familiar with these proceedings at the Commission?

A: Yes. I understand that T-Mobile and Sprint have submitted two filings with the Commission. One filing seeks approval of the transfer of Sprint Communications, a wireline provider in the state, to T-Mobile. The other filing provides the Commission with information about the wireless merger. My understanding is that the Commission has set these hearings to consider various issues related to those filings.

Q: Please describe your role in relation to the proposed transfers of control.

A: I, along with my colleagues Michael Katz and Bryan Keating ("Israel, Katz and Keating," or "IKK"), have analyzed the proposed merger of T-Mobile US, Inc. ("T-Mobile") and Sprint Corporation ("Sprint") (together, the "Parties"), of which the proposed transfers of control at issue are a part, and submitted our results to the Federal Communications Commission ("FCC") and U.S. Department of Justice ("DOJ"). Attachment B contains the declaration that IKK submitted to the FCC on September 17, 2018.[1]

In this testimony, I summarize the results of IKK's prior work with a particular focus on how the transaction will affect consumers in California. I also respond to concerns raised by Dr. Lee L. Selwyn in his Direct Testimony submitted in this proceeding on behalf of the Public Advocates Office at the California Public Utilities Commission[2] and to testimony submitted on behalf of the Communication Workers of America.[3]

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[1] In the Matter of Applications of T-Mobile US, Inc. and Sprint Corporation, WT Docket No. 18-197, Reply Declaration of Mark Israel, Michael Katz, and Bryan Keating, September 17, 2018 (hereinafter *IKK Declaration*).

Katz is the Sarin Chair Emeritus in Strategy and Leadership at the University of California at Berkeley and holds a joint emeritus appointment in the Haas School of Business Administration and in the Department of Economics. Keating is an Executive Vice President at Compass Lexecon.

[2] Direct Testimony of Lee L. Selwyn, Applications 18-07-011 and 012, January 7, 2019 (hereinafter *Selwyn Testimony*).

[3] Opening Testimony of Debbie Goldman, Dr. Andrew Afflerbach and Matt Dehaven on Behalf of Communications Workers of America District 9, Applications 18-07-011 and 012, January 7, 2019 (hereinafter *CWA Testimony*). I focus on the CWA discussions of competitive concerns.

Q: Can you summarize your conclusions?

A: I conclude that the proposed merger will strengthen competition and benefit California consumers by increasing consumer welfare. Consumers will enjoy greater benefits than they would without the merger because New T-Mobile's planned network will allow the combined firm to achieve lower marginal costs of providing services, expand capacity, and offer higher quality services than would either merging party operating on its own.[4] With lower costs, New T-Mobile's incentives are to lower prices and increase product quality in order to attract more customers and thereby earn higher profits. New T-Mobile's ability to offer consumers greater value for their money (sometimes referred to as lower quality-adjusted prices) will, in turn, exert competitive pressures on rival service providers to respond by both reducing their own prices and improving their own services, further benefiting consumers.

Q: Does Dr. Selwyn's testimony change any of your conclusions?

A: No. Dr. Selwyn raises generalized concerns about effects arising from the change in market structure, but he does not undertake the work required to assess those concerns and assess the merger's competitive effects, including the work required to actually model either the potential costs or benefits of the proposed merger. I have done that work and demonstrated that California consumers will, on net, receive significant benefits from the merger. Conversely, consistent with my findings that this merger benefits consumers, California consumers would be worse off if the transaction were prohibited.

Q: Has Dr. Selwyn offered any criticism of the IKK methods or conclusions?

A: No. Although Dr. Selwyn has had access for months—since September 17, 2018—to the public version of the modeling described in the declaration IKK submitted to the FCC, about which I testify below, his criticisms are directed only at a different (complementary) model put

[4] I will often use the term "marginal cost" in my testimony. This term refers to the cost of providing service to an incremental consumer. Reductions in marginal costs are particularly important in merger review because, when it is less costly to acquire a new customer, firms have incentives to lower prices in order to obtain more new customers. For a general discussion of how these types of incentives are thought of by firms like T-Mobile and Sprint, see Rebuttal Testimony of G. Michael Sievert, January 29, 2019, pp. 23-25.

forward by John Asker, Timothy Bresnahan and Kostis Hatzitaskos[5] (which he refers to as the "Cornerstone" model). Dr. Selwyn never so much as mentions the existence of the IKK model. Notably, Dr. Selwyn does cite to my filings in his testimony, but makes no reference to the model at the core of those filings.[6] In addition to the detailed description of the methodology, assumptions and results contained in the September 17, 2017 filing, electronic backup to the model was provided to Dr. Selwyn, at request of the California Public Advocates Office, on December 21, 2018, at the same time the backup to the "Cornerstone" model was provided.[7]

Q: How does the "Cornerstone" model relate to your analysis?

A: The "Cornerstone" model is complementary to my analysis. It uses detailed individual-level data to assess current competitive conditions and to address certain elements of consumer benefits my model does not, such as improved coverage. My analysis focuses on comparing competitive conditions for a longer period into the future, evaluating consumer benefits with standalone networks against consumer benefits with a merged network, and demonstrating that the merger benefits consumers even though I conservatively quantify only a subset of the consumer benefits from the transaction.

Q: Do Dr. Selwyn's criticisms of the "Cornerstone" model affect your analysis?

A: No. Although I incorporate certain results from the "Cornerstone" model into my analysis, my results are robust to and consistent across a wide range of assumptions, as I describe below, and my conclusions do not depend on the "Cornerstone" model. In any event, as I explain below and as Dr. Bresnahan explains in his testimony, Dr. Selwyn's criticisms of the "Cornerstone" model are incorrect, as they are based on faulty application of antitrust economics and misunderstandings of the model's methodology and conclusions.

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[5] John Asker, Timothy F. Bresnahan, and Kostis Hatzitaskos, "Economic Analysis of the Proposed T-Mobile/Sprint Merger," WT Docket No. 18-197, November 6, 2018 (hereinafter *ABH Whitepaper*).

[6] Selwyn *Testimony*, note 48.

[7] CWA similarly claims that "Applicants have not submitted their economic studies in this proceeding." (*CWA Testimony*, p. 30.) To the contrary, IKK was disclosed publicly in September 2018, and electronic backup was made available to the Public Advocate's Office upon request.

Dr. Selwyn's critique of the "Cornerstone" model consists of two arguments: 1) that the data on which the "Cornerstone" model relies have limitations; and 2) that the efficiencies claims are unsupported.[8] Dr. Bresnahan has submitted rebuttal testimony responding directly to these critiques,[9] and Mr. Ray has submitted rebuttal testimony responding to criticisms of the efficiencies claims.[10] In addition, although Dr. Selwyn does not tie his specific criticisms to my own work, I nonetheless address his criticisms when I describe the foundations and assumptions of the IKK model.

[8] The conclusions in the *ABH Whitepaper* are not tied to a particular set of marginal cost reductions, but the range of marginal cost reductions considered is based off of those analyzed in IKK.

[9] Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019.

[10] Rebuttal Testimony of Neville R. Ray, January 29, 2019.

III. OVERVIEW OF ECONOMIC ANALYSIS OF MERGERS

Q: Can you provide an overview of proper economic analysis of mergers?

A: The fundamental goal of the economic analysis of mergers is to determine whether the merger intensifies or weakens competition—that is, whether it is pro- or anti-competitive. Because mergers have multiple effects, which must be jointly considered to determine the merger's effect on competition, either outcome is possible. The way economists determine which outcome holds for a particular merger is to assess how that merger affects consumer welfare. Ultimately the goal is to prevent mergers that substantially lessen competition and thus substantially reduce consumer welfare while permitting mergers that enhance competition and thus enhance consumer welfare.

Broadly speaking, mergers may affect consumer welfare in several ways. On the one hand, a merger may produce efficiencies which, by bringing together the assets of the merging parties, may reduce the merged firm's (marginal) costs thus putting downward pressure on prices, increase the quality provided by the merged firm, or both, resulting in increased intensity of competition with respect to price and quality. On the other hand, a merger will eliminate a competitor. That may result in less intense competition with respect to price and quality, potentially resulting in higher quality-adjusted prices. Any meaningful analysis of the effects of a merger must incorporate both of these possibilities and determine the net effect of the merger on competition and consumer welfare.

Q: How do those effects play out in this case?

A: In this case, there are three primary effects that economic theory and marketplace evidence indicate the merger will have:

- On the one hand, the merger will bring T-Mobile and Sprint into common ownership, and, therefore, will internalize the value of sales diverted from one to the other that otherwise would have been viewed as lost sales by each separate firm, putting upward pressure on prices;
- On the other hand, the merger will lower the combined firm's marginal costs of serving additional customers relative to the marginal costs facing the standalone firms, creating incentives to cut prices and expand output; and
- In addition, the merger will improve the quality of service, at any given price, that the combined firm will offer relative to what the standalone firms would offer.

Each of these effects interact to determine what the firm's final incentives are with respect to price and quality after the merger.

Q. Does Dr. Selwyn evaluate the interaction of these three effects in order to assess the merger's effect on competition and consumer welfare?

A: No. Dr. Selwyn does not perform an analysis combining these effects and accounting for these interactions. Instead, he offers only conclusory statements that the (unquantified) potential harms he discusses will outweigh the efficiencies.

Q. Do you perform such an analysis?

A: Yes. Both Dr. Bresnahan and I have performed analyses accounting for the interactions and evaluating the overall effect of the proposed merger. As I demonstrate below, the efficiencies expressed as marginal cost reductions and quality improvements will combine to far more than offset any potential upward pricing pressure created by the transaction, leading to increased consumer welfare.

Q: What specific metrics do economists examine to determine if mergers are good or bad for consumer welfare?

A: One should look at price, quality, and, most importantly, output to determine whether consumer welfare increases or decreases. If consumers get more for their money (quality-adjusted prices decrease), then output to consumers will increase, and consumer welfare will be higher. To be clear, multiple aspects of quality—including the amount of data consumers are able to use, the throughput (speed) of the network, and the coverage and consistency of the network—are very important determinants of consumer welfare, particularly in this industry, and any analysis of prices must be accompanied by an analysis of quality to be meaningful.

Q: Can industry concentration metrics alone determine whether a merger will benefit or harm consumers?

A: Absolutely not. Analyses of industry concentration and number of competitors may provide a starting place for analysis, but they are only a first step. If there is low industry

concentration and many competitors, then there is unlikely to be any competitive concern, and so further investigation is generally not warranted. If, on the other hand, there is high industry concentration and few competitors, that does not mean there will be a competitive problem, only that further investigation is warranted. It may very well be the case that a more concentrated market will benefit consumers if it allows a firm to achieve lower costs. Once concentration measures are found to be high, it is generally important to investigate the welfare effects in detail, with an actual model of competition and efficiencies so that the different potential effects discussed above can be combined and an overall assessment of the merger's effects reached. Otherwise, consumers can be hurt by prohibiting mergers that actually would benefit them.

Q: Does Dr. Selwyn's discussion of the Herfindahl-Hirschman Index ("HHI") establish that the proposed transaction will harm consumer welfare?

A: No. HHIs themselves cannot establish that the proposed transaction will harm consumer welfare. Dr. Selwyn's extensive discussion of concentration and HHIs can establish at most that there is reason to dive deeper (that is, that the merger does not fall into a safe harbor, in which there is no cause for further review).[11] I have done that deeper analysis, while Dr. Selwyn has not.

Indeed, although Dr. Selwyn cites to the DOJ/FTC Horizontal Merger Guidelines to support his presentation of HHI statistics, he fails to mention that the Horizontal Merger Guidelines make clear that HHIs serve only as a screening mechanism to determine if further inquiry is appropriate. According to the Horizontal Merger Guidelines cited by Dr. Selwyn, the HHI thresholds he uses do *not* "provide a rigid screen to separate competitively benign mergers from anticompetitive ones," but "[r]ather, they provide one way to identify some mergers *unlikely* to raise competitive concerns and some others for which it is particularly important to

[11] CWA also provides national HHIs and makes similar arguments to Dr. Selwyn. *CWA Testimony*, p. 13. My criticisms of Dr. Selwyn's approach apply also to the *CWA Testimony*. I note that CWA agrees that "market shares and HHIs do not necessarily tell the whole story. Industries with few players may be intensely competitive." *CWA Testimony*, p. 16.

examine whether other competitive factors confirm, reinforce, or counteract the potentially harmful effects of increased concentration."[12]

The relevant question is, as Dr. Selwyn himself states, how consumer welfare based on the prices charged and the quality of the combined network compares with the standalone networks going forward.[13] HHIs or changes in HHIs cannot answer that question. Indeed, as explained below, Dr. Selwyn provides no analysis that enables a comparison of consumer welfare between the two possible worlds. I do provide such an analysis, and it shows that the merger is good for California consumers.

Q: But doesn't Dr. Selwyn argue that the "mobile wireless market in the US has been undergoing massive consolidation for more than a decade" and that "further market consolidation is neither warranted nor in the public interest"?[14] How do you respond?

A: Strikingly, Dr. Selwyn notes that there has been an increase in industry consolidation, but does not address the obvious next question: Has this been associated with an increase in prices or other harm to consumers? In fact, the consolidation that Dr. Selwyn discusses has been associated with substantial declines in prices, as Dr. Selwyn acknowledges elsewhere in his testimony. See Dr. Selwyn's Figure 2, reproduced below.[15] Given that the "massive

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[12] U.S. Department of Justice and the Federal Trade Commission, Horizontal Merger Guidelines, August 19, 2010 (hereinafter *Horizontal Merger Guidelines*), p. 19 [emphasis added].

See also *In the Matter of Communications Marketplace Report*, GN Docket No. 18-231, Report, December 26, 2018, ¶ 30 ("High market concentration levels in any market may raise some concern that a market is not competitive, although we note that this is not necessarily the case."); n. 92 ("It is well understood that we can observe intense competition even with a small number of firms in the market" (citing Ernest Gellhorn, Antitrust Law and Economics (4th ed.), West Publishing, at 117 (1994) (stating "[m]arket shares are not synonymous with market power; they should mark the beginning for careful analysis, not the end of it"))).

[13] See, *e.g.*, *Selwyn Testimony*, p. 107:13-17 ("[W]hat [Cornerstone] *should have done* is to compare *future* standalone Sprint and T-Mobile network quality with *future* incremental New T-Mobile network quality at a corresponding future point in time, assuming that, if the merger is denied, both companies would continue to invest in their networks, *as both had stated, before they announced plans to merge, that they intended to do*." Emphasis in original.)

[14] *Selwyn* Testimony, ¶¶ 11, 13.

[15] See, *e.g.*, *Selwyn Testimony*, Figure 2, below. Dr. Selwyn also discusses average revenue per user ("ARPU") and EBITDA margins (Tables 12 and 13). He makes no effort to control for quality increases,

consolidation" that Dr. Selwyn expresses concerns about has been associated with, according to Dr. Selwyn, a roughly 85 percent decline in prices over the same time period, Dr. Selwyn's claim that further consolidation must necessarily be anticompetitive is without basis.

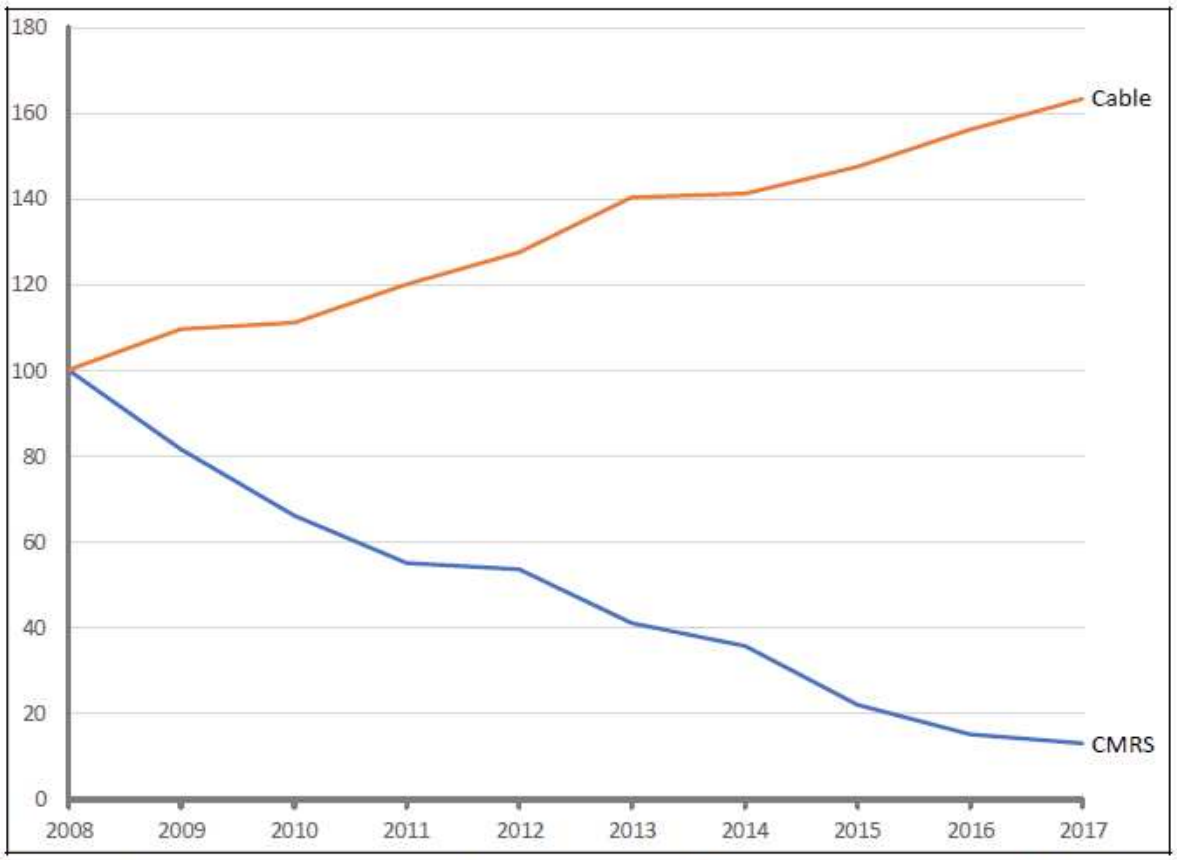

Figure 2. Prices for wireless voice and data services have been steadily decreasing, while Basic Cable prices have steadily risen. Index (2008=100) of Basic Cable average service price and Average Revenue per Mixed Unit for CMRS. Sources: FCC Cable Report; CTIA Semi-Annual Wireless Industry Survey, year end 2013, 2017. Note that prices for Basic Cable for 2016 and 2017 have not been published; those shown here are linearly extrapolated from the previous trend. Wireless usage rates for 2015 were not published; the 2015 index value was constructed using actual 2015 pricing and the average for the 2014 and 2016 usage values.

which have been substantial, but even so, he reports ARPU for the industry falling from $45.63 in 2013 to $35.93 in 2016—a roughly one-fifth decline in three years.

Q: If HHI measures are only the starting point for economic analysis, what additional analysis did you undertake?

A: I conducted a full economic simulation of the proposed merger,[16] which interacts each of the three primary effects discussed above (impact of cost reductions, quality improvement, and one less competitor), and thus enables an economist to assess the net effect of the merger on consumer welfare. Merger simulation is a commonly used workhorse economic tool for making predictions about the effects of a proposed merger on competition and consumer welfare.[17]

It is important to recognize that a merger simulation does not calculate a price increase from a merger and then "offset" it with efficiencies. Rather, the simulation appropriately determines a merger's competitive effects by evaluating the combined effects of the economic forces identified on the merged company's incentives to raise or lower its quality-adjusted prices relative to those prices that would prevail absent the merger.[18]

Q: Does Dr. Selwyn attempt to integrate the various effects of a merger into an overall assessment of the proposed transactions effects on competition and welfare, using a merger simulation or otherwise?

A: No. Indeed, Dr. Selwyn quantifies neither upward nor downward pricing pressure. In particular, unlike the IKK analysis, Dr. Selwyn not only fails to account for how the various economic effects are interrelated, but he does not even attempt to quantify either predicted price effects or consumer welfare benefits from efficiencies on their own.

Moreover, to the extent Dr. Selwyn analyzes such effects qualitatively, he considers each in isolation. This cannot yield an accurate measure of the merger's competitive effects, as it ignores the important ways these economic effects interact with one another. Attempting to predict price effects, for example, without accounting for the effects of efficiencies on marginal

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[16] I refer throughout to the work I have done with Michael Katz and Bryan Keating—the "IKK" referred to earlier.

[17] *Horizontal Merger Guidelines,* § 6.1.

[18] *Horizontal Merger Guidelines,* p. 21 ("Where sufficient data are available, the Agencies may construct economic models designed to quantify the unilateral price effects resulting from the merger. These models often include independent price responses by non-merging firms. They also can incorporate merger-specific efficiencies.")

costs, is not a reliable approach, because estimating price effects and efficiency effects separately and then comparing the two would fail to account for the interactions between them.[19]

Bottom line, Dr. Selwyn makes no quantitative prediction as to how prices might change post-merger, and he makes no quantitative estimate of the consumer welfare benefits from merger efficiencies, even though he notes that the merger is likely to accelerate the transition to 5G to at least some degree.

Q. What is your overall assessment of the points Dr. Selwyn raises regarding merger efficiencies?

A: His points are without merit. For example, Dr. Selwyn claims that "[w]hile spectrum integration of this type may facilitate the *transition* to 5G, it is of far less importance once a steady-state 5G deployment has been completed."[20] I disagree with Dr. Selwyn's suggestion that there is such a thing as a "steady-state" deployment level in this industry. Historically, networks have never reached a steady state. Rather, every year wireless carriers have invested billions of dollars in continuing to upgrade and expand their networks. A faster transition to 5G thus does not mean simply reaching some steady-state equilibrium where investment ceases, but rather means that later investments in further upgrades and expansions will be moved up (and will become more cost effective and more quality enhancing), which provides permanent and ongoing benefits, contrary to Dr. Selwyn's claim.

Q: How does Dr. Selwyn take account of efficiencies?

A: He does not. Rather, Dr. Selwyn simply asserts that it cannot possibly be the case that efficiencies could justify any further consolidation. But he has no basis for this conclusory statement because he does not even attempt to quantify the efficiencies from the merger or to rebut my quantification. My analysis (described below), by contrast, does provide quantitative

[19] My discussion here applies also to the *CWA Testimony* which, like Dr. Selwyn's testimony, provides neither quantitative modeling nor estimates. The only quantitative estimates mentioned in the *CWA Testimony* are references to a submission by economists associated with the Brattle Group on behalf of DISH. *CWA Testimony*, p. 30. I discuss the Brattle Group analysis below.

[20] *Selwyn Testimony*, ¶ 141. Emphasis in original.

estimates for the net effects of the proposed merger, demonstrating that it will benefit California consumers.

IV. OVERVIEW OF MERGER SIMULATION ANALYSIS

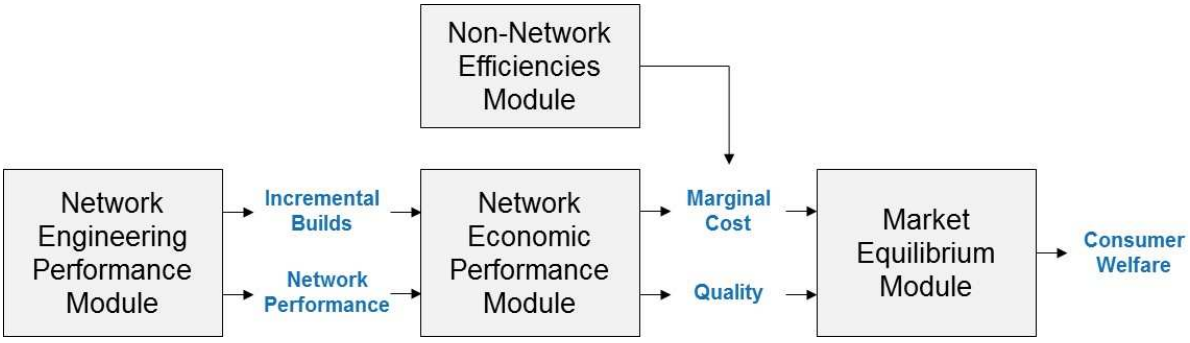
Q: What is a merger simulation model?

A: A merger simulation is an economic model that is designed to assess or simulate the effects of the merger. Such a model captures the main effects of the merger described above (efficiencies and the loss of a competitor) and provides a framework within which to balance those effects in order to assess the net effects of the merger on consumers.

Q: Please describe the methodology of your merger simulation.

A: The merger simulation consists of four "modules": 1) the Network Engineering Performance Module; 2) the Non-Network Efficiencies Module; 3) the Network Economic Performance Module; and 4) the Market Equilibrium Module. Figure 1 provides a schematic description of the elements of the full merger simulation framework.

Figure 1: Merger Simulation Schematic



Q: Let's go through these pieces in turn. First, please describe the Network Engineering Performance Module.

A: The Network Engineering Performance Module is a tool that determines the required network investments, calculates the associated network performance, and serves as a basis for quantifying the network efficiencies that arise from combining the Parties' networks. This tool is derived from the model that T-Mobile uses in the ordinary course of business to assess network investments. For each of three networks (*i.e.*, standalone Sprint, standalone T-Mobile, and New T-Mobile), the module calculates: (a) the number and type of incremental investments (*e.g.*, spectrum overlays and cell splits) necessary to achieve the desired network performance

metrics, and (b) measures of network performance delivered to users expressed in engineering terms (*e.g.*, megabits per second (Mbps) of throughput).[21] Comparing the output of the Network Engineering Performance Module for New T-Mobile's network with the outputs of the module for the standalone networks provides a measure of the efficiencies gained from integrating the networks. I refer to these improvements in performance as "network efficiencies."

Q: What does the Non-Network Efficiencies Module cover?

A: Although network efficiencies constitute the bulk of the expected efficiencies in this merger, the Parties also expect to realize other merger specific cost savings beyond just those associated with operating the network, which I refer to as "non-network efficiencies." The Non-Network Efficiencies Module analyzes these non-network cost savings. As shown in Figure 1 above, these efficiencies are also inputs into the Market Equilibrium Module.

Q: Can you describe what the Network Economic Performance Module contains?

A: The Network Economic Performance Module translates engineering estimates of network builds and performance into projected network marginal cost curves (which show, for any starting traffic level, the incremental network costs required to serve additional traffic at acceptable congestion levels) and projected consumer valuations of network quality for each of the three networks. These projections are compared across networks to quantify the marginal cost savings and consumer valuation of the quality improvements due to the merger.

Q: Finally, how do these come together in the Market Equilibrium Module?

A: The marginal cost and quality valuations are fed into the Market Equilibrium Module, which also incorporates the effect of the loss of Sprint as an independent competitor, to predict the consumer welfare levels with and without the proposed merger. The predicted consumer-welfare effects of the proposed merger are then computed by comparing the predicted consumer welfare level with the merger to the predicted consumer welfare level without the merger, thus

[21] The Network Engineering Performance Module does not capture all meaningful elements of network quality and merger-specific quality improvements. For example, it does not measure latency and does not fully capture improvements in coverage and consistency.

computing the merger's bottom-line effect accounting for all of the relevant effects, described above.

Critically, then, the model's finding that the proposed merger will benefit consumers is based on an integrated and internally consistent framework that incorporates efficiencies from marginal cost and quality improvements, as well as the effect of the loss of a competitor, to arrive at an estimate of the proposed merger's competitive effects.

Q: Dr. Selwyn asserts that the merger will reduce Sprint's and T-Mobile's incentives to support and facilitate mobile virtual network operator ("MVNO") resale.[22] Does your analysis account for such merger effects on wholesale customers?

A: Yes. The Market Equilibrium Module explicitly considers the effects of the merger on wholesale customers. Specifically, to implement an integrated model of mobile network operator ("MNO") and MVNO competition, which includes the fact that MVNOs are wholesale customers of the MNOs but also compete with the MNOs in the retail marketplace for mobile wireless service, I model demand and competitive interactions at the brand level, accounting for underlying ownership and wholesale relationships. I treat MVNOs such as TracFone as distinct retail competitors. I explicitly account for the MNO wholesale pricing incentives that arise from the fact that MNOs sell wireless services to MVNO's for resale in retail markets. Specifically, I estimate merger-related changes in MVNO input costs using a vertical Gross Upward Pricing Pressure Index ("vGUPPI") that accounts for both the effect of the merger on the incentive to facilitate MVNO resale and network marginal cost efficiencies. In doing so, I account for the fact that MNOs will take into account the profits they earn on sales of wholesale network services to MVNOs and any merger-induced change in those incentives such as those that Dr. Selwyn alleges. I embed these effects in an overall model of market equilibrium, thus jointly determining the bottom-line effect on MNO and MVNO pricing and incorporating this in my measure of the merger's effect on consumer welfare.[23]

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[22] *Selwyn Testimony*, p. xii.

[23] I note that TracFone, the largest MVNO, has concluded that the merger will benefit MVNOs and their customers. See Comments of TracFone Wireless, Inc., September 13, 2018, at 2 ("TracFone expects that the strong 5G network to be built by the New T-Mobile, with the additional coverage, speed and capacity can only improve the wholesale market for MVNOs and thus TracFone's customers going forward.").

V. MERGER EFFECTS ON COSTS

Q: Let's dive into merger-specific efficiencies in more detail. What are the categories of merger-specific efficiencies that will be realized by the merger?

A: I consider three primary types of merger-specific efficiencies that will be realized by the merger:

- Non-network marginal cost efficiencies that create incentives to lower prices;
- Network efficiencies, expressed as reductions in marginal cost, which create incentives to lower prices; and
- Network efficiencies expressed as improvements in quality, which create a more valuable product for consumers.

I consider the marginal cost efficiencies in this section and quality efficiencies in the next section.

Q: Why do you focus primarily on marginal cost efficiencies as opposed to other types of cost efficiencies?

A: I focus on marginal cost efficiencies because reductions in marginal cost most directly create downward pricing pressure. Economics has demonstrated that marginal (or incremental) cost reductions—reductions in the costs associated with serving incremental customers—create immediate incentives for firms to lower nominal prices.

Q: Are fixed cost efficiencies relevant for considering the implications of the merger?

A: Yes. Although I do not rely on fixed cost savings in reaching my conclusion that the merger will be procompetitive, I note that the parties expect to achieve substantial fixed cost savings.[24] As economists recognize (and thus the Horizontal Merger Guidelines reflect), such fixed cost savings can benefit consumers by reducing the costs of research and development projects and thus further increasing incentives to invest and innovate, especially over the longer

[24] T-Mobile expects to achieve **[Begin Highly Confidential – Attorneys' Eyes Only ("BHC-AEO")]** [redacted] **[End Highly Confidential – Attorneys' Eyes Only ("EHC-AEO")]** in merger efficiencies. Rebuttal Testimony of G. Michael Sievert, January 29, 2019, pp. 2-3.

term.[25] The Antitrust Modernization Commission has recognized the importance of accounting for fixed cost efficiencies:[26]

> **The Agencies Should Ensure that they Give Sufficient Credit to Certain Fixed-Cost Efficiencies**. The agencies should account for the value of fixed-cost efficiencies in assessing the likely competitive effects of a merger. As one commenter explained, "[s]ince all costs vary in the long run, reductions in capital expenses or other costs fixed in the short run should also be considered." Failure to take account of and give proper weight to such fixed costs in evaluating a merger could deprive consumers and the U.S. economy of significant benefits from a procompetitive merger… reductions in total costs (including fixed costs)—such as through the elimination of redundant facilities or by improvement upon the rate and quality of innovation—have less (if any) effect on pricing in the short run. In the longer run, however, some (if not all) such efficiencies are also likely to benefit consumers in the form of lower prices or improved quality… [such] efficiencies do not necessarily lower prices to consumers immediately, but have the potential to bring significant benefits to consumers through new, improved, or lower priced products in the longer run.

Q: What are the incentives for firms to pass through lower marginal costs to customers in the form of lower prices? Do these incentives depend on firms not having market power?

A: It is well established in economics that all firms have an incentive to pass through marginal cost changes: This is a fully general result that does not depend on any specific assumption about the degree of competition in the market (indeed, even monopolists pass through some or all marginal cost reductions). There is no meaningful controversy about this in economics.[27] To see why this is a non-controversial point, recognize that the profit-maximizing

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[25] *Horizontal Merger Guidelines,* § 10, note 15 ("Efficiencies relating to costs that are fixed in the short term are unlikely to benefit customers in the short term, but can benefit customers in the longer run, e.g., if they make a new product introduction less expensive.")

[26] Antitrust Modernization Commission, Report and Recommendations, April 2007, pp. 58-60. See also Michael L. Katz and Howard A. Shelanski (2007), "Mergers and Innovation," *Antitrust Law Journal,* 74(1): 1-85, p. 56 ("[E]ven a small change in fixed costs can lead to a large change in consumer welfare [when] the cost change (or other merger efficiency) tips the balance in favor of a supplier's undertaking a discrete investment that generates a large amount of surplus, such as the introduction of a new product.").

[27] See, *e.g.*, Paul L. Yde and Michael G. Vita (1996), "Merger Efficiencies: Reconsidering the Passing-on Requirement," *Antitrust Law Journal*, 64(3): 735-747; Luke Froeb, Steven Tschantz, and Gregory J. Werden (2005), "Pass-through rates and the price effects of mergers," *International Journal of Industrial Organization*, 23(9-10): 703-715.

price for any firm is the price that just balances the incentive to raise prices to make more per unit with the incentive to cut prices to sell more units. When the scales are equally balanced between those two incentives, prices are at their profit-maximizing level. A reduction in marginal costs tips the scales by making it more profitable to sell an incremental unit of output, meaning that prices must be cut to bring the scales back in balance and once again maximize profits. Thus, a firm—even a firm with market power—has an incentive to lower its price relative to the profit-maximizing price that prevailed prior to the cost decrease, in order to sell more units.

Q: Dr. Selwyn argues that "such efficiency gains as may arise will only be flowed through as 'economic benefits' to consumers if New T-Mobile is compelled by competitive marketplace forces to reduce its prices to reflect such efficiencies,"[28] and he asserts that such flow through is unlikely. How do you respond?

A: Dr. Selwyn is incorrect as both a matter of logic and of economics.

First, Dr. Selwyn simply assumes his result, while I demonstrate the contrary by implementing an economic model. Dr. Selwyn claims that there will not be sufficient competition post-merger to force any cost reductions to be passed through to consumers. However, he provides no economic model to support such a claim. My analysis, by contrast, takes into account the inter-relationship of competitive forces and cost reductions and demonstrates that pass through will occur.

Second, Dr. Selwyn's claim is simply incorrect as a matter of economics. As noted above, it is a fundamental principle of economics that pass through occurs regardless of the degree of competition and even a monopolist will pass through marginal cost reductions to some degree. There is simply no basis in economics to claim that a reduction in marginal costs will produce no consumer benefits through lower prices.[29] Nor is it necessarily the case that consolidation will produce a lower pass-through rate. Again, my analysis addresses the interplay

[28] *Selwyn Testimony*, ¶ 57.

[29] See note 28.

of the various factors and computes equilibrium pass-through rates with and without the merger, rather than merely (incorrectly) speculating about pass-through rates as Dr. Selwyn does.

Q: Before turning to a more detailed discussion of the efficiencies, can you explain whether it is necessary to measure efficiencies specific to California to assess the effects of the merger in California?

A: With respect to marginal cost efficiencies, it is not necessary to evaluate California-specific costs. The reason is that marginal costs are relevant through their effect on prices, and both Sprint and T-Mobile offer national pricing plans, which are driven by each firm's national marginal costs, not by California (or any state) specific costs. Merger-induced changes in the cost structure will affect national pricing incentives and therefore the prices that California customers will realize.

With respect to network quality efficiencies, network quality does vary state to state. Hence, in my analysis, I focus on the California-specific quality of each standalone network and the New T-Mobile network.

Q: Turning to the efficiencies in detail, can you describe your analysis of non-network efficiencies?

A: The Parties expect to achieve ongoing, annual non-network cost savings of approximately **[BHC-AEO]** [redacted] **[EHC-AEO]** per year by 2024.[30] These savings include cost reductions in sales, service and marketing (including retail distribution, advertising, customer care, equipment costs, repair, and logistics) and back office operations (including information technology, billing and other G&A). Although the majority of these cost savings constitute fixed cost savings, certain savings, including dealer commissions, device purchases, and device repair insurance, are variable costs because they vary with the number of customers that New T-Mobile attracts. In total, these variable costs account for approximately one third of the total estimated non-network cost savings. Because these costs vary with the number of subscribers, the combined firm will experience lower marginal costs, which, just as with marginal network costs,

[30] Financial Model Build 8.0/9.0.

it will have an incentive to pass through to consumers (at least in part) in the form of lower prices.

Table 1 summarizes the magnitude of the non-network marginal cost efficiencies.

Table 1: Non-Network Efficiencies, 2019-2024

[BHC-AEO]

[redacted]

[EHC-AEO]

Q: Does the fact that you separately estimate prepaid and postpaid non-network efficiencies imply that prepaid and postpaid products are in separate relevant markets?

A: No. Business categorizations are distinct from antitrust markets. For example, both Sprint and T-Mobile maintain separate prepaid brands, which I model separately in my merger simulation, but these separate brands also do not constitute separate markets. As I explain further below, despite differences both within and across prepaid and postpaid products, in economic terms, all of these products should be treated as part of a single relevant market for wireless services.

Q: Turning to network efficiencies, can you start with an intuitive explanation of where these efficiencies come from?

A: The network efficiencies come from several sources, some of which will be realized quickly post-merger and some of which play out over a longer term. Below I provide an intuitive, economic-implication-focused overview of some of these sources of efficiencies as derived from my own work and modeling and with the network engineers.

First, bringing together the cell towers of T-Mobile and Sprint creates an immediate, low-cost way to expand the combined network: T-Mobile's spectrum can be deployed through radios on Sprint towers and Sprint's spectrum can be deployed through radios on T-Mobile's towers. In many cases, this can be done at little or no incremental cost (relative to the cost required to integrate the networks) because new radios need to be deployed as part of integration anyway

and because, in some cases (*e.g.*, adding Sprint's PCS spectrum to T-Mobile's AWS and PCS spectrum), the spectrum can be deployed through existing radios. Deploying additional spectrum to existing towers creates a much lower cost method of increasing network capacity and quality than building new towers (cell splits). Put simply, deploying the combined spectrum of both parties on a combined set of towers makes full use of the multiplicative gain from the fact that network capacity depends on the amount of spectrum multiplied by the number of cell sites. Hence, the combination immediately improves network quality and reduces the need for additional costly solutions over time to deal with congestion, thus lowering marginal cost.

Second, the benefits of deploying combined spectrum on towers increase the gain from each cell split going forward. When new cell splits are required over time, the combined firm can deploy the combined spectrum holdings on the new towers, thus multiplying the capacity gain (and thus congestion reduction and quality enhancement) of each cell split without multiplying the cost. The separate firms would need two separate cell splits for what the combined firm can do as one, thus increasing the gain per dollar and reducing marginal cost.

Third, bringing together the two networks and two sets of customers can make use of excess capacity on either network today. Where there are congested T-Mobile sites in areas where Sprint has excess capacity (above congestion thresholds), a merger enables the excess capacity to be used for the T-Mobile customers, thus serving the full set of customers at levels above congestion thresholds, avoiding the low throughput levels that are especially disliked by consumers, and avoiding the need for costly solutions. The same holds where there are congested Sprint sites in areas where T-Mobile has excess capacity.

Fourth, combining spectrum on a given tower creates more effective capacity (thus improving quality and reducing required solutions and thus costs) than separate spectrum. This follows due to what are often called "trunking" or "queueing" efficiencies. Due to the random nature of demand on a cellular network (what economists refer to as "stochastic" demand), at certain points in time at a given location, either the T-Mobile or the Sprint networks may reach congestion levels at a time that the other is not congested. By combining the networks, the excess capacity on either network can be used to offset the congestion on the other; the full set of spectrum is available to the full set of customers. A simple analogy comes from lines at a bank, where one line may be jammed while another is empty; by having a combined line in which the

front person goes to whichever teller is open, the capacity can be better used, effectively creating additional capacity, improving the consumer experience, and reducing the need to open more registers to deal with the congested ones, which increases costs.

Table 2 summarizes the magnitude of the network marginal cost efficiencies.

Table 2: Network Marginal Cost Efficiencies, 2019-2024 ($/Subscriber/Month)

[BHC-AEO]

[redacted]

[EHC-AEO]

Q: Can you explain how to interpret the numbers in Table 2?

A: Each entry in the table reflects the network marginal cost savings from the merger, expressed as a per-subscriber-per-month figure. For example, my analysis indicates that it will cost New T-Mobile **[BHC-AEO]** [redacted] **[EHC-AEO]**/subscriber/month less, in network costs, to provide wireless service to a marginal postpaid customer in 2024 relative to the network costs that standalone Sprint would incur to provide service to that same customer (the corresponding savings relative to standalone T-Mobile is **[BHC-AEO]** [redacted] **[EHC-AEO]**/subscriber/month).

Q: What is the total value per subscriber of merger-specific efficiencies that will be realized from the merger, combining network and non-network efficiencies?

A: Table 3 summarizes the total network and non-network marginal cost efficiencies, described above, by year. Continuing the example from above, the 2024 postpaid savings once

non-network savings are added in are **[BHC-AEO]** [redacted] **[EHC-AEO]**/subscriber/month for **[BHC-AEO]** [redacted] **[EHC-AEO]**/subscriber/month for T-Mobile.

Table 3: Marginal Cost Efficiencies, 2019-2024 ($/Subscriber/Month)

[BHC-AEO]

[redacted]

[EHC-AEO]

Q: How do these numbers compare to average revenue per user (ARPU)?

A: T-Mobile's current ARPU is approximately $45/subscriber/month, so a marginal cost reduction of **[BHC-AEO]** [redacted] **[EHC-AEO]** is equivalent to **[BHC-AEO]** [redacted] **[EHC-AEO]** percent of ARPU.

Q: How do you respond to Dr. Selwyn's claims that the efficiencies are overstated and not credible in light of the FCC's rejection of efficiency claims in the attempted AT&T/T-Mobile merger?

A: The two mergers and the analyses of efficiencies used in each are entirely different. Dr. Selwyn cites to the FCC Staff analysis of the AT&T/T-Mobile proposed merger for the proposition that the FCC rejected network efficiency arguments.[31] This is false; Dr. Selwyn

[31] *Selwyn Testimony*, p. xv, ¶ 162.

mischaracterizes the FCC Staff report and ignores subsequent FCC opinions evaluating wireless mergers. Contrary to Dr. Selwyn's claim, the FCC Staff "recognize[d] that models can be valuable tools for assessing a proposed transaction, and that any model will necessarily abstract from reality and include certain assumptions about the structure, conduct, and performance of industries and companies."[32] The Staff did not reject the logic of such efficiencies, but simply explained that "the developers of those models must show that their predictions are reliable, demonstrating, e.g., a reasonable correspondence between the models and actual business practices, a reasonable factual basis for selecting the values of key model inputs, the robustness of the results with respect to plausible variation in those values, internal consistency within the model components, and indicia of the model's predictive value in the real world."[33] In that case, the FCC Staff found that the network model was not reliable, in part because it was not used in the ordinary course of business (and also because it contained errors that are not present in the model in this case).

Critically, the model being used here is not the same as the model put forward by AT&T in the AT&T/T-Mobile transaction, and Dr. Selwyn provides no support for his assertion that criticisms of one must necessarily apply to the other. In fact, there is no such linkage. Indeed, the network engineering model used here (unlike that put forward by AT&T) is derived directly from that used by T-Mobile for years in the actual construction of its network. The model's predictions are thus demonstrably accurate.[34]

Q. What about Dr. Selwyn's claims regarding the success of T-Mobile following the failure of the AT&/T-Mobile merger?

A: Dr. Selwyn's claim that "T-Mobile's spectacular growth in the immediate aftermath of [the AT&T/T-Mobile] merger's demise puts the lie to such claims" is incorrect and misleading.[35]

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[32] FCC Staff Analysis and Findings, Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer Control of Licenses and Authorizations, FCC WT Docket No. 11-65, November 30, 2011, ¶ 130.

[33] *Id.*

[34] Rebuttal Testimony of Neville R. Ray, January 29, 2019, p. 26.

[35] *Selwyn Testimony*, p. xv.

T-Mobile received $3 billion in cash, $2 billion in spectrum, and a roaming agreement valued at $1 billion as part of the break-up of that transaction. Dr. Selwyn acknowledges this fact in passing but suggests that it is irrelevant to T-Mobile's later performance.[36] In fact, T-Mobile had noted it was constrained by its spectrum holdings and cash flow before the AT&T transaction, and Dr. Selwyn provides no basis to support his claim that receiving billions of dollars of both spectrum and cash did nothing to ameliorate T-Mobile's problems. Indeed, the evidence is to the contrary, because, as Dr. Selwyn notes, T-Mobile's performance improved following the infusion of cash used to buy spectrum and spectrum received directly.

Q. Has the FCC approved mergers based on efficiency claims and models like those used here?

A: Yes. Dr. Selwyn also fails to recognize that the FCC has approved numerous mergers based on precisely these types of efficiency claims, including T-Mobile's merger with MetroPCS. This merger occurred after the 2011 AT&T/T-Mobile attempted transaction, and the FCC credits that merger with the success of T-Mobile's LTE expansion, which Dr. Selwyn suggests occurred in spite of the failure of the AT&T/T-Mobile transaction.[37] In particular, the FCC explained in the order approving that merger that the merged company would deploy a "broader, deeper, and faster LTE deployment than either company could accomplish on its own."[38]

> We find, based on the record before us and the Applicants' descriptions discussed above, that the proposed combining of T-Mobile USA and MetroPCS likely would result in meaningful public interest benefits that support approval of the proposed transaction. We find that the Applicants have demonstrated that many of the claimed benefits are feasible and likely to be put into effect soon after the proposed transaction is concluded. In particular, we anticipate that the combination of T-Mobile USA and MetroPCS would enable the deployment of a substantial LTE network nationally that would enhance competition and provide important benefits for consumers. By merging the two companies, and their

[36] *Selwyn Testimony*, ¶ 159.

[37] *Selwyn Testimony*, p. 107.

[38] FCC, Memorandum Opinion and Order and Declaratory Ruling, T-Mobile/MetroPCS, DA 13-384, March 12, 2013, ¶ 74. I also note that the FCC calculated HHIs in that Order which, as here, exceeded the thresholds cited by Dr. Selwyn. The FCC, however, did not stop with HHIs, and concluded that on balance the merger would benefit consumers.

> network assets and spectrum, we find that the resulting Newco would provide for a broader, deeper, and faster LTE deployment than either company could accomplish on its own. Existing MetroPCS customers would have access to a more robust, national network and a broader array of service and handset options. Consumers outside of MetroPCS's current limited service area will have the benefit of the MetroPCS service plans becoming available as an additional option. T-Mobile USA customers would experience improved service quality, particularly in major metropolitan markets in which the existing T-Mobile USA and MetroPCS networks would be combined. We expect that these public interest benefits may significantly enhance the competitiveness of Newco, as the fourth largest nationwide service provider, to the top three providers than T-Mobile USA could achieve alone.[39]

Mr. Keys also explains that MetroPCS customers benefited from the merger. Indeed, churn actually fell during the integration period, consistent with consumers valuing the new service more than the service that standalone MetroPCS offered.[40] Mr. Sievert explains that the predicted efficiencies were achieved ahead of schedule and at even higher levels than predicted.[41]

Q: Was the model that T-Mobile used for the T-Mobile/MetroPCS capacity planning process the same as the model that T-Mobile used in analyzing this transaction?

A: Yes. My understanding is that the LTE model used in this transaction is identical to the model that T-Mobile used in the T-Mobile/MetroPCS transaction. And while 5G did not exist at the time of the T-Mobile/MetroPCS transaction, the 5G network engineering model that T-Mobile used in this transaction is based on T-Mobile's ordinary-course engineering principles just as the LTE model is.[42]

[39] FCC, Memorandum Opinion and Order and Declaratory Ruling, T-Mobile/MetroPCS, DA 13-384, March 12, 2013, ¶ 74.

[40] Rebuttal Testimony of Thomas C. Keys, January 29, 2019, p. 15.

[41] Rebuttal Testimony of G. Michael Sievert, January 29, 2019, pp. 12-13.

[42] Rebuttal Testimony of Neville R. Ray, January 29, 2019, pp. 26-27.

Q: How do you respond to CWA's claims that the efficiencies are overstated and not credible?

A: Mr. Ray responds to CWA's claims in detail.[43] However, I note that CWA's arguments appear to be based on misunderstandings of the basis for the efficiencies that will arise from the merger. In particular, CWA argues that "[b]oth companies are viable on a standalone basis and are already in the process of improving their networks, including their ability to provide initial 5G services."[44] Although I understand there are serious questions about Sprint's viability, which Mr. Draper will address, I nonetheless fully incorporate the parties' standalone plans in my analysis. None of the efficiencies depend on any claims that either standalone company would not work to improve their networks or would not deploy 5G on its own. The relevant question is the incremental improvement of the combined network relative to the improvement that each standalone firm can make on its own. And my modeling, described above, demonstrates that New T-Mobile would operate more efficiently—with lower cost and higher quality—than would either standalone company. These efficiencies are merger-specific and the models used to demonstrate those efficiencies were accepted by the FCC in the T-Mobile/MetroPCS merger.

[43] See generally Rebuttal Testimony of Neville R. Ray, January 29, 2019.

[44] *CWA Testimony*, p. 32.

VI. MERGER EFFECTS ON NETWORK QUALITY

Q: Have you analyzed the effect of the merger on network quality in California?

A: Yes.

Q: What have you concluded about the effects of the merger on network quality in California?

A: In addition to reducing the costs associated with serving any given level of traffic, the efficiencies derived from combining the Sprint and T-Mobile networks increase product quality along several dimensions, including, among others, improvements in throughput, consistency of experience, and reduced usage restrictions. This is the case in both California and for the nation as a whole.

Q: Have you fully quantified all of these dimensions of improvement?

A: No. There are many additional improvements beyond those that I have quantified, and my analysis therefore does not capture the full benefits of the transaction (and nevertheless demonstrates that the merger is beneficial to California consumers). For example, the Network Build Model is, fundamentally, a capacity model designed to assess capacity and throughput within the footprint of the network. It is not designed to measure coverage limitations and thus does not fully capture Sprint's coverage disadvantages, and, conversely, the merger-induced benefits from addressing those disadvantages.[45]

Q: What do you find with regard to throughput improvements?

A: I find there will be substantial throughput improvements in California as a result of the merger. Figure 2 and Figure 3 show the distribution of (weighted-average) LTE and 5G throughput in California in 2021 and 2024 for the New T-Mobile network versus the standalone networks. In both years, throughput in the New T-Mobile network (black line) is far above

[45] The *ABH Whitepaper* analyzes coverage and captures some of the benefits Sprint consumers will enjoy in that regard. See also Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019, p. 21.

throughput in either the standalone Sprint (yellow line) or the standalone T-Mobile network (magenta line). The combined firm will offer the combined set of customers far higher speeds than either standalone firm can offer its customers. That is a major benefit to consumers.

Figure 2: California Throughput by Network, 2021[46]

[BHC-AEO]

[EHC-AEO]

[46] These are results from the 2021 "Maintain" case, which means simply that I assume usage per customer will not increase and that the analysis runs through 2021. In fact, if I allow for the possibility of increased usage, the IKK model predicts large increases in usage that will surely generate significant consumer value. *IKK Declaration,* § VI.C.2.

Figure 3: California Throughput by Network, 2024

[BHC-AEO]

[EHC-AEO]

Q: Have you quantified the value of increased throughput to consumers?

A: Yes. I have used a very conservative approach to assess the value of increased throughput. Specifically, to develop one quantitative estimate of the quality benefits of the proposed merger, I turn to estimates of the valuations of increased throughput in the academic literature.[47] The most relevant measures in the academic literature for present purposes come

[47] Beyond the specific article on which I rely for my quantification, I note that the academic papers that have studied the topic have generally found high consumer valuation on various aspects of network quality, including throughput, coverage, and usage limits. (See, *e.g.*, Yu-Hsin Liu, Jeffrey Prince, and Scott Wallsten (2018), "Distinguishing Bandwidth and Latency in Households' Willingness-to-Pay for Broadband Internet Speed," unpublished manuscript; Kyle Wilson (2018), "Does Public Competition Crowd Out Private Investment? Evidence from Municipal Provision of Internet Access," unpublished manuscript.) The large increases in consumer welfare for a given increment of speed can be seen by comparing estimates from older papers with the 2017 estimates from Liu *et al*. For example, the consumer benefit for a given speed increment in Liu *et al.* is roughly seven times higher than for the same speed increment as of 2009. (See Mark Dutz, Jonathan Orszag and Robert Willig, "The Substantial Consumer Benefits of Broadband Connectivity for U.S. Households," Report Commissioned by the Internet Innovation Alliance, July 2009, pp. 26-27.) The *ABH Whitepaper* also studies detailed current wireless data and finds still greater throughput valuations, suggesting that using the older estimates from the academic literature is likely to be conservative.

from a paper by former DOJ Deputy Assistant Attorney General for Economic Analysis Aviv Nevo and coauthors, who analyze, among other questions, customers' willingness to pay ("WTP") for increased throughput.[48]

To compute consumer valuation on increased throughput, I first compute the weighted average throughput for each network sector— weighting the 5G and LTE throughputs by the traffic on each sector—for each of the standalone networks and new T-Mobile. I then use the *Nevo et al.* results to determine the consumer valuation of this weighted average throughput at each sector.[49] I weight the resulting sector-level valuations up to the network level by using the sector traffic levels as weights. Finally, I compute consumer valuation of the merger-induced improvements in network quality by taking the difference between the valuation of the New T-Mobile network and that of each standalone network.

Q: How much is the increased network throughput worth to consumers in California?

A: After the networks are integrated, consumer benefits from increased network throughput alone are in the range of one to three dollars per subscriber per month. Table 4 summarizes the value to consumers of the increased throughput that the merger will generate.

[48] Aviv Nevo, John L. Turner, and Jonathan W. Williams (2016), "Usage-Based Pricing and Demand for Residential Broadband," *Econometrica,* 84(2): 411-443 (hereinafter, *Nevo et al.*).

[49] In running the model from *Nevo et al.*, I assume consumers do not face explicit usage constraints. This approach simplifies the model substantially while maintaining its validity as a tool to measure the value of network quality. In the unadjusted runs, I select the most common consumer type from *Nevo et al.* for each parameter, as described in the article's supplemental appendix on page 11, and compute the valuations using the closed form solution. In the adjusted runs, I start from these most common consumer types, but I then re-calibrate the model so that the usage predicted by the model matches that in the Network Build Model for the New T-Mobile network. I do so by finding the value of μ, the main parameter governing the consumer's average value of content, such that the *Nevo et al.* model predicts expected monthly usage on the New T-Mobile network equal to that in the Network Build Model. For example, my calibrated values of μ for the case where New T-Mobile relaxes usage restrictions are **[BHC-AEO** [redacted] **[EHC-AEO]**.

Table 4: Valuation of Throughput Improvements

[BHC-AEO]

[EHC-AEO]

Q: Are your estimates of the value of quality improvements conservative?

A: Yes. For several reasons.

First, I do not quantify the full value of relaxing restrictions on usage. By reducing the marginal cost of increased traffic on the network, the merger creates incentives to allow consumers to use more data. In the *IKK Declaration,* I showed that relaxing the usage restrictions leads to increases in the projected average usage across Sprint and T-Mobile 5G subscribers of roughly 75 percent in 2021 and 100 percent in 2024. Doubling or nearly doubling the amount of usage per customer will surely generate significant consumer value. Effectively the merger is giving consumers more of the product without charging them more for it; like doubling the number of M&Ms in a bag without raising the price. That's an enormous benefit that my throughput-focused quality valuation estimates do not capture.

Second, my quantification of the value of throughput improvements is itself conservative. Consumers will almost surely value network speed and quality more highly in the future than they do today. The history of the mobile wireless industry demonstrates that, as wireless speeds increase and the application ecosystem evolves to keep up, consumer demand for faster and better networks increases, meaning that consumer willingness to pay for (and thus benefit from)

improved network quality—particularly at the high end of what networks can offer—increases substantially.[50] A critical implication of this fact is that any attempt to utilize unadjusted estimates of the amounts by which consumers currently value network speed and quality to assess how consumers will value the proposed merger's quality benefits will almost surely understate those benefits.

Third, my analysis does not quantify the full value of improvements in network coverage and consistency, especially for Sprint customers. **[BHC-AEO]** [redacted] **[EHC-AEO]** Thus, New T-Mobile will offer substantially broader and more consistent coverage in California than would standalone Sprint. This surely generates significant consumer value which I do not quantify, making my results highly conservative.[54] In fact, the "Cornerstone" model, upon which Dr. Selwyn commented, demonstrates that increased coverage is valuable to consumers.[55]

[50] David S. Evans, "Economic Analysis of the Impact of the Proposed Merger of T-Mobile and Sprint on the Deployment of 5G Cellular Technologies and the Resulting Impact on Consumers, Enterprises, and the Economy," June 15, 2018, § II.

[51] *In the Matter of Applications of T-Mobile US, Inc. and Sprint Corporation*, WT Docket No. 18-197, Reply Declaration of John C. Saw, September 17, 2018 (hereinafter *Saw Reply Declaration*), ¶ 6.

[52] Testimony of Brandon Dow Draper, January 29, 2019, p. 37. See also *Saw Reply Declaration,* ¶ 8 ("5G deployment will be limited to areas in and around major cities").

[53] Rebuttal Testimony of Neville Ray, January 29, 2019, p. 18.

[54] For further discussion of these benefits, see Testimony of Brandon Dow Draper, January 29, 2019, pp. 13, 16, 22-23.

[55] *ABH Whitepaper,* Exhibit 6.

One specific implication of the Sprint deployment plan is that Sprint customers would frequently be forced to "leak" to Sprint's LTE network or onto the LTE networks of Sprint's roaming partners with the associated losses in network quality. The fact that standalone Sprint will severely limit the deployment of its 5G network for many years (because the cost of expansion would exceed the benefits to Sprint given its small customer base) means that standalone Sprint customers will have to rely on LTE far more often than will New T-Mobile customers and thus deprive the standalone Sprint customers of the full benefit of the benefits of 5G, including among other things, lower latency and lower power requirements for certain devices. Although I do account for throughput increases, my analysis does not quantify these additional benefits of expanded access to 5G for Sprint's customers; doing so would lead to even greater merger benefits.

VII. CONSUMER WELFARE EFFECTS OF THE MERGER

Q: Can you describe the key findings of the IKK merger simulation?

A: Even if one maintains conservative assumptions (beginning in many cases with assumptions made by parties challenging the merger and generally erring on the side of being conservative) the projected merger efficiencies will, on average, outweigh any adverse competitive effects from the loss of a competitor. Specifically, the projected merger efficiencies are large enough that the net present value ("NPV") of the consumer welfare effects of the proposed merger will be substantially greater than zero. I establish this result with a standard methodology: estimating the consumer-welfare effects of the merger in each year and then applying a discount factor to obtain their NPV, thus determining the all-in effect of the merger on California consumers.

Under a range of different model specifications, my analysis shows that the merger enhances consumer welfare. In my baseline case, the merger creates **[BHC-AEO]** [redacted] **[EHC-AEO]** in incremental consumer surplus for California customers. To put this number in context, given **[BHC-AEO]** [redacted] **[EHC-AEO]** total wireless subscribers in California in 2018, the total gains in consumer surplus correspond to gains of **[BHC-AEO]** [redacted] **[EHC-AEO]** per subscriber.[56]

In sum, this analysis demonstrates that, considering both the effect of loss of a competitor and efficiencies in a unified framework, the merger will benefit California consumers.[57]

Q: Can you provide more details on your model and its conclusions?

A: I provide additional details in the Appendix to this testimony. Further information can also be found in the *IKK Declaration.*

[56] For a description of the sources of subscriber estimates, see *IKK Declaration,* note 164.

[57] CWA, like Dr. Selwyn, argues by anecdote that Sprint and T-Mobile are close competitors and that therefore merger must lead to an anticompetitive outcome. See, *e.g.*, *CWA Testimony*, pp. 20-30.

Q: Is the NPV of consumer welfare a reasonable way to measure the effects of the merger?

A: Yes. It combines the changing effects of the merger on consumers in different years and thus provides the economically appropriate measure of the overall impact of a transaction. In this way, it permits an all-in comparison of the net effects of the proposed merger, unlike Dr. Selwyn's anecdotal and unquantified approach.

NPV is particularly useful in a case like this where the vast majority of mobile wireless consumers will purchase services today and for many years in the future. This fact means that the NPV of welfare effects is relevant even from the point of view of a single consumer. This fact reinforces the conclusion that the NPV calculation is an appropriate way to evaluate the proposed merger's overall welfare effects and that the proposed merger will benefit consumers and strengthen competition. Focusing on any particular year, rather than looking at the overall NPV, would yield an incomplete picture and risk blocking a merger to help a consumer in one year while harming that *same* consumer overall.

Q: Do you agree with Dr. Selwyn's claim that any benefits from the merger will be only transitional?

A: No. My analysis demonstrates that the merger will create persistent benefits for consumers. The NPV analysis described above explicitly models benefits through 2024 and also accounts for the possibility of additional benefits beyond 2024.

Q: Switching topics, given that you rely on diversion ratios based on the ABH ("Cornerstone") demand model, do Dr. Selwyn's criticisms of the "Cornerstone" model refute your analysis?

A: No. Professor Bresnahan responds to Dr. Selwyn's criticisms in his own rebuttal testimony.[58] However, even if Dr. Selwyn's criticisms of ABH were correct, they would not refute my analysis. To understand why Dr. Selwyn's critiques do not affect my analysis, it is important to understand the basic structure of the ABH analysis. First, they estimate a model of

[58] See generally Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019.

consumer demand for wireless services. They then use that demand model as an input into a merger simulation model that assesses the net effect of the merger on consumer welfare. Some of Dr. Selwyn's critiques of the ABH model apply to the demand model (on which I do rely certain aspects of for diversion ratios) while others apply only to the merger simulation (on which I do not rely).

Dr. Selwyn's primary critique of Cornerstone's demand model is that it relies on data from the Nielsen Mobile Performance ("NMP") survey, which only reflect the usage patterns of Android mobile device users.[59] Notably, the authors of the Cornerstone study themselves recognize this and explain why their analysis nevertheless remains valid.[60] They conclude that "[t]he fact that NMP data only sample Android devices is unlikely to lead to any systematic biases in our estimates of consumers' valuations of network quality."[61]

Dr. Selwyn provides no reason why the reliance on NMP data might render the resulting diversion ratios, the one part of the "Cornerstone" model I rely on, to be invalid. The diversion ratios on which I rely are identified by the extremely rich, individual-level variation in network experience, which is a particular strength of the NMP data. Dr. Selwyn provides no basis to conclude that such diversion ratios are unreliable. Moreover, as I demonstrate above, my conclusions are robust to a broad range of diversion ratios, meaning that my conclusions hold even if I do not rely on the "Cornerstone" model at all.

Q: What will be the effect of the merger for low-income consumers? Do low-income customers derive as much value from network quality as other customers?

A: Yes. This is a critical feature of this industry to understand. Because of wireless phone usage patterns, low-income consumers benefit from quality improvements at least as much as higher income consumers. Data collected by Pew Research and the Census show that low-income households are more likely to use mobile networks as their sole source of Internet access

[59] *Selwyn Testimony*, ¶ 98.

[60] *ABH Whitepaper,* n. 87.

[61] *ABH Whitepaper,* n. 87. See also Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019, p. 30.

than are other households.[62] In addition, data show that these consumers are often heavy data users.[63] These facts demonstrate that the improvements in mobile broadband quality due to the merger will be especially valuable to low-income households.

Similarly, findings of the ABH analysis indicate that improved service quality is more valuable to low-income consumers than to high-income consumers. Specifically, the study revealed that consumers who live in lower-income zip codes are more likely to be moderate and heavy data users than consumers in higher-income zip codes.[64] Furthermore, this study finds that medium and heavy data users place higher value on speed and coverage (time on LTE) than do low data users.[65]

Q: Are these findings consistent with your experience as an economist who studies telecommunications issues?

A: Yes. These findings are precisely what I would expect to see in light of the fact that wireless is a substitute for expensive fixed broadband service for those who cannot afford or do not want to pay for fixed broadband service. In this sense, improvements in wireless service can be viewed as improvements at the "less expensive end" of the overall broadband services marketplace. So the network quality improvements described above are likely *particularly valuable* to many low-income consumers.

Q: The CWA cites to a study by economists associated with the Brattle Group to claim that "the merger would increase prices as much as 15.5% on the new T-Mobile's prepaid

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[62] Pew Research Center, "Internet/Broadband Fact Sheet," February 5, 2018, *available at* http://www.pewinternet.org/fact-sheet/internet-broadband/. Camille Ryan, "Computer and Internet use in the United States: 2016," American Community Survey Reports, ACS-39 ("A small percentage of households have smartphones but no other type of computer for connecting to the Internet. These 'smartphone only' households were more likely to be low income, Black or Hispanic."), *available at* https://www.census.gov/content/dam/Census/library/publications/2018/acs/ACS-39.pdf.

[63] Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019, pp. 33-35.

[64] Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019, pp. 33-35.

[65] *ABH Whitepaper* Exhibit 6: A medium/heavy data user's WTP for speed improvement is 5-12 times higher than that of a light data user. See also Rebuttal Direct Testimony of Timothy F. Bresnahan, January 29, 2019, pp. 34-35, discussing distributions by zip code and credit score.

plans and as much as 9.1% for postpaid plans."[66] Have you reviewed the Brattle Group analysis?

A: Yes. A response to the Brattle Group analysis was a subject of my September 17, 2018 submission to the FCC. There I referred to the Brattle Group analysis based on the initials of the authors' last names—"HBVZ". In my discussion below, therefore, references to HBVZ are to the same analysis as referenced by CWA.

Q: What did you conclude?

A: Just as Dr. Selwyn failed to account for merger efficiencies, so did HBVZ. HBVZ therefore did only half the appropriate analysis, meaning their analysis is unable to reach any meaningful conclusions. Once modified to account for efficiencies, their model predicts that the merger will benefit consumers.

Going into more detail, I found that "HBVZ's simulation analyses suffer from several weaknesses. By far the biggest one is that it does not consider the beneficial effects that the merger's efficiencies will have on competition and consumer welfare. Other weaknesses arise from certain methodological choices made by HBVZ and their use of poor estimates of parameter values that are critical to their models' results."[67]

I further concluded, even ignoring the other deficiencies in the HBVZ analysis, that:[68]

> The HBVZ merger simulation analysis demonstrates that the merger is procompetitive once modified to account for efficiencies. HBVZ merger simulation analysis ignores the efficiencies that will arise from the merger. Because it ignores the beneficial aspects of the merger for consumers, HBVZ's analysis, without further modification, would necessarily find that any merger of firms competing for the same customers harms competition and consumers and, thus, this analysis cannot support any conclusions about the net effect of the proposed transaction on competition and consumer welfare. Incorporating the merger-specific efficiencies projected by the Parties' network plans and their Network Build Model into the HBVZ merger simulation model leads to the conclusion that the merger will strengthen competition and raise consumer welfare. Specifically, all of HBVZ's merger simulations require less than $3/subscriber/month of efficiencies for the proposed merger to be procompetitive,

[66] *CWA Testimony*, p. 30.

[67] *IKK Declaration*, ¶ 15.

[68] *IKK Declaration*, ¶ 6.

and the Parties' projected marginal cost savings alone exceed this threshold. Accounting for the quality benefits of the merger strengthens the conclusion that the proposed merger will benefit consumers.

VIII. RELEVANT MARKETS

Q: What relevant markets did Dr. Selwyn propose?

A: Dr. Selwyn claims that geographic wireless markets are "fundamentally *local.*"[69] Dr. Selwyn is not entirely clear on what local area he is proposing, but suggests that it should be "much smaller than even the FCC's 'Economic Areas.'"[70] He provides HHIs at the county level, but claims that even those "may be too expansive" and that a census block or tract might be more appropriate.[71]

With respect to product markets, Dr. Selwyn claims that prepaid and postpaid wireless services "are separate and distinct relevant product markets."[72]

Q: Before turning to your responses on market definition, let's put the issue in context. Do the conclusions that you reach above depend on the precise definition of the relevant market(s)?

A: No. One benefit of merger simulation is that it does *not* depend on a precise delineation of the relevant market.[73] Consumers, including low-income consumers, will benefit from the proposed transaction. That is what matters and that is not dependent on defining a market.

Q: Do you agree with Dr. Selwyn's proposed relevant geographic markets?

A: No. Dr. Selwyn's claim that the "fact that four carriers exist nationally is of no real importance" in areas where fewer than all four provide service is incorrect. Dr. Selwyn is implicitly assuming that pricing is set at the level of his (unspecified) very small geographic area.

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[69] *Selwyn Testimony*, ¶ 30. CWA notes that local areas may be defined as geographic markets but "there are important national characteristics which make it appropriate to consider also a national market." *CWA Testimony*, p. 12.

[70] *Selwyn Testimony*, ¶ 30.

[71] *Selwyn Testimony,* ¶¶ 34-35.

[72] *Selwyn Testimony*, ¶ 51. CWA argues for both an overall mobile telephony market, but also for a "narrower market for prepaid wireless retail services." *CWA Testimony*, pp. 5-6.

[73] *Horizontal Merger Guidelines,* p. 21 ("These merger simulation methods need not rely on market definition.")

That is not the case. Sprint and T-Mobile set prices nationally, and customers benefit from competition on national prices regardless of their location. Indeed, Dr. Selwyn elsewhere cites to the FCC that "providers offer the same plans and charge the same prices nationwide."[74]

Q: How should the geographic market be defined? Should it be California specific?

A: No. It should be national. Dr. Selwyn notes that, contrary to what he proposes, the FCC analyzes wireless competition based on "geographically expansive and aggregated areas."[75] Similarly, the Department of Justice has previously concluded that wireless competition is national in scope.[76]

> In competing for customers […] AT&T and T-Mobile (as well as Verizon and Sprint) utilize networks that cover the vast majority of the U.S. population, advertise nationally, have nationally recognized brands, and offer pricing, plans, and devices that are available nationwide. For a variety of reasons, there is little or no regional variation in the pricing plans offered by the Big Four nationwide carriers. Nationwide pricing simplifies customer service and billing, reduces consumer confusion that might otherwise result from regional pricing disparities, and allows the carriers to take advantage of nationwide advertising in promoting their services. Similarly, when the Big Four carriers make devices available to the public, they typically make them available nationwide. This too minimizes customers' confusion and dissatisfaction, and allows the carriers to take advantage of nationwide marketing. In addition, the Big Four carriers generally deploy system technology on a nationwide basis, including critical components such as network standards, e.g., LTE or HSPA+. These technological choices are an important aspect of competition in the mobile wireless telecommunications services market.
>
> The national decision-making of the Big Four carriers results in nationwide competition across local markets. Each of the Big Four firms making a competitive choice regarding a pricing plan, or other national competitive attribute, will consider competitive conditions across the United States, as the decision will take effect throughout the United States.

I agree with this conclusion.

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[74] *Selwyn Testimony*, ¶ 17. See also Rebuttal Testimony of G. Michael Sievert, January 29, 2019, pp. 25-26; Testimony of Brandon Dow Draper, January 29, 2019, p. 31.

[75] *Selwyn Testimony*, ¶ 46.

[76] *United States v. AT&T & T-Mobile*, Case 1:11-cv-01560-ESH (D.D.C. filed Sept. 30, 2011), Second Amended Complaint, pp. 10-11.

Other commentators have expressed similar views. For example, Professor Roger Noll of Stanford shared this view at the CPUC Technical Workshop on December 10, 2018: "But for this particular case, I think that it makes no sense to think about regional markets."[77]

Q: Do you agree with Dr. Selwyn's product market definition?

A: No. His claims that not every prepaid customer can obtain postpaid service, and that not every postpaid customer will be willing to substitute prepaid service for postpaid service, are largely irrelevant. These claims do not mean that prepaid and postpaid are separate economic markets nor that they should be considered separately for purposes of analyzing welfare effects of the merger. Relevant markets are defined based on substitution of *marginal* ("likely-to-switch") customers because pricing is determined by these marginal customers. There are always some customers who will not change their behavior in response to a price increase, but the question of whether a price increase will be profitable for a firm or not is determined by the customers who will change. The customers who will change (the marginal customers) therefore protect those who will not (the non-marginal customers). The fact that many (non-marginal) customers will not react to a price change does not mean that such a price change will be profitable. There need only be enough customers on the margin willing and able to react to prevent price increases.[78]

Furthermore, given evidence (described below) that there is substantial movement between services—not hypothetical responses to hypothetical price changes, but large numbers of actual switchers—consideration of welfare effects should take both prepaid and postpaid segments into account. Users of prepaid and postpaid wireless services are not distinct groups—there is substantial overlap between them, and many customers will be purchasers of each service at different times. For that reason, an assessment of the consumer welfare effects of the transaction should consider prepaid and postpaid together, rather than drawing a boundary that consumers regularly cross.

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[77] California Public Utilities Commission, Workshop on Proposed Transfer of Control of Sprint Communications Company L.P. to T-Mobile USA (A. 18-07-011 & 012), December 10, 2018, *available at* http://www.adminmonitor.com/ca/cpuc/workshop/20181210/.

[78] This also means that having products marketed under different labels, or by different business units within a firm, does not establish that the products are in different economic markets.

Q: With respect to product markets, have the Department of Justice and Federal Communications Commission defined prepaid and postpaid services as part of the same market or as different markets?

A: The Department of Justice and Federal Communications Commission have concluded that "mobile wireless telecommunications services" or "mobile telephony/broadband services" constitute a single relevant product market.[79]

Q: Do you agree with the DOJ's and FCC's conclusions?

A: Yes.

Q: Why?

A: I agree because it is the most sensible way to analyze this merger's effect on consumers. As I mentioned earlier, customers of prepaid and postpaid services are not distinct groups. There is a lot of switching between the categories—not just hypothetical switching in response to hypothetically different prices, but actual switching. Most importantly, focusing on only one segment would not be good for consumers. That approach risks harming overall welfare to preserve a competitor in a particular sub-segment. And it risks harming a single consumer's overall lifetime welfare to protect it for a period of time, if that customer is one who will switch between prepaid and postpaid, as many do.

[79] *United States v. AT&T & T-Mobile*, Case 1:11-cv-01560-ESH (D.D.C. filed Sept. 30, 2011), Second Amended Complaint, ¶ 12 ("Mobile wireless telecommunications services accordingly is a relevant product market"); *In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services*, WT Docket No. 17-69, Twentieth Report, September 27, 2017, p. 38 ("As postpaid offerings have shifted away from term contracts and equipment subsidies, service providers have adopted pricing plans and promotions for their high-end prepaid monthly service offerings that are similar to those they have for postpaid offerings."). CWA also argues for a "mobile telephony/broadband services" market and notes that the FCC has used that product market definitions. *CWA Testimony*, p. 5.

Q: Is there evidence of substantial switching between prepaid and postpaid?

A: Yes. The degree of switching is currently substantial and is increasing over time.[80] For example, on average, **[BHC-AEO]** [redacted] **[EHC-AEO]** MetroPCS subscribers originate from T-Mobile postpaid and vice versa. See Figure 4.

Figure 4[81]

[BHC-AEO]

[redacted]

[EHC-AEO]

This should not be surprising as prepaid and postpaid features and pricing have both been converging. For example, ARPUs have been converging. (See Figure 5.) Furthermore, as explained by Mr. Keys, "the historical distinctions between prepaid and postpaid plans no longer exist and both types exist in the same market for wireless services. For all intents and purposes, the primary difference between prepaid and postpaid plans today is (i) whether you pay your bill at the beginning of the month or the end of the month and (ii) whether you need to undergo a

[80] Rebuttal Testimony of Thomas C. Keys, January 29, 2019, p. 7.

[81] T-Mobile, "Metro growth strategy discussion," May 2018, TMUS-DOJ-01163705, p. 7.

credit check or not."[82] Indeed customers can now obtain smartphones, high-speed data, unlimited usage, and multi-line family features on both postpaid and prepaid plans, and need not take a long-term service contract to get postpaid service.[83] Similar devices are available with similar financing.[84] Credit profiles are also converging, particularly after "Bring Your Own Device" options have reduced the cost of switching from prepaid to postpaid, and credit checks are not normal practice now.[85]

Figure 5[86]

[BHC-AEO]

[redacted]

[82] Rebuttal Testimony of Thomas C. Keys, January 29, 2019, p. 2.

[83] Rebuttal Testimony of Thomas C. Keys, January 29, 2019, p. 6.

[84] See, *e.g.*, Testimony of Brandon Dow Draper, January 29, 2019, p. 29.

[85] Rebuttal Testimony of Thomas C. Keys, January 29, 2019, pp. 6-7. Testimony of Brandon Dow Draper, January 29, 2019, p. 29.

[86] *In the Matter of Applications of T-Mobile US, Inc. and Sprint Corporation*, WT Docket No. 18-197, Declaration of Dr. Glenn Woroch, September 17, 2018, Figure 2.

[EHC-AEO]

Q: If the Commission were to determine that prepaid products compete in a separate relevant market from postpaid products, would high shares in such a market prove the merger would harm prepaid consumers?

A: No.

First, as discussed above, measures of shares and concentration provide only a starting point for assessing the effects of the merger.

Second, even in such a hypothetical prepaid-only market, as the Horizontal Merger Guidelines explains, overall shares (including both pre- and postpaid products) are likely to provide a more reliable indicator of the state of competition in the market.[87] In this case, prepaid and postpaid products generally run on the same networks and, therefore, improvements in the quality of the network or reduction in costs are relevant to both customers who pay at the beginning of the month or customers who pay the day before at the end of the previous month. And there are no barriers that prevent a firm offering postpaid plans to begin selling or expand its sales of prepaid plans. Instead, because the network capacity is used to serve both sets of customers, capacity will transition dynamically to serve either type of customer, and thus the combined share that captures the overall strength of each carriers' network is likely to be the most informative measure of market share.

Third, Dr. Selwyn again makes no effort to quantify pricing pressures, either upward or downward, or to account for interactions with efficiencies. As I discuss below, when I do so, I find that even in a hypothetical market limited to prepaid products, the merger will benefit consumers.

[87] *Horizontal Merger Guidelines,* § 5.2 ("The Agencies normally calculate market shares for all firms that currently produce products in the relevant market, subject to the availability of data. The Agencies also calculate market shares for other market participants if this can be done to reliably reflect their competitive significance.")

Q: Can your merger simulation model be used to assess the effects of the merger on customers of prepaid products?

A: Yes. As discussed above, an advantage of my merger simulation model is that it does not rely on any specific definition of the relevant market, but rather takes into account relevant dimensions of competition. Nonetheless, I can use my model to assess the effects of the merger specifically on customers of prepaid products. When I do so, I find that consumers of prepaid products will benefit from the merger. See Table 5, which demonstrates that the NPV of the merger's effects on quality-adjusted prices paid by prepaid products is positive, which means that, even if customers of prepaid products *never* switched to postpaid products (an extremely conservative assumption), they would benefit from the merger.[88]

Table 5: Net Present Value of Consumer Welfare Effects for Prepaid Products in California ($ billions)

[BHC-AEO]

[EHC-AEO]

[88] This measure of consumer welfare is conservative. The option value of switching to a postpaid product, which I do not account for here, would increase consumer welfare.

IX. COORDINATED EFFECTS

Q: Dr. Selwyn suggests that the merger will increase the likelihood of coordinated effects.[89] Do you agree with his analysis?

A: No. For several reasons.

First, Dr. Selwyn's claim that "eliminating a disruptive firm" like T-Mobile would be "likely to cause adverse coordinated effects"[90] simply does not apply to this transaction. As a basis for this claim, he cites language from the AT&T/T-Mobile transaction,[91] which is based on the assumption that AT&T would control T-Mobile, thus eliminating T-Mobile as an independent firm. To the contrary, the present transaction will leave T-Mobile in control and strengthen its ability to compete with AT&T and Verizon.

Second, Dr. Selwyn's argument that the smaller number of national firms might be able to identify "a mutually agreeable coordinated price" because the firms "offer the same plans and charge the same prices nationwide"[92] does not hold up to scrutiny. As an aside, Dr. Selwyn's argument here that pricing is done at a national level is in tension with his claim that market definition should be local and that rural areas will not benefit from the efficiencies from this merger. Setting that aside, concerns about coordinated effects require that a proposed merger be associated with a significant increase in the ability or incentive for competing firms to coordinate to reduce competition, but in this industry, such coordination would be unlikely.

Q: What makes coordination difficult in this industry?

A: Coordination is difficult because, given the nature of competition in this industry, successful coordination would require much more than coordination on price. Rather, competition is multi-dimensional and complex, a circumstance which is known to make coordination more difficult.

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89 *Selwyn Testimony*, ¶ 17.

90 *Id.* (citing the FCC staff analysis of the AT&T/T-Mobile merger).

91 *Id.*

92 *Id.* (citing the FCC staff analysis of the AT&T/T-Mobile merger).

For example, networks compete across the multiple dimensions of service plans. There are many different types of wireless plans with many different types of features (*e.g.*, with or without contract, with or without handset subsidy, prepaid or postpaid, number of minutes, number of texts, data allowance, congestion policies, policies when above a data allowance, with and without bundled features like Hulu, with and without any of a wide range of international and domestic roaming options, *etc.*), and within a given type of plan with a given set of features, there is wide variance in the quality of the underlying networks and the services. As I have repeatedly emphasized, quality is a critical dimension of competition.

Critically, even if firms were able to coordinate on pricing, and thus raise profit margins, that would create incentives to compete on other dimensions to capture those margins. For example, firms could increase the quality offered at a given price point by, among other possibilities, slightly lowering congestion thresholds or slightly softening usage restrictions. Basic economics predicts such competition will occur unless it is explicitly stamped out, and it is difficult to see how firms could coordinate on such a wide range of quality dimensions as to prevent the obvious outcome.

Q: Are there differences across carriers that would tend to hinder coordination?

A: Yes. For example, AT&T and Verizon both offer wireline cable and broadband services in addition to their wireless services. Similarly, since its acquisition of DirecTV and Time Warner, AT&T is vertically integrated into content. Hence, the business interests of T-Mobile and Sprint are fundamentally different from AT&T and Verizon, making coordination highly unlikely. Indeed, strengthening a competitor that does not have interests in multiple industries, but rather is focused on mobile wireless offerings, is a key benefit of this transaction.

Q. Are there any other industry features that tend to hinder coordination?

A: Yes. The large "lumpy" investments required to transition to 5G also make coordination difficult. It is difficult in general to monitor rivals' network investment with any degree of precision (*i.e.*, knowledge of an overall capital budget provides little information as to the precise application of those funds to the network and the precise changes in network quality that will result) or timeliness. Moreover, the lumpy nature of such investments creates incentives to

compete for customers because marginal costs are typically lower once the investments are made. Finally, investments require long lead times, making any retaliation by competitors difficult.[93]

[93] *Horizontal Merger Guidelines,* § 7.2 ("Firms are also less likely to be deterred by whatever responses occur if competition in the relevant market is marked by leapfrogging technological innovation, so that responses by competitors leave the gains from successful innovation largely intact.").

X. REMEDIES

Q: Are remedies needed to address competitive issues in this matter?

A: No. Remedies are only justified if a merger raises substantial competitive concerns; this merger does not. As I have explained, consumers will benefit from this merger—the net present value of consumer welfare effects is positive, and significantly so. So no remedies are justified.

Remedies also run the risk of imposing regulatory burdens, distorting markets, and undermining the realization of efficiencies. For example, it would potentially hurt consumers to impose costly remedies on New T-Mobile, while the two industry leaders do not bear these burdens. There is a strong consensus among economists that regulation should be avoided if there is no clear harm to be addressed.

Q. How do you respond to the specific remedies proposed by Dr. Selwyn?

A: The only remedy proposed by Dr. Selwyn is removal of mandatory arbitration conditions from T-Mobile and Sprint contracts.[94] I understand that, contrary to Dr. Selwyn's claim, the arbitration clauses in T-Mobile contracts are not in fact mandatory,[95] but setting that aside and without getting into the merits of arbitration conditions in contracts in general, the current contractual clauses for both T-Mobile and Sprint have been established for years and are entirely unrelated to the proposed transaction. Indeed, Dr. Selwyn makes no claim that those clauses would change as a result of the transaction. Dr. Selwyn is effectively saying that this is a business practice of which he disapproves. Dr. Selwyn's proposal is not a *remedy*, but rather a proposed means of regulating the industry without having to go through the regulatory or legislative process.

Use of the merger process to impose an unrelated regulation is likely to result in economic inefficiencies and distortions. The merits of such regulations are most efficiently

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[94] *Selwyn Testimony*, p. xvi ("Thus, any approval of the proposed merger should be expressly conditioned upon the Joint Applicants' agreement to eliminate all mandatory arbitration and class action waiver provisions in their adhesion contracts with residential and small business customers.")

[95] T-Mobile, "Terms and Conditions," effective as of August 22, 2018, *available at* https://www.t-mobile.com/responsibility/legal/terms-and-conditions. Rebuttal Testimony of Marie R. Sylla Dixon, January 29, 2019, pp. 16-18.

addressed in a full regulatory or legislative process where those issues can be examined in detail. And, if Dr. Selwyn is correct about the net effects of those provisions, that process would apply them to the whole industry, not just to these two competitors.

I also note that although Dr. Selwyn claims that the arbitration conditions are the result of coordination between carriers,[96] he offers no evidence to support that claim and it does not hold up to scrutiny. As the materials he cites discuss, many firms in many industries not conducive to coordination, including "mom and pop" operations, have begun using arbitration clauses.[97] Dr. Selwyn provides no evidence that the use of such clauses by wireless carriers has anything to do with market power or anticompetitive coordination.

[96] *Selwyn Testimony*, p. xi.

[97] See articles attached to *Selwyn Testimony*: "Arbitration Everywhere, Stacking the Deck of Justice," and "In Arbitration, a "Privatization of the Justice System," indicating that even "a theater in Los Angeles and a hamburger joint in East Texas" post signs that entering the premises means agreeing to arbitration, and that "thousands of businesses across the country – from big corporations to storefront shops – have used arbitration…"

XI. OTHER CONSIDERATIONS

Q: Have you evaluated other statements made by Dr. Selwyn in support of his opposition?

A: Yes, I have considered Dr. Selwyn's claims about wireless pricing in other countries.

Q: What do you conclude about these claims?

A: I conclude that Dr. Selwyn's anecdotal discussion of pricing of wireless service in other countries with fewer wireless carriers is incomplete and misleading. As he does throughout his testimony, Dr. Selwyn fails to account for quality differences, and that consideration is particularly important with respect to the international comparisons.

For example, Dr. Selwyn claims that the two countries he discusses with three wireless carriers—Canada and Australia—have high wireless prices.[98] He attempts to draw an inference that those allegedly high prices are due to less competition in those countries. However, research in Canada has specifically found that, although Canada may have higher nominal prices than some other countries, those prices reflect higher quality and higher network investment than in other countries—that is, that the *quality-adjusted* prices are not, in fact, higher, and that Canadian consumers are *not* suffering due to a lack of competition. As a recent article explains in a series of bullets:[99]

- "Despite a widely shared perception, the available data do not support the conclusion that Canadians pay significantly higher prices for telecommunications services than consumers in other developed countries.
- The Nordicity study upon which this perception is based compares prices for general categories of products, but ignores most factors that explain how these products and the markets where they are produced and sold are different.

[98] *Selwyn Testimony*, ¶¶ 24-27.

[99] See, *e.g.*, Martin Masse, "The State of Competition in Canada's Telecommunications Industry – 2018," May 2018, Montreal Economic Institute, p. 5. See also NGL Nordicity Group Ltd., "2017 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions," October 5, 2017, prepared for Innovation, Science and Economic Development Canada.

- International metrics have consistently shown that Canada has some of the highest quality wireless networks in the world.
- Wireless carriers in Canada invested on average US$78 per connection between 2010 and 2016, almost twice as much as their European counterparts, which only invested $40.
- Canadians are heavy users of telecommunications services, and they're paying for world-class networks that can deliver the fast, reliable, high-quality services they expect.
- Nordicity's [and Dr. Selwyn's] limited set of data hides the simple reality that Canadians have many more affordable options: They can get similar service baskets at cheaper prices by switching either to a flanker brand, a regional provider, or a reseller.
- The average bill that Canadians pay for their wireless and internet services keeps increasing not because they have to pay more for the same services, but because they are paying more for more and better services."

Nor is there agreement as to whether even nominal prices in the various countries are in fact relatively high. For example, the Nordicity study commissioned by the Canadian government reports, contrary to Dr. Selwyn's claim, that Australian nominal prices are relatively low compared to other countries, stating that for "most of the Mobile Wireless Telephony services, the UK, France, Italy, *and Australia were among the lowest priced markets*."[100]

Furthermore, the FCC's data on international broadband comparisons indicate that both Canada and Australia have substantially faster average wireless speeds than the U.S.[101] The data also indicate that the quality-adjusted wireless broadband prices for Australia have been substantially lower than in the U.S.[102]

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[100] NGL Nordicity Group Ltd., "2017 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions," October 5, 2017, prepared for Innovation, Science and Economic Development Canada, p. 4, emphasis added.

[101] *In the Matter of International Comparison Requirements Pursuant to the Broadband Data Improvement Act*, DA-18-99A1, Sixth Report, February 2, 2018, Appendix B, Table 7.

[102] For example, Dr. Selwyn states that Canada and Australia have three competitors each, and attempts to draw an inference that those countries have high wireless prices as a result (*Selwyn Testimony*, ¶¶ 26-27), but after quality adjustment, the FCC ranks them 23rd and 5th best, respectively, in terms of quality-adjusted prices. Dr. Selwyn states that the U.S., France and UK have four competitors each, and the FCC ranks them 10th, 19th and 3rd, respectively. (*Selwyn Testimony*, ¶ 26) Dr. Selwyn also discusses pricing in Israel, but the FCC report does not cover Israel.) *In the Matter of International Comparison Requirements*

Overall, there is simply no particular correlation between the number of competitors and quality-adjusted prices in Dr. Selwyn's testimony.

Q: Dr. Selwyn states that the "Cornerstone" model inappropriately relies on a *Bertrand* model instead of a *Cournot* model. Do you agree with Dr. Selwyn's criticism of the "Cornerstone" model?

A: No.

Q: Do you agree with Dr. Selwyn's description of the implications of the *Bertrand* model?

A: No. Dr. Selwyn fails to note that there are multiple versions of *Bertrand* models and his criticisms do not apply to the version of *Bertrand* model actually used in the "Cornerstone" and IKK models. Dr. Selwyn states that the *Bertrand* model assumes that "for each dollar decrease in marginal cost … price will be decreased by exactly the same amount" and that price equals marginal cost in equilibrium.[103] This is false. The "Cornerstone" model, as well as the IKK model, rely on a version of the *Bertrand* model that incorporates the fact that mobile wireless firms offer differentiated products and thus that pass through of cost changes need not be 100 percent and price generally will not equal marginal cost in equilibrium. Hence, Dr. Selwyn's criticisms do not correctly characterize the differentiated-product *Bertrand* model that "Cornerstone" and IKK actually use.

Q: Do you agree with Dr. Selwyn that the *Cournot* model provides a more appropriate framework to analyze the wireless industry?

A: No. Dr. Selwyn asserts that the *Cournot* model provides a mechanism with which to assess coordinated conduct.[104] This is not a valid reason to favor the *Cournot* model for several reasons. First, as I explain above, harm through coordinated effects is unlikely in this industry

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Pursuant to the Broadband Data Improvement Act, DA-18-99A1, Sixth Report, February 2, 2018, Appendix C, p. 72, Table 8, Model 4 (adjusted for demographics and content quality).

[103] *Selwyn Testimony*, pp. 119, 122.

[104] *Selwyn Testimony*, ¶ 103.

for reasons the *Cournot* model cannot capture. Second, the *Cournot* model is based on the assumption that firms choose a quantity (in this case the number of wireless subscriptions sold)—thus yielding an implied market equilibrium price—a poor assumption to describe mobile wireless competition. The differentiated-products *Bertrand* model that IKK and Cornerstone use is based on the more reasonable assumption that firms compete by setting price, thus yielding implied numbers of subscriptions sold by each firm as a function of prices and qualities. Notably, both the Federal Communications Commission and the academic literature have used differentiated-product *Bertrand* models to analyze wireless competition.[105]

[105] See, *e.g.*, *In the matter of Applications of AT&T Wireless Services, Inc. and Cingular Wireless Corporation For Consent to Transfer Control of Licenses and Authorizations File Nos. 0001656065, et al*, WT Docket No. 04-70, Memorandum Opinion & Order, October 26, 2004, ¶ 123; T. Randolph Beard, George S. Ford, and Richard P. Saba (2006), "An Econometric-Driven Merger Simulation: Considerations and Application," *International Journal of the Economics of Business*, 13(2): 217-228; Jonathan Lhost, Brijesh Pinto, and David Sibley (2015), "Effects of Spectrum Holdings on Equilibrium in the Wireless Industry," *Review of Network Economics,* 14(2): 111-155; Katja Seim and V. Brian Viard (2011). "The Effect of Market Structure on Cellular Technology Adoption and Pricing," *American Economic Journal: Microeconomics*, 3(2): 221-251.

XII. CONCLUSION

Q: Does this conclude your rebuttal testimony?

A: Yes, it does.

XIII. APPENDIX

Q: Can you provide more details on the key findings of the IKK merger simulation?

A: Yes. I present the results in Table 6, below, which reports the results for two cases, both of which show that the merger enhances consumer welfare.

- In my baseline case, I use a discount rate (*i.e.*, the rate by which I discount future benefits) of two percent for each year they occur in the future. This is the upper bound (meaning it is conservative) of the discount rate recommended by the Council of Economic Advisors for studies of intertemporal consumption.[106] I also assume that net consumer benefits in each year after 2024 remain at the 2024 level.[107]
- I also consider a sensitivity case in which I conservatively assume: (a) a very high (and thus very conservative) annual discount rate of 10 percent (which effectively gives less credit to future benefits),[108] and (b) a highly conservative terminal value of projected consumer benefits equal to zero after 2024.

The values in each row and column in the table report the total NPV (in billions of dollars) of the merger in California under the associated set of assumptions.[109]

Table 6: Net Present Value of Consumer Welfare Effects in California ($ billions) [BHC-AEO]

[106] For purposes of computing the NPV of consumer welfare, it is appropriate to use a discount rate that corresponds to one used to evaluate intertemporal consumption patterns. The Council of Economic Advisors recently recommended using a discount rate of "at most 2 percent." (Council of Economic Advisors, "Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate," Issue Brief, January 2017 (hereinafter *CEA Issue Brief*), p. 3.)

[107] For a discussion of this assumption, see *IKK Declaration,* ¶ 151.

[108] For example, the Office of Management and Budget currently uses discount rates of three and seven percent when performing cost-benefit analyses. (*CEA Issue Brief,* p. 1.)

[109] Many Californians travel elsewhere in the country, and improvements to the network they use in other parts of the country will also benefit them, as will improvements to the networks used by people they call in other parts of the country.

[EHC-AEO]

This analysis demonstrates that, considering both the effect of loss of a competitor and efficiencies in a unified framework, the merger will benefit California consumers.

This conclusion also holds under a variety of different model specifications. In my baseline specification (Row 1.A), I use diversion ratios derived from the ABH demand model,[110] I assume an industry elasticity of -0.3,[111] I assume a wholesale pass-through rate of 75 percent,[112] and I measure vertical incentives without input substitution.[113] I also consider several robustness checks to the value of breakeven efficiencies by altering these assumptions. Across this broad range of assumptions, my model demonstrates that the merger would generate more than **[BHC-AEO]** **[EHC-AEO]** in value for consumers.

I describe the specifics below, but the intuition behind these various specifications is as follows. First, I allow for alternative diversion ratios. When customers leave a carrier, diversion

[110] A diversion ratio is the fraction of customers departing one firm going to each potential destination, whether a rival firm or dropping service entirely. See *IKK Declaration,* ¶¶ 173-178.

[111] For a discussion of industry elasticity, see *IKK Declaration,* ¶¶ 179-180.

[112] For a discussion of wholesale passthrough rates, see *IKK Declaration,* ¶¶ 159-164.

[113] For a discussion of my treatment of vertical incentives, see *IKK Declaration,* ¶¶ 159-164.

ratios indicate where they go. I look to data from surveys from T-Mobile, surveys from Sprint, and customer shares for alternative estimates of how many customers will go where. Second, industry elasticity is simply how many people will drop wireless service in response to an industry wide price increase. I take the estimate based on academic literature of -0.3 and take plus or minus -0.2, which is a substantial range in terms of elasticities. Third, I vary my assumptions on how wholesale prices are affected, allowing for the possibility that the pass-through rate might be less than 100 percent, or that there might be interactions with MVNOs substituting wholesale services (referred to above as input substitution).

- *Diversion Ratios:* Rows 1.B through 4 consider alternative diversion ratios based on assuming either diversion rates derived from survey data from T-Mobile and Sprint, diversion proportional to share of gross adds, or diversion proportional to share of subscribers (meaning a logit model with one nest for all inside goods and one for the outside good). The NPV for California ranges from **[BHC-AEO]** [redacted] **[EHC-AEO]**.
- *Industry Elasticity:* Rows 5 and 6 consider alternative industry elasticity assumptions (-0.1 or -0.5). The NPV for California is **[BHC-AEO]** [redacted] **[EHC-AEO]** with an industry elasticity equal to -0.1 (corresponding to little substitution with the outside good), and **[BHC-AEO]** [redacted] **EHC-AEO]** when using an industry elasticity of -0.5 (corresponding to greater substitution with the outside good).
- *Vertical Upward Pricing Pressure Assumptions:* Rows 7 through 9 consider different assumptions about the effect of vertical upward pricing pressure on wholesale prices to MVNOs. When the pass-through rate is 50 percent, the NPV is **[BHC-AEO]** [redacted] **[EHC-AEO]**. When vertical upward pricing pressure is fully passed through, the NPV is **[BHC-AEO]** [redacted] **[EHC-AEO]**. Finally, if the calculation of vertical upward pricing pressure accounts for potential input substitution on the part of the MVNOs, the NPV is **[BHC-AEO]** [redacted] **[EHC-AEO]**. Thus, under a broad range of assumptions about the nature of wholesale pricing, the merger is procompetitive and benefits California consumers.

ATTACHMENT A

—PUBLIC VERSION—

Mark A. Israel **January 2019**
Senior Managing Director, Compass Lexecon

555 12th Street NW, Suite 501
Washington, DC 20004
(202) 753-5205 (direct)
misrael@compasslexecon.com

PROFESSIONAL EXPERIENCE HIGHLIGHTS

- Served as an expert for both the Federal Government and private parties in cases involving: fixed and mobile telecommunications, cable television, broadband internet service, social media, other high technology industries, food distribution, airlines, railroads, shipping, health insurance, financial markets, credit cards, beverages, retail, energy, and many others.
- Testified in Federal Court, in multiple state courts, in front of the United States Copyright Royalty Judges, in front of international competition authorities, and in arbitration proceedings. Appeared in front of government agencies including DOJ, FTC, and FCC, and state agencies on behalf of numerous clients.
- Submitted expert reports in Federal Court, and affidavits, declarations, and papers to U.S. competition agencies, FCC, DOT, international competition authorities, and state regulators.
- Written numerous academic articles on topics including competition economics, merger policy, telecommunications, airlines, insurance markets, and labor markets. Research published in leading scholarly and applied journals including *The American Economic Review*, *The Rand Journal of Economics*, *International Journal of Industrial Organization*, *The Journal of Competition Law and Economics*, and many others, and presented to business, government, and academic audiences worldwide.
- Co-author of the chapter on Econometrics and Regression Analysis in the ABA Treatise, *Proving Economic Damages: Legal and Economic Issues*, 2017.

AREAS OF EXPERTISE

- Antitrust and competition economics; industrial organization economics
- Applied econometrics
- Economic and econometric analysis of horizontal and vertical mergers
- Economic and econometric analysis of antitrust litigation topics, including: Class certification, damages, and liability issues in cases involving price fixing, exclusive dealing, monopolization, bundling, price discrimination, and exclusionary practices

EDUCATION

- Ph.D., Economics, STANFORD UNIVERSITY, June 2001.
- M.S., Economics, UNIVERSITY OF WISCONSIN-MADISON, August 1992.
- B.A., Economics, ILLINOIS WESLEYAN UNIVERSITY, Summa Cum Laude, May 1991.

EMPLOYMENT HISTORY

Compass Lexecon: *Senior Managing Director*, Head of Compass Lexecon North American Antirust Practice, January 2016 – Present.

(Previously: *Executive Vice President*, April 2013 – January 2016; *Senior Vice President*, January 2009 – March 2013; *Vice President*, January 2008 – December 2008; *Economist*, January 2006 – December 2007.)

Kellogg School of Management, Northwestern University: *Assistant Professor of Management and Strategy*, 2000 – 2006; *Associate Professor of Management and Strategy*, 2007 – 2008.

State Farm Insurance: *Research Administrator,* 1992 – 1995.

RECENT PROFESSIONAL RECOGNITIONS

Global Competition Review Who's Who Legal: Thought Leaders – Competition 2019, Thought Leader in Economics.

Global Competition Review Who's Who Legal: Competition 2018, leading Economist.

Global Arbitration Review's 2018 International Who's Who of Commercial Arbitration, leading Expert Witness.

American Antitrust Institute 2015 Antitrust Enforcement Awards, *Outstanding Antitrust Litigation Achievement in Economics,* Finalist.

LIVE TESTIMONIAL EXPERIENCE

Testimony as Economic Expert on behalf of Wilh. Wilhelmsen Holding ASA, In the Matter of the *Federal Trade Commission v. Wilh. Wilhelmsen Holding ASA Wilhelmsen Maritime Services As Resolute Fund II, L.P. Drew Marine Intermediate II B.V. and Drew Marine Group, Inc.*, In the United States District Court for the District of Columbia, No. 1:18-cv-00414-TSC; Deposition: May 24, 2018; Live Trial Testimony: June 12, June 13, 2018.

Testimony as Economic Expert on behalf of Joint Sports Claimants, In the Matter of *Determination of Cable Royalty Funds*, United States Copyright Royalty Judges in the Library of Congress, Docket No. 14-CRB-0010-CD (2010-2013); Live Testimony: March 12, 2018.

Testimony as Economic Expert on behalf of Comcast Corporation, In the Matter of *Viamedia, Inc. v. Comcast Corporation and Comcast Spotlight, LP*, In the United States District Court Northern District of Illinois Eastern Division, Case No. 16-cv-5486; Deposition: January 5, 2018.

Testimony as Economic Expert on behalf of Trinity, In the Matter of *Jackson County, Missouri, Individually and on behalf of a class of others similarly situated, v. Trinity Industries, Inc., and Trinity Highway Products, LLC,* In the Circuit Court of Jackson County, Missouri at Independence, Case No. 1516-CV23684; May 24, 2017.

Testimony as Economic Expert on behalf of Energy Solutions, Inc., In the Matter of the *United States of America v. Energy Solutions, Inc., Rockwell Holdco, Inc., Andrews County Holdings, Inc., and Waste Control Specialists, LLC*, In the United States District Court for the District of Delaware, Civil Action No. 16-cv-01056-SLR; Deposition: April 17, 2017; Live Trial Testimony: May 2, May 3, 2017.

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Testimony as Economic Expert on behalf of Regal Entertainment Group, In the Matter of *iPic – Gold Class Entertainment, LLC et al., v. Regal Entertainment Group, AMC Entertainment Holdings, Inc., et al.*, In the District Court of Harris County, Texas, 234th Judicial District, No. 2015-68745; Deposition: January 12, 2016, February 15, 2017; Live Trial Testimony: January 21, 2016.

Testimony as Economic Expert on behalf of Anthem Inc., In the Matter of the *United States of America et al. v. Anthem Inc. and Cigna Corp.*, In the District Court of the District of Columbia, No. 16-cv-01493 (ABJ); Deposition: November 9, 2016; Phase 1 Live Trial Testimony: December 1, December 2, 2016; Phase 2 Live Trial Testimony: December 22, 2016.

Testimony as Economic Expert on behalf of Defendants, In the Matter of *Darren Ewert v. Nippon Yusen Kabushiki Kaisha et al.*, Supreme Court of British Columbia, No. S-134895; Deposition: September 14, 2016.

Testimony in Commercial Arbitration on Issues Related to Mobile Wireless Competition; New York, NY; April 12, 2016.

Testimony as Economic Expert on behalf of Federal Trade Commission, In the Matter of *Federal Trade Commission et al. v. Sysco Corporation and USF Holding Corp.*, Civil Action No. 15-cv-00256 (APM); Deposition: April 28, 2015; Live Trial Testimony: May 7, May 8, May 14, 2015.

Appearances in Federal Communications Commission, Economists Panels:

- Comcast/Time Warner, January 2015
- AT&T/T-Mobile, July 2011
- Comcast/NBCUniversal, August 2010

Appearance before California Public Utility Commission, Public Hearings on Comcast/Time Warner Merger, Los Angeles; April 2015.

Appearance as Economic Testifying Expert in front of Department of Justice, Federal Trade Commission, Federal Communications Commission, and State Regulatory Agencies in many additional transactions, including: Danaher/NetScout, AT&T/Leap Wireless, T-Mobile/MetroPCS, American Airlines/US Airways, SpectrumCo/Cox/Verizon Wireless, oneworld antitrust immunity application, PepsiCo/bottlers, Houghton Mifflin/Harcourt, Chicago Mercantile Exchange/Chicago Board of Trade.

EXPERT REPORTS, AFFIDAVITS, AND DECLARATIONS

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Second Declaration of Mark Israel, Daniel Rubinfeld, and Glenn Woroch, "Analysis of the Regressions and Other Data Relied Upon in the Business Data Services FNPRM And a Proposed Competitive Market Test," Federal Communications Commission, WC Docket Nos. 16-143, 05-25, RM-10593, June 28, 2016.

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Declaration of Mark Israel and Allan Shampine, In the Matter of Amendment of the Commission's Rules Related to Retransmission Consent, Appendix B to "Comments of the National Association of Broadcasters," Federal Communications Commission, MB Docket No. 10-71, June 26, 2014.

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Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Sprint's Proposed Weighted Spectrum Screen Defies Economic Logic and Is Inconsistent with Established Facts," Federal Communications Commission, WT Docket No. 12-269, March 14, 2014.

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Declaration of Mark A. Israel, "An Economic Analysis of Competitive Effects and Consumer Benefits from the Proposed Acquisition of Leap Wireless by AT&T," Federal Communications Commission, WT Docket No. 13-193, August 1, 2013.

Supplemental Reply Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Comments on Appropriate Spectrum Aggregation Policy with Application to the Upcoming 600 MHz Auction," Federal Communications Commission, WT Docket No. 12-269, June 13, 2013.

Reply Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Comment on the Submission of the U.S. Department of Justice Regarding Auction Participation Restrictions," Federal Communications Commission, WT Docket No. 12-269, June 13, 2013.

Reply Declaration of Michael L. Katz, Philip A. Haile, Mark A. Israel, and Andres V. Lerner, "Spectrum Aggregation Policy, Spectrum-Holdings-Based Bidding Credits, and Unlicensed Spectrum," Federal Communications Commission, GN Docket No. 12-268, March 12, 2013.

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Reply Declaration of Mark A. Israel and Michael L. Katz, "Economic Analysis of Public Policy Regarding Mobile Spectrum Holdings," Federal Communications Commission, WT Docket No. 12-269, January 7, 2013.

Declaration of Mark A. Israel and Michael L. Katz, "Economic Analysis of Public Policy Regarding Mobile Spectrum Holdings," Federal Communications Commission, WT Docket No. 12-269, November 28, 2012.

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Expert Report of Mark Israel, "Implications of the Verizon Wireless & SpectrumCo/Cox Commercial Agreements for Backhaul and Wi-Fi Services Competition," Federal Communications Commission, WT Docket No. 12-4, August 1, 2012.

Expert Report of Mark A. Israel, Michael L. Katz, and Allan L. Shampine, "Promoting Interoperability in the 700 MHz Commercial Spectrum," Federal Communications Commission, WT Docket No. 12-69, July 16, 2012.

Affidavits of Dr. Mark A. Israel in the Matter of *Bloomberg L.P. v. Comcast Cable Communications, LLC*, Federal Communications Commission, MB Docket No. 11-104, Declaration: June 21, 2012; Declaration: June 8, 2012; Supplemental Declaration: September 27, 2011; Declaration: July 27, 2011.

Expert Report of Robert Willig, Mark Israel, Bryan Keating, and Jonathan Orszag, "Response to Supplementary Comments of Hubert Horan," Docket DOT-OST-2009-1055, October 22, 2010.

Expert Report of Robert Willig, Mark Israel, Bryan Keating, and Jonathan Orszag, "Measuring Consumer Benefits from Antitrust Immunity for Delta Air Lines and Virgin Blue Carriers," Docket DOT-OST-2009-1055, October 13, 2010.

Expert Report of Mark Israel and Michael L. Katz, "Economic Analysis of the Proposed Comcast-NBCU-GE Transaction," Federal Communications Commission, MB Docket No. 10-56, July 20, 2010.

Expert Report of Mark Israel and Michael L. Katz, "The Comcast/NBCU Transaction and Online Video Distribution," Federal Communications Commission, MB Docket No. 10-56, May 4, 2010.

Expert Report of Mark Israel and Michael L. Katz, "Application of the Commission Staff Model of Vertical Foreclosure to the Proposed Comcast-NBCU Transaction," Federal Communications Commission, MB Docket No. 10-56, February 26, 2010.

Expert Report of Robert Willig, Mark Israel, and Bryan Keating, "Competitive Effects of Airline Antitrust Immunity: Response of Robert Willig, Mark Israel, and Bryan Keating" in Docket DOT-OST-2008-0252, January 11, 2010.

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Expert Reports of James Levinsohn and Mark Israel, In the Matter of 2006 NPM Adjustment Proceeding pursuant to Master Settlement Agreement, October 6, 2008, January 16, 2009, March 10, 2009.

OTHER EXPERT WORK IN REVIEW OF MERGERS/TRANSACTIONS

Successful acquisition of Keystone Foods by Tyson Foods, Inc. 2018. Served as lead economic expert for U.S. jurisdiction. Presented economic analyses demonstrating that competition would remain strong post-merger. Ultimately, antitrust agencies in the U.S., China, Japan, and Korea cleared the transaction.

Successful acquisition of NEX Group PLC by CME Group Inc. 2018. Co-lead economic expert with Thomas Stemwedel. Presented several econometric analyses demonstrating that Treasury futures contracts and cash Treasury securities were economic complements rather than substitutes. Based heavily on these Compass Lexecon submissions, the DOJ and CMA closed their investigations without requiring any divestitures.

Successful acquisition of Time Warner by AT&T, Inc. 2018. Lead economist throughout the DOJ investigation. Then director of all economic work during trial, serving as the central connection point between all experts and counsel and directing development of all aspects of the economic case. Defendants ultimately prevailed in trial and the merger closed in June 2018.

Successful acquisition of VCA Inc. by Mars, Inc. 2017. Co-lead economic expert with Mary Coleman. Made multiple presentations to FTC demonstrating ample competition in general, emergency, and specialty veterinary services, including econometric analyses showing lack of direct competitive impact of Mars and VCA on one another. Transaction was ultimately cleared subject to a small number of divestitures.

Successful acquisition of Mobileye by Intel. 2017. Served as lead economic expert for Intel. Assisted counsel in preparing FTC presentations and materials demonstrating lack of significant head-to-head competition and lack of valid vertical foreclosure theories. Investigation was closed without Second Request.

FTC litigation against DraftKings, Inc. and FanDuel Inc. (Civil Action No. 17-cv-1195 (KBJ)). 2017. Served as lead economic expert for FTC and prepared to serve as FTC's testifying expert against the merger, prior to the parties' abandonment of the proposed merger. Developed economic and econometric evidence that the merging parties were closest substitutes and thus likely would have increased prices as a result of their proposed merger.

Successful merger of ASE Group and SPIL. 2017. Lead economic expert on behalf of ASE Group. Submitted reports and testified to the Taiwan Fair Trade Commission, which ultimately cleared the transaction, then made multiple presentations to U.S. FTC, which also cleared the transaction. Economic analyses focused on implications of profit margins for market definition and competitive effects, ultimately demonstrating that the transaction was unlikely to cause significant harm to competition.

Successful acquisition of Alarm.com of two business units (Connect and Piper) from iControl Networks. 2017. Led team that demonstrated substantial and growing competition in home security and connected home marketplace and thus lack of competitive harm from acquisition. Work focused on importance of downstream market definition as well as empirical evidence of impact of competition on Alarm.com pricing and profitability.

Successful acquisition of Samsung Electronics, Ltd.'s printer business by HP Inc. 2016. Led team in evaluating the competitive effects of the acquisition, including assessing shares and competitive effects in overlap areas. Notably, the transaction gained regulatory approval in the U.S. during the initial review period without issuing a Second Request.

Successful acquisition of Sun Products Corp. by Henkel AG. 2016. Led team demonstrating lack of competitive impact despite overlaps in laundry detergent and related products.

Successful acquisition of Starwood Hotels & Resorts by Marriott International. 2016. Led team that performed detailed analysis of competitive conditions, extensive econometric analysis of pricing, and full review of Marriott's internal pricing models to demonstrate that Starwood and Marriott were not close competitors, combined ownership of the brands would not lead to upward pricing pressure, and competition would remain robust post-merger.

Successful acquisition of PR Newswire by GTCR. 2016. Lead economic expert for GTCR. Made presentations to DOJ showing lack of competitive harm from the transaction, based on detailed analysis of win/loss data, including calculations showing no possible upward pricing pressure (UPP) concerns regardless of the level of margins.

Successful acquisition of Schurz Communications' Broadcast Stations by Gray Television. 2015. Lead economic expert for Gray. Made presentations to DOJ demonstrating output expanding effects of proposed transaction in light of the scale economies in television production and advertising and the small size of the DMAs affected by the transaction.

Successful acquisition of the Communications Business of Danaher Corporation by NetScout Systems. 2015. Lead economic expert for NetScout. Made presentations to DOJ describing proper economic framework for analysis of competition and potential merger harms, and demonstrated that the presence of multiple viable competitors and numerous other credible threats to be used by powerful buyers in a dynamic industry made theories of anti-competitive harm from the merger implausible.

Successful acquisition of Windmill Distribution Co. by Manhattan Beer Distributors. 2015. Lead economic expert for Manhattan Beer Distributors. Submitted White Paper to DOJ demonstrating, based on margin data, that the merger would be highly unlikely to lead to anti-competitive effects. Transaction was granted early termination from the Hart Scott Rodino process by the DOJ.

Proposed acquisition of Time Warner Cable by Comcast Corporation. 2014-2015. Served as lead economic expert on broadband issues on behalf of Comcast Corporation. Submitted multiple Declarations and made multiple presentations to DOJ and FCC, explaining lack of horizontal, bargaining, or vertical/foreclosure concerns with regard to broadband competition as a result of the transaction.

Successful acquisition of Leap Wireless by AT&T. 2014. Lead economic expert for AT&T. Submitted multiple Declarations to FCC and made presentation to DOJ, demonstrating the transaction would generate substantial consumer benefits, while generating at most minimal upward pricing pressure in a properly defined mobile wireless services market and no issues related to spectrum concentration or other competitive concerns.

Successful merger of American Airline and US Airways. 2013. Lead consulting expert, managing Compass Lexecon team of over 25 economists supporting multiple experts. Made multiple presentations to DOJ, worked on expert reports in litigation, and assisted counsel with the analysis leading to settlement of litigation, permitting transaction to close.

Successful merger of T-Mobile USA and MetroPCS. 2013. Lead economic expert for T-Mobile USA. Conducted economic analyses of competitive effects of the transaction, as well as consumer benefits from reduced costs and increased network quality. Presented analyses to both DOJ and FCC.

FTC investigation of acquisition of Dollar Thrifty Automotive Group by Hertz. 2012. Served as a lead economic expert for FTC and prepared to serve as FTC's testifying expert against the merger, prior to case settlement. Conducted empirical analyses based on previous rental car mergers demonstrating likely price increases from the transaction.

Decision by Federal Communications Commission not to extend the ban on exclusive contracts for satellite-delivered, cable-affiliated networks. 2012. Lead economic expert for National Cable and Telecommunications Association. Submitted economic analysis demonstrating that the ban on exclusive distribution of satellite-delivered, cable affiliated networks is no longer warranted given increased marketplace competition. FCC made decision to allow the ban to sunset.

Successful sale of wireless spectrum by SpectrumCo and Cox ("Cable Companies") to Verizon Wireless and successful completion of related commercial agreements. 2012. On behalf of the Cable Companies, performed economic analyses demonstrating lack of competitive harm from the transaction on markets for backhaul and Wi-Fi services. Presented analyses to FCC.

Successful acquisition by LIN Media of broadcast television stations from NVTV. 2012. Lead economic expert for LIN Media. Prepared economic analysis demonstrating lack of competitive concern over potential issues related to Shared Service and Joint Sale Arrangements.

Proposed acquisition of T-Mobile USA by AT&T. 2011. Served as one of the lead economists, initially for T-Mobile (along with Michael Katz) and ultimately for both parties (along with Michael Katz and Dennis Carlton). Made multiple presentations to DOJ and FCC. Appeared in FCC Workshop, ex parte meeting.

S*uccessful application for antitrust immunity by Delta and Virgin Blue*. 2010. Together with Robert Willig, Bryan Keating, and Jon Orszag, prepared economic analyses demonstrating substantial net consumer benefits from antitrust immunity. Submitted results in expert reports to Department of Transportation.

Successful joint venture between Comcast and NBC Universal (and ultimate full acquisition of NBC Universal by Comcast). 2010. Served as one of the lead economists (along with Michael Katz) on behalf of the merging parties. Wrote multiple reports submitted to FCC (with Michael Katz) demonstrating lack of significant competitive concerns from the transaction. Made multiple presentations to DOJ and FCC. Appeared in FCC Workshop of economists, ex parte meeting.

Successful application for antitrust immunity for oneworld alliance and associated joint venture of American Airlines, British Airways, and Iberia Airlines. 2009-2010. Together with Robert Willig and Bryan Keating, prepared economic analyses demonstrating substantial net consumer benefits associated with antitrust immunity for the joint venture. Submitted results in expert reports to Department of Transportation.

Successful acquisition by PepsiCo of bottlers, PBG and PAS. 2009. Performed econometric and simulation analyses demonstrating pro-competitive effect of merger on PepsiCo's own brands, other brands distributed by PBG and PAS, and overall marketplace. Presented results to FTC (together with Dennis Carlton).

Successful merger of Delta Airlines and Northwest Airlines. 2008. In support of Dennis Carlton, developed empirical and theoretical analyses to demonstrate merger's pro-competitive nature. Work focused on (ultimately settled) private litigation opposing the merger.

Successful acquisition of Harcourt Education by Houghton Mifflin. 2007. Along with Daniel Rubinfeld and Frederick Flyer, developed econometric analyses demonstrating lack of competitive harm from proposed merger. Presented results to DOJ.

Successful acquisition of Chicago Board of Trade by Chicago Mercantile Exchange. 2007. Along with Robert Willig and Hal Sider, developed and presented multiple empirical analyses demonstrating lack of competitive harm from merger. Submitted multiple white papers and made multiple presentations to DOJ.

SELECTED OTHER EXPERT/CONSULTING WORK

Led team supporting Dennis Carlton's testimony in Toshiba/Hannstar TFT-LCD Antitrust litigation vs. Plaintiff Best Buy, 2013.

Led team supporting Dennis Carlton's testimony in Toshiba's TFT-LCD Class Action Antitrust litigation. Named Litigation Matter of the Year for 2012 by *Global Competition Review*, 2012.

As economic expert for US Airways, developed econometric analysis of air traffic at major US airports, presented to Philadelphia Airport management team, 2011.

Prepared analysis of the competitive impact of low-cost-carrier competition in Washington, D.C. and New York airports. Filed with DOT, 2011.

On behalf of major pharmaceutical firm, developed econometric model to forecast pharmaceutical expenditures, 2009.

Developed econometric model to measure of the importance of network effects in credit cards in the context of measuring damages incurred by a major credit card issuer, 2007-2008.

PUBLICATIONS

"Are Legacy Airline Mergers Pro- or Anti-Competitive? Evidence from Recent U.S. Airline Mergers," (with Dennis Carlton, Ian MacSwain, and Eugene Orlov), Volume 62, Pages 58-95, in the *International Journal of Industrial Organization*, January 2019.

"Competitive Effects of International Airline Cooperation," (with Robert J. Calzaretta and Yair Eilat), Volume 13, Issue 3, Pages 501-548, in the *Journal of Competition Law & Economics*, September 2017.

"Econometrics and Regression Analysis," (with Chris Cavanagh, Paul Denis, and Bryan Keating), Chapter 6 in the *American Bar Association's Proving Antitrust Damages: Legal and Economic Issues, Third Addition*, 2017.

"Complementarity without Superadditivity," (with Steven Berry, Philip Haile, and Michael Katz), Volume 151, Pages 28-30, in *Economics Letters*, February 2017.

"Antitrust in a Mobile World," (with Yonatan Even, Jonathan M. Jacobson, Scott Martin, and Dr. Helen Weeds), Chapter 17 of *International Antitrust Law & Policy: Fordham Competition Law 2015*, Edited by James Keyte, Juris Publishing, Inc., 2016.

"Buyer Power in Merger Review," (with Dennis W. Carlton and Mary Coleman), Chapter 22 of *The Oxford Handbook of International Antitrust Economics*, Volume 1, Roger D. Blair and D. Daniel Sokol, eds, Oxford University Press, 2015.

"The Evolution of Internet Interconnection from Hierarchy to 'Mesh': Implications for Government Regulation," (with Stanley M. Besen), *Information Economics and Policy*, December 2013.

"Airline Network Effects and Consumer Welfare," (with Bryan Keating, Dan Rubinfeld, and Robert Willig), *Review of Network Economics*, November 2013.

"The Delta-Northwest Merger: Consumer Benefits from Airline Network Effects (2008)," (with Bryan Keating, Daniel L. Rubinfeld, and Robert D. Willig), *The Antitrust Revolution*, Sixth Edition, Edited by John E. Kwoka, Jr. and Lawrence J. White, Oxford University Press, New York, July 2013.

"Proper Treatment of Buyer Power in Merger Review," (with Dennis W. Carlton), *Review of Industrial Organization*, July 2011.

"Response to Gopal Das Varma's Market Definition, Upward Pricing Pressure, and the Role of the Courts: A Response to Carlton and Israel," (with Dennis W. Carlton), *The Antitrust Source*, December 2010.

"Will the New Guidelines Clarify or Obscure Antitrust Policy?" (with Dennis W. Carlton), *The Antitrust Source*, October 2010.

"Should Competition Policy Prohibit Price Discrimination?" (with Dennis W. Carlton), *Global Competition Review*, 2009.

"The Empirical Effects of Collegiate Athletics: An Update Based on 2004-2007 Data," (with Jonathan Orszag), Paper commissioned by National Collegiate Athletic Association, available *at* *http://www.epi.soe.vt.edu/perspectives/policy_news/pdf/NCAASpending.pdf*, February 2009.

"Services as Experience Goods: An Empirical Examination of Consumer Learning in Automobile Insurance," *The American Economic Review*, December 2005.

"Tenure Dependence in Consumer-Firm Relationships: An Empirical Analysis of Consumer Departures from Automobile Insurance Firms," *The Rand Journal of Economics*, Spring 2005.

"The Impact of Youth Characteristics and Experiences on Transitions Out of Poverty," (with Michael Seeborg), *Journal of Socio-Economics*, 1998.

"Racial Differences in Adult Labor Force Transition Trends," (with Michael Seeborg), *Journal of Economics*, 1994.

WORKING PAPERS AND RESEARCH IN PROGRESS

"Do Premiums Increase After Health Insurance Mergers? – A Reassessment of Guardado et al.'s Findings," (with Robert C. Bourke, Ben Wagner, and David A. Weiskopf), available at *https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2933062*, March 2017.

"Are You Pushing Too Hard? Lower Negotiated Input Prices as a Merger Efficiency: The Anthem-Cigna Merger," (with Erica Benton, Loren Smith, Thomas Stemwedel, and Ka Hei Tse), February 2017.

SELECTED RECENT PRESENTATIONS

Concurrences Review and The George Washington University Law School, 6th Bill Kovacic Antitrust Salon: Where is Antitrust Policy Going?, "A Judge's Eye View on Antitrust: Mergers, Cartels, Remedies…," Panelist, September 2018.

Fordham Competition Law Institute, 45th Annual Conference on International Antitrust Law and Policy, "Merger Remedies," Panelist, September 2018.

Georgetown Center for Business and Public Policy, "Airline Competition Conference," Panelist, July 2017.

J.P. Morgan Special Situations Investor Forum, "The Antitrust Merger Review Process," Panelist, March 2017.

American Bar Association Section of Antitrust Law, "Economic Issues Raised In The Comcast – Time Warner Cable Merger," Panelist, February 2016.

Fordham Competition Law Institute, 42nd Annual Conference on International Antitrust Law and Policy, "Antitrust in a Mobile World," Panelist, October 2015.

American Bar Association Section of Antitrust Law, "Merger Practice Workshop," Faculty Member, October 2015.

Searle Center Conference on Antitrust Economics and Competition Policy, Panel on Recent Transactions in the Telecom Industry, Panelist, September 2015.

National Bureau of Economic Research, Summer Institute 2015, Industrial Organization Meetings, "Panel Discussion of the Comcast-Time Warner Merger," Panelist, July 2015.

Federal Communications Bar Association, "How the Antitrust Agencies and the FCC are Likely to Analyze Vertical Mergers," Panelist, November 2014.

The Coca Cola Company Global Antitrust Forum, "Round Table Discussion on Use of Economics and Economists," Panel Chair, November 2014.

Compass Lexecon Competition Policy Forum, Lake Como Italy, "Consolidation of the Telecoms Industry in the EU and the U.S.," Panelist, October 2014.

The IATA Legal Symposium 2014, Aviation Law: Upfront and Center, "Merger Analysis – A sudden shift in approach by DOJ in the American Airlines and US Airways merger," Panelist, February 2014.

Georgetown Law 7th Annual Global Antitrust Enforcement Symposium, "Merger Enforcement and Policy," Panelist, September 2013.

American Bar Association Section of Antitrust Law, "Airline Mergers: First Class Results or Middle-Seat Misery?" Panelist, May 2013.

American Bar Association Section of Antitrust Law, "Go Low or Go Home! Monopsony a Problem?" Panelist, March 2012.

Federal Communications Bar Association Transactional Committee CLE Seminar, "The FCC's Approach to Analyzing Vertical Mergers," Panelist, October 2011.

The Technology Policy Institute Aspen Forum, "Watching the Future: The Economic Implications of Online Video," Panelist, August 2011.

American Bar Association Forum on Air & Space Law, 2011 Update Conference, "Antitrust Issues: What's on the Horizon for the Industry," Panelist, February 2011.

American Bar Association Section of Antitrust Law, "Antitrust in the Airline Industry," Panelist, September 2010.

GRANTS AND HONORS

Searle Fund for Policy Research Grant, 2004-2006, for "An Empirical Examination of Asymmetric Information in Insurance Markets."

Kellogg School of Management Chairs' Core Course Teaching Award, 2003 & 2005.

Bradley Dissertation Fellowship, Stanford University, 1999-2000.

Stanford University, Outstanding Second Year Paper Prize, 1997.

ADVISORY, EDITORIAL, AND TRUSTEE BOARDS

Global Competition Review, Editorial Board, Member

Illinois Wesleyan University, Board of Trustees, Trustee

REFEREE FOR ACADEMIC JOURNALS

American Economic Review

The Journal of Industrial Economics

The Rand Journal of Economics

Journal of the European Economic Association

The Review of Economic Studies

The Review of Economics and Statistics

Journal of Risk and Insurance

ATTACHMENT B

-PUBLIC VERSION-

APPENDIX F: DECLARATION OF COMPASS LEXECON

Mark Israel, Michael Katz, and Bryan Keating

September 17, 2018

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Executive Summary

Counsel for T-Mobile has asked us to provide our expert assessment of the unilateral effects analyses of the proposed merger of T-Mobile US, Inc. and Sprint Corporation submitted by Joseph Harrington, Coleman Bazelon, Jeremy Verlinda, and William Zarakas ("HBVZ").

HBVZ present both a simulation to predict the proposed merger's effects on mobile broadband retail pricing and a vertical Gross Upward Pricing Pressure Index ("vGUPPI") analysis to assess the effect of the merger on wholesale pricing incentives. Both models are seriously deficient, most importantly because they ignore the beneficial effects of the merger on marginal costs and product quality. Simply incorporating the marginal cost savings implied by Sprint's and T-Mobile's network planning and engineering analyses into HBVZ's merger simulation demonstrates that the proposed merger would promote competition and consumer welfare, even if one ignored consumer benefits from the merger's substantial network quality improvements and corrected none of the other problems with HBVZ's analysis.

To test the robustness of the conclusion that the proposed merger will promote competition and consumer welfare, we: (a) correct methodological and data errors in HBVZ's analyses; (b) complete HBVZ's analyses by including all efficiencies, including quality improvements; and (c) consolidate the analyses by integrating vGUPPIs into the merger simulation. In doing so, we make several assumptions that are conservative in the sense that they tend to underestimate the net competitive and consumer benefits of the proposed merger.

Our analysis begins in 2021, when the merger integration process will be substantially complete. Although our analysis is more conservative than HBVZ's, we still find that the merger's marginal cost savings and quality improvements will prevent any adverse unilateral competitive effects in all model specifications we examine. This analysis demonstrates that the proposed merger will strengthen competition and benefit consumers from 2021 through the foreseeable future.

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I. INTRODUCTION AND OVERVIEW

1. T-Mobile US, Inc. ("T-Mobile") and Sprint Corporation ("Sprint") (collectively, the "Parties") have requested the consent of the Federal Communications Commission ("Commission") to combine to form "New T-Mobile."[1] Counsel for T-Mobile has asked us to provide our expert assessment[2] of the unilateral effects analyses submitted by Joseph Harrington, Coleman Bazelon, Jeremy Verlinda, and William Zarakas ("HBVZ").[3]

2. We have identified several serious shortcomings in HBVZ's merger simulation analysis of mobile broadband services and their upward pricing pressure analysis of wholesale services.[4] First and most important is that they do not consider the beneficial effects that the

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[1] Description of Transaction, Public Interest Showing, and Related Demonstrations, *In the Matter of Applications of T-Mobile US, Inc., and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations*, WT Docket No. 18-197, June 18, 2018 (hereinafter, *T-Mobile/Sprint Public Interest Showing*). As part of their application, T-Mobile and Sprint submitted several declarations that we reference below: Declaration of Neville R. Ray (hereinafter, *Ray Declaration*); Declaration of Brandon "Dow" Draper (hereinafter, *Draper Declaration*); Declaration of John C. Saw (hereinafter, *Saw Declaration*); Joint Declaration of Professor Steven C. Salop and Dr. Yianis Sarafidis (hereinafter, *Salop-Sarafidis Declaration*); David S. Evans, "Economic Analysis of the Impact of the Proposed Merger of T-Mobile and Sprint on the Deployment of 5G Cellular Technologies and the Resulting Impact on Consumers, Enterprises, and the Economy" (hereinafter *Evans Declaration*).

[2] Our qualifications are summarized in Appendix II to this declaration.

[3] Declaration of Joseph Harrington, Coleman Bazelon, Jeremy Verlinda, and William Zarakas, Exhibit B to Petition to Deny of DISH Network Corporation, *In the Matter of Applications of T-Mobile US, Inc., and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations*, WT Docket No. 18-197, August 27, 2018 (hereinafter, *HBVZ Declaration*), § III.

[4] We also note that HBVZ present other analyses of unilateral effects. Specifically, HBVZ present analyses of concentration (based on the Herfindahl-Hirschman Index ("HHI")) and pricing pressure (based on the Gross Upward Pricing Pressure Index ("GUPPI")). (*HBVZ Declaration*, §§ III.B, III.C.1.) Because each of these indices is intended as a screening mechanism and not a full model of the merger, we focus on HBVZ's merger simulation analysis, which more fully analyzes the same economic incentives that the HHI and GUPPI analyses are designed to assess. (See, e.g., *HBVZ Declaration* at 39 ("The analysis of market

merger's efficiencies will have on both New T-Mobile's retail and wholesale pricing incentives and, thus, on competition and consumer welfare. Second, HBVZ's merger simulation analyses of pricing incentives contain data and methodological errors. Lastly, HBVZ (incompletely) analyze wholesale pricing separately from their retail mobile broadband simulation, rather than combining wholesale and retail effects in an integrated model. In the real world, wholesale and retail pricing are inextricably linked and must be considered together when assessing the bottom-line effect of the proposed merger on consumer welfare.

3. To address these shortcomings, we modify HBVZ's merger simulation analysis to: (1) account not only for any adverse unilateral competitive effects that would occur absent efficiencies, but also for the efficiencies that the merger will generate in the form of lower marginal costs and higher quality;[5] (2) correct several data and methodological errors in

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shares and concentration levels in the relevant product and geographic markets is *a useful starting point* for assessing the effect of a proposed merger." [emphasis added]); *HBVZ Declaration* at 43 ("The GUPPI does not take merger synergies into account."). See, also, U.S. Department of Justice and the Federal Trade Commission, *Horizontal Merger Guidelines*, August 19, 2010 (hereinafter, *Horizontal Merger Guidelines),* §§ 5.3, 6.1.)

[5] HBVZ did not assess the impact of the transaction on the provision of wireless broadband services that are full substitutes for conventional fixed broadband services. (*HBVZ Declaration* at 7-8.) Although we do not address this topic, Dr. Harold Furchtgott-Roth has separately projected that the merger will generate substantial consumer benefits for consumers of such services. (Declaration of Dr. Harold Furchtgott-Roth, September 17, 2018 (hereinafter, *Furchtgott-Roth Declaration*)). It is our understanding that New T-Mobile will offer a full substitute for conventional fixed broadband services in areas where it has sufficient capacity to do so without materially raising marginal costs. (Reply Declaration of G. Michael Sievert, September 17, 2017, (hereinafter, *Sievert Reply Declaration*), ¶ 6.) Because we do not account for the merger-specific benefits due to such services, and provision of these services will not materially affect mobile broadband services, our approach understates the overall competitive and consumer welfare benefits of the merger.

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HBVZ's analyses, and (3) consolidate the analyses by integrating wholesale pricing into our overall merger simulation.

4. Because it accounts for merger efficiencies, the modified analysis describes how the relevant wireless networks will evolve over time with and without the merger. The initial evolution of the New T-Mobile network will be driven by integration needs, as opposed to responding to changes in output levels.[6] Consequently, our merger assessment commences in 2021, by which time the integration of the Parties' wireless networks is anticipated to be largely complete, meaning that the available tools can be used to model the endogenous evolution of the New T-Mobile network.

A. SUMMARY OF FINDINGS

5. Our central findings are as follows. The companies' plans indicate that New T-Mobile will build a far more capable wireless network than would either T-Mobile or Sprint acting on its own. By "more capable," we mean that New T-Mobile's planned network will allow the combined firm to achieve lower marginal costs of providing services and to offer higher quality services than would either merging party operating on its own. Incorporating these merger efficiencies in either HBVZ's original simulation analysis or our conservative alternative model indicates that the lower marginal costs and higher product quality will create downward pressure on New T-Mobile's quality-adjusted prices that will outweigh any upward price pressure from the loss of a competitor, thus benefiting consumers. New T-Mobile's lower quality-adjusted prices will also create competitive pressures on rival service

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6 Reply Declaration of Neville R. Ray, September 17, 2018, (hereinafter *Ray Reply Declaration*), ¶ 15.

providers to respond by reducing their prices and improving their services, further benefiting consumers. In short, the merger of Sprint and T-Mobile will strengthen mobile broadband competition.

6. More specifically, we find the following:

- *The proposed transaction is projected to generate significant marginal cost savings, which will strengthen the combined firm's incentive and ability to compete for users by offering lower quality-adjusted prices.* The Parties' network plans and T-Mobile's Network Build Model (described below) imply that New T-Mobile's network will have significantly lower marginal costs than would either company's network absent the merger. This is especially true with respect to standalone T-Mobile's network. Moreover, Parties project that the proposed merger will lead to reductions in non-network marginal costs. By significantly lowering non-network and network marginal costs, the proposed transaction will increase the incentive and ability of the merged firm to compete for new customers and to expand the volume of services sold to existing customers by lowering prices, increasing quality, or both. These practices will, in turn, increase competitive pressures on rival mobile broadband service providers.

- *The proposed transaction will generate significant quality improvements, which will benefit consumers and increase competitive pressures on rival service providers.* The Parties' network plans and their Network Build Model indicate that New T-Mobile's network will provide significantly higher quality services than would either company's network absent the merger. These quality improvements will come in the form of:

- *Faster Data Speeds.* New T-Mobile's network will offer users higher data throughput rates (colloquially, data speeds) than would the standalone network of either company.
- *Better Coverage.* New T-Mobile's network will offer users better signal strength and broader geographic access to 5G services than the standalone network of either company. This is particularly true relative to Sprint's standalone network.
- *Relaxation of Usage Restrictions.* Because the merger reduces New T-Mobile's marginal costs of carrying traffic, the merged company will be incented to allow users to consume greater amounts of data on a per-subscriber basis by relaxing usage restrictions such as data caps or limitations on throughput. These improvements can be viewed as an increase in output or, equivalently, as an improvement in the quality of a subscription.

All of these improvements will be valuable to consumers.

- *The HBVZ merger simulation analysis demonstrates that the merger is procompetitive once modified to account for efficiencies.* HBVZ merger simulation analysis ignores the efficiencies that will arise from the merger. Because it ignores the beneficial aspects of the merger for consumers, HBVZ's analysis, without further modification, would necessarily find that *any* merger of firms competing for the same customers harms competition and consumers and, thus, this analysis cannot support any conclusions about the net effect of the proposed transaction on competition and consumer welfare. Incorporating the merger-specific efficiencies projected by the Parties' network plans and their Network Build Model into the HBVZ merger simulation model leads to the conclusion that the merger will strengthen competition and raise consumer welfare. Specifically, all of HBVZ's merger simulations require [redacted] of efficiencies for the proposed merger to be procompetitive, and the Parties' projected

marginal cost savings alone exceed this threshold. Accounting for the quality benefits of the merger strengthens the conclusion that the proposed merger will benefit consumers.

- *Our alternative merger simulation analysis, which makes several more conservative assumptions than do HBVZ, also demonstrates that the merger is procompetitive and pro-consumer.* In addition to using more accurate data, we make several conservative assumptions relative to HBVZ, including using higher estimated diversion ratios between Sprint and T-Mobile, assuming a lower (in absolute value) industry elasticity, and accounting for incentives associated with wholesale pricing in an integrated framework with retail pricing incentives. Even taking this more conservative approach than HBVZ, we find that the merger promotes competition and benefits consumers. We run several sensitivity analyses and find that all of the variants of the alternative merger simulation require [redacted] of efficiencies for the proposed merger to be procompetitive. In all years except 2021, the Parties' projected marginal cost savings alone exceed this threshold. In 2021, the proposed merger is procompetitive as long as the average subscriber values the proposed merger's substantial projected quality improvements by [redacted]—a threshold that is surely cleared.

7. The remainder of this declaration explains these findings in greater depth and provides details of the facts and analysis that led to them.

B. DESCRIPTION OF HBVZ'S UNILATERAL EFFECTS ANALYSES

8. We begin by providing high-level summaries of HBVZ's merger simulation analysis of mobile broadband services and upward pricing pressure analysis of wholesale mobile

wireless services.[7] In Part I.C below, we provide more background on all the pieces of a proper merger simulation analysis for this case, including the pieces that HBVZ omit; here, because HBVZ's model is already in the record, we provide only a summary description of what they have done.

1. HBVZ's Merger Simulation Model

9. As is standard in merger simulation models, HBVZ start with assumptions about the shape of the demand curve, which affects the extent of substitution among the products offered by the merging parties, the upward pricing pressure created by that substitution and (when included) the downward pricing pressure created by efficiencies, and the extent to which each of these forces is translated into equilibrium prices. HBVZ make two alternative assumptions about the structure of demand for mobile wireless services. They assume it is either: (1) logit, which HBVZ sometimes refer to as the antitrust logit model or ALM, or (2) PC-AIDS.[8] These demand models differ primarily in the assumed curvature of the relationship between prices and quantities.[9] Specifically, HBVZ show that, because the ALM model assumes a flatter curvature than the PC-AIDS model, it generates lower estimates of

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7 We note at the outset that HBVZ did not provide worksheets, code, or other backup materials with their submission, and counsel has informed us that DISH refused to provide these materials when requested. Hence, there are various components of their analysis that we have had to reverse engineer to the best of our ability given the limited information that HBVZ were willing to provide.

8 *HBVZ Declaration* at 48.

9 Curvature refers to the extent to which the slope of a function changes at different points. A linear function has a constant slope everywhere; other functional forms allow the slope to change, meaning here that the effect of price on quantity demanded varies depending on the price (and quantity) level considered.

upward pricing pressure.[10] Below, we show that, for the same reason, the ALM model implies a lower pass-through rate of efficiencies than does the PC-AIDS model and that, once both upward pricing pressure *and* efficiencies are properly taken into account, the two demand models generate similar predictions about the consumer-welfare effects of the transaction.[11]

10. HBVZ also make several specific modeling assumptions about industry structure.[12] First, HBVZ separately model prepaid and postpaid segments, which means that they assume that price changes or other strategic decisions made by brands in one segment have no effect on the equilibrium decisions made by brands in the other segment. Second, within each segment, HBVZ treat each firm as a separate, differentiated product. In the postpaid segment, HBVZ model consumers as choosing from among five competitors: AT&T, Verizon, Sprint, T-Mobile, and U.S. Cellular. In the prepaid segment, HBVZ model six independent competitors: AT&T, Verizon, Sprint, T-Mobile, TracFone, and an aggregation of other mobile virtual network operators (MVNOs) that is treated as if it were a single firm ("Other MVNO").[13] Third, HBVZ include an "outside good" as a consumer option, which represents

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10 *HBVZ Declaration* at 48.

11 For a discussion of the implications of different demand systems for pass-through, see Luke Froeb, Steven Tschantz, and Gregory J. Werden (2005), "Pass-through Rates and the Price Effects of Mergers," *International Journal of Industrial Organization*, **23**(9-10): 703-715 ("We find that the demand conditions that cause a merger to result in large price increases absent synergies also cause the pass-through rate to be high.").

12 *HBVZ Declaration* at 48-49.

13 HBVZ note that mobile network operators (MNOs) supply network capacity to MVNOs on a wholesale basis and that the merger could therefore affect the input prices of MVNOs. However, they do not model these incentives in their merger simulation model. (*HBVZ Declaration*, n. 69.)

the choice to forego obtaining one of the options in the segment (postpaid or prepaid) being studied.[14]

11. Having specified a model of industry behavior, HBVZ calibrate their model to real-world outcomes. HBVZ do so using 2017 data from company annual reports on shares and average revenue per user (ARPU), the latter of which they use as a proxy for price.[15] HBVZ calculate marginal costs for each product using data from industry analysts and company financial reports.[16]

12. A component of HBVZ's marginal cost estimates is their estimate of network Marginal Capital Cost.[17] HBVZ make several highly simplifying assumptions in order to develop this estimate, including assuming values for: (1) the share of subscribers added by building towers; (2) the share of subscribers added by deploying radios; (3) the cost per tower; (4) the number of LTE channels; and (5) the cost of adding a radio.[18] HBVZ provide no sources to substantiate the numerical values that they assume. Moreover, and perhaps most important, HBVZ assume that the merger has no effect on the marginal capital costs of expanding the mobile operator's network, as well as no effect on non-network marginal costs. In other words, their analysis assumes that the proposed transaction will generate no marginal

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14 This does not necessarily mean that a household goes without mobile broadband service. Instead, for example, it could mean that a household chooses to go without an extra mobile broadband subscription on an extra device that it was considering adding.

15 *HBVZ Declaration at* 50.

16 See *HBVZ Declaration,* Appendix A for more details on how HBVZ calculate marginal costs for each brand.

17 *HBVZ Declaration,* Table 11 and Appendix A.

18 *HBVZ Declaration,* Table 11.

cost efficiencies. However, as we describe in Section IV.A below, T-Mobile's Network Build Model and the Parties' business plans and ordinary course data and assumptions imply that that the proposed merger will generate substantial network capex and opex savings, as well as non-network cost savings, which together generate substantial marginal cost reductions.

13. Limitations in the data available to HBVZ cause them to use different calibration approaches for postpaid and prepaid products for their ALM model:[19]

- *Postpaid Segment:* HBVZ collect or estimate data on ARPU, segment share, and margins for each of the five modeled brands. As a result, HBVZ have more data points than model parameters, making it unclear without additional investigation (not reported in their declaration) exactly how they pin down (identify) their model's parameters.[20] We have reverse engineered their Antitrust Logit merger simulation model, and it appears that HBVZ base their calibration of the subscriber price sensitivity parameter and the industry elasticity on the estimated marginal costs of AT&T and T-Mobile, and not the other brands.

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19 *HBVZ Declaration,* nn. 68-69.

20 *HBVZ Declaration,* n. 68:

> The system of equations derived from the model under standard assumptions is an over-identified system; there are more model equations than parameters to be calibrated. This is because for postpaid services we have all carriers' ARPU, incremental costs and subscriber counts, which leaves only the price sensitivity parameter and the market elasticity to be calibrated. Industry priors are employed to pin down the set of equations that will be used for the calibration. [Internal citations omitted.]

- *Prepaid Segment:* HBVZ lack ARPU data for AT&T and Verizon and lack marginal cost estimates for TracFone. HBVZ treat the ARPUs for AT&T and Verizon as unknown model parameters, which they calibrate based on the following: ARPUs for Sprint, T-Mobile, TracFone, and Other MVNO; estimated marginal costs for AT&T, Verizon, Sprint; and the subscriber count for each carrier's prepaid service.[21] HBVZ assume, without justification, that the prepaid industry elasticity is equal to their estimated postpaid industry elasticity.

14. HBVZ calibrate their PC-AIDS merger simulations using revenue shares derived from company financial reports and Sprint's marginal costs.[22] They import the industry elasticity calibrated from the postpaid logit model into their PC-AIDS models. For the prepaid model, they also use the prepaid ARPUs for AT&T and Verizon that are calibrated in the prepaid logit model as inputs.

15. As we will discuss below, HBVZ's simulation analyses suffer from several weaknesses. By far the biggest one is that it does not consider the beneficial effects that the merger's efficiencies will have on competition and consumer welfare. Other weaknesses arise from certain methodological choices made by HBVZ and their use of poor estimates of parameter values that are critical to their models' results.

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21 *HBVZ Declaration,* n. 69.

22 *HBVZ Declaration* at 52-53.

2. HBVZ's Gross Upward Pricing Pressure Index Calculation

16. In addition to their merger simulation model, HBVZ also calculate a Gross Upward Pricing Pressure Index ("vGUPPI") to "assess New T-Mobile's incentives to increase wholesale prices."[23] The vGUPPI attempts to account for the competitive implications of the fact that, today, each network both supplies wholesale network services to MVNOs and competes with those MVNOs for retail customers. The idea is that the merger potentially changes those wholesale pricing incentives by causing New T-Mobile to internalize the fact that a wholesale price increase to an MVNO may cause that MVNO to raise its retail price, generating diversion to Sprint's retail services in addition to T-Mobile's (the latter incentive is already reflected in pre-merger wholesale pricing). Today, T-Mobile obtains no benefit on sales diverted to Sprint, but post-merger those sales diverted to Sprint would go to the integrated New T-Mobile, so that New T-Mobile would internalize the benefit of such diverted sales. The vGUPPI attempts to evaluate the magnitude of the induced incentive to raise wholesale prices.

17. HBVZ calibrate their vGUPPI model using the following data. They assume diversion between TracFone and Sprint and between TracFone and T-Mobile is proportional to the share of prepaid subscribers.[24] They use the same retail prices and margins as they use in

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23 *HBVZ Declaration* at 54.

24 *HBVZ Declaration,* Table 25.

their merger simulation.[25] Finally, they derive Sprint's and T-Mobile's wholesale ARPU from their respective 2017 annual reports.[26]

18. HBVZ do not properly implement the vGUPPI.[27] Specifically, HBVZ do not properly account for the fact that Sprint and T-Mobile account for only a portion of each MVNO's traffic. In addition, HBVZ incorrectly implement the mathematical formula for the vGUPPI. HBVZ's wholesale pricing analysis also is not integrated into their retail mobile broadband simulation, which means that HBVZ cannot properly assess the bottom-line effects of any wholesale pricing changes on consumer welfare.

C. A PROPER MERGER SIMULATION FRAMEWORK

19. As described above and further explained below, HBVZ's unilateral effects analyses suffer from serious deficiencies. The problem is not with the idea of using a merger simulation; merger simulation is an accepted method for making predictions about the effects of a proposed merger on competition and consumer welfare.[28] Rather, the problem is with

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25 *HBVZ Declaration,* Table 25.

26 *HBVZ Declaration,* Table 16.

The T-Mobile wholesale ARPU that HBVZ report in Table 16 does not match the T-Mobile wholesale ARPU that HBVZ use in their vGUPPI calculations in Table 25. It is unclear what accounts for the difference.

27 For additional discussion of problems with HBVZ's implementation of the vGUPPI, see Joint Supplemental Declaration of Professor Steven C. Salop and Dr. Yianis Sarafidis, September 17, 2018 (hereinafter, *Salop/Sarafidis Reply Declaration*), § V.A.

28 The Commission, the Department of Justice ("DOJ"), and other competition agencies frequently use this methodology to evaluate mergers, and such models have been used to evaluate competitive effects in recently litigated horizontal merger cases. (*Horizontal Merger Guidelines*, § 6.1. See, also, Memorandum Opinion, *United States of America v. H&R Block, Inc., et al.*, Civil Action No. 11-00948 (BAH), November 10, 2011 (hereinafter, *H&R Block Opinion*), § III.B.2.c; Memorandum Opinion, *Federal Trade Commission, et al., v. Sysco Corporation, et al.,* Civil No. 1:15-cv-00256 (APM), June 29, 2015 (hereinafter, *Sysco/US*

HBVZ's implementation of merger simulation. In what follows, we modify HBVZ's merger simulation analysis to correct major deficiencies from which it suffers. In particular, we: (a) correct methodological and data errors in HBVZ's analyses; (b) complete the analyses by including all efficiencies, including quality improvements; and (c) consolidate the analyses by integrating vGUPPIs into the merger simulation. Among other things, we show that, *even if one accepts all of the other assumptions of HBVZ's merger simulation analysis, simply correcting it to account for the proposed merger's projected efficiencies leads to the conclusion that the proposed merger will strengthen competition and benefit consumers.*

20. Unlike HBVZ's analysis, our more complete merger simulation analysis accounts for all three of the primary effects that economic theory and marketplace evidence indicate that the merger will have:[29]

- The merger will change the ownership structure such that T-Mobile will jointly own both Sprint and T-Mobile and, therefore, will internalize the value of sales diverted between the two firms (that otherwise would have been viewed as lost sales by each separate firm);

Foods Opinion), § II.C.2.; Memorandum Opinion and Order, *In the Matter of Applications of AT&T Inc. and DIRECTV for Consent to Assign or Transfer Control of Licenses and Authorizations*, MB Docket 14-90, rel. July 28, 2015 (hereinafter, *AT&T/DIRECTV Order*), § IX.A and Appendix C; Memorandum Opinion, *United States of America, et al., v. Aetna Inc., et al.,* Civil Action No. 16-1494 (JDB), January 23, 2017 (hereinafter, *Aetna/Humana Opinion*), § I.A.4.)

[29] Because it does not account for the second and third effects, HBVZ's merger simulation analysis does not provide a valid prediction of the effects of the proposed merger. HBVZ's vGUPPI analysis is similarly invalid.

- the merger will lower the marginal costs of serving additional customers facing the combined firm relative to those facing the standalone firms, creating incentives to cut prices and expand output; and
- the merger will improve the quality of service that the combined firm will offer relative to what the standalone firms would offer.

All else equal, the first effect—the only one HBVZ consider—will tend to create incentives to raise quality-adjusted prices (and therefore lower consumer welfare), while the second and third effects will tend to create incentives to lower quality-adjusted prices (and therefore raise consumer welfare).

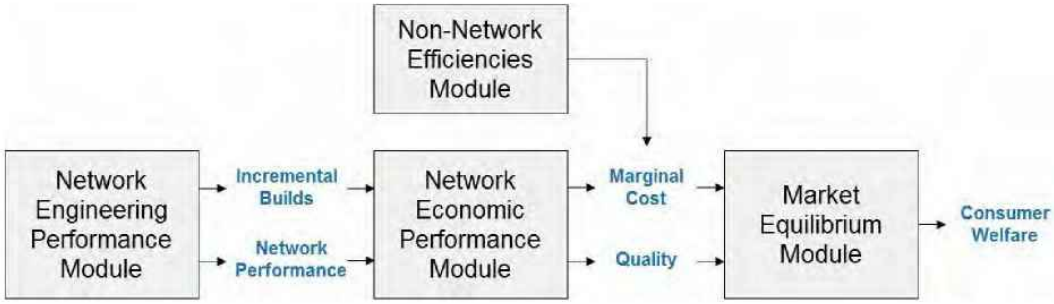
21. Properly done, merger simulation provides a framework within which the net effects of these three forces on the combined company's incentives can be determined. It is important to recognize that, contrary to popular misunderstanding, a merger simulation does not calculate a price increase from a merger and then "offset" it with efficiencies. Rather, the simulation appropriately determines a merger's competitive effects by evaluating the combined effects of the economic forces identified above on the merged company's incentives to raise or lower its quality-adjusted prices relative to those prices that would have prevailed absent the merger.

22. As described further below, both HBVZ's merger simulation models and our alternative merger simulation model also incorporate competitor reactions via price responses. The models allow AT&T, Verizon, and other competitors to respond to the merger by raising or lowering their prices. The fact that, when one accounts for merger efficiencies, both HBVZ's merger simulation models and our alternative merger simulation model predict that

AT&T and Verizon will lower their prices in response to the merger indicates that the merger will strengthen competition.

23. Figure 1 provides a schematic description of the elements of the full merger simulation framework that we employ.

Figure 1: Merger Simulation Schematic



24. The *Network Engineering Performance Module,* which we describe in greater detail in Section III below, is a tool that models the required network investments, determines the associated network performance, and serves as a basis for quantifying the network efficiencies that arise from combining the Parties' networks. Specifically, for each of three networks (i.e., standalone Sprint, standalone T-Mobile, and New T-Mobile), the module calculates: (a) the number and type of incremental investments (e.g., spectrum overlays and cell splits) necessary to achieve the desired network performance metrics, and (b) measures of network performance delivered to users expressed in engineering terms (e.g., megabits per second (Mbps) of throughput).[30] Comparing the output of the Network Engineering Performance

[30] As we describe in more detail below, the Network Engineering Performance Module does not capture all meaningful elements of network quality and merger-specific quality improvements.

Module for New T-Mobile's network with the outputs of the module for the standalone networks provides a measure of the efficiencies gained from integrating the networks. We refer to these improvements in performance as "network efficiencies."

25. Although network efficiencies constitute the bulk of the expected efficiencies in this merger, the Parties also expect to realize non-network, merger-specific efficiencies. The *Non-Network Efficiencies Module*, which we describe in Section IV.B below, analyzes merger-specific efficiencies unrelated to the network. As shown in Figure 1 above, these efficiencies are also inputs into the Market Equilibrium Module.

26. The *Network Economic Performance Module,* which we describe in greater detail in Sections IV.A and VI below, translates engineering estimates of network builds and performance into projected marginal cost curves and projected consumer valuations of network quality for each of the three networks. These projections are compared across networks to quantify the marginal cost savings and consumer valuation of the quality improvements due to the merger.

27. The marginal cost and quality valuations are fed into the *Market Equilibrium Module,* which we describe in Section II, to predict the consumer welfare levels with and without the proposed merger. The predicted consumer-welfare effects of the proposed merger are found by comparing the predicted consumer welfare level with the merger to the predicted consumer welfare level without the merger. The model's finding that the proposed merger will benefit consumers is based on an integrated and internally consistent framework that incorporates

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For example, it does not measure latency and does not fully capture improvements in coverage and consistency.

efficiencies from marginal cost and quality improvements, as well as the effect of the loss of a competitor, to arrive at an estimate of the proposed merger's competitive effects.

28. Before describing the components of our analysis further, it is useful to describe how HBVZ's analyses fit within the framework described in Figure 1 above. HBVZ's logit and PC-AIDS models are alternative versions of the Market Equilibrium Module. Although HBVZ develop estimates of existing marginal costs, they do so based on minimal modeling and make no attempt to estimate any effects of the proposed merger on marginal costs.[31] They also fail to estimate quality effects. In other words, their analyses lack a Network Engineering Performance Module, an Economic Performance Module, and a Non-Network Efficiencies Module, or reliable substitutes for those modules. Lastly, their vGUPPI analysis is conducted as a standalone analysis and is not incorporated into the Market Equilibrium Module of their simulations, meaning it cannot properly contribute to analyzing the merger's bottom-line effect on consumer welfare, which is the relevant question for economic merger analysis.

II. MARKET EQUILIBRIUM

29. Starting at the final stage, the Market Equilibrium Module, is useful because it illuminates how the outputs of the other modules are used to predict the effects of the proposed merger. This module consists of an economic model of the industry that is a calibrated to industry conditions (e.g., prices, shares, and margins) and then used to predict

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[31] *HBVZ Declaration,* § III.C. See especially *HBVZ Declaration* at 54 (using their merger simulation model to make predictions about post-merger price increases with no consideration of potential efficiencies).

consumer-welfare levels with and without the merger. In Part A, we describe how our alternative Market Equilibrium model: (a) corrects data and methodological errors in HBVZ's analyses; (b) completes the analyses by incorporating efficiencies; and (c) consolidates the analyses by integrating the vGUPPI analysis into the overall merger simulation. In Part B, we then describe the implications of both of HBVZ's and our models for predicting the net consumer-welfare effects due to any adverse unilateral competitive effects and the merger's efficiencies. As part of this discussion, we demonstrate that our alternative approach is based on a more conservative set of assumptions than is HBVZ's model, which has the effect of increasing the upward pricing pressure predicted by our model relative to HBVZ's model.[32]

A. OUR ALTERNATIVE MARKET EQUILIBRIUM MODEL

30. In this part we first describe how our alternative market equilibrium model modifies HBVZ's approach. We then describe how the model is calibrated.

1. Model Description

31. As does HBVZ's model, our alternative merger market equilibrium model assumes firms choose prices to maximize profits, taking into account the anticipated reactions of rival firms (the "Bertrand-Nash" assumption).[33] For our assumption about the shape of demand, we also use a type of logit model (nested logit) that is similar to HBVZ's ALM model in many respects. An important feature of logit demand is that diversion ratios are assumed to

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32 In Section VI below, we show that, even under these more conservative assumptions, the merger is procompetitive once projected efficiencies are incorporated.

33 We describe the technical details of our model in more detail in Part A of Appendix I.

be proportional to market shares (at least for products within the same nest in a nested logit),[34] making the model easy to implement and the assumption about diversion ratios simple, transparent, and well-understood and frequently-used by economists. We consider it an advantage that we demonstrate that the merger is procompetitive using a simple, standard, commonly used demand model.

32. Starting from this baseline, our alternative model makes several changes to HBVZ's ALM model, which together have the effect of making our model more conservative than HBVZ's model.

33. First, we include all postpaid and prepaid brands in one model to allow for substitution between prepaid and postpaid brands. We used a nested version of the logit model to allow for the fact that, although there is substitution between postpaid and prepaid products, postpaid products may be closer substitutes for other postpaid products and prepaid products closer substitutes for other prepaid products. The nested logit model accomplishes this by allowing diversion among products in a given nest to potentially be scaled up relative to what shares would imply, with diversion to products in other nests is scaled down.

34. Second, our nested logit approach more generally allows for richer substitution patterns than does the ALM model. Specifically, we do not force diversion among all products included in the model to be proportional to share. Instead, diversion in our model is

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[34] In the simple logit model, diversion is assumed to be proportional to shares. In a nested logit model, diversion *within nests* is assumed to be proportional to shares. Diversion across nests is allowed to be less than proportional, but even in this case, the diversion ratios between a product in one nest and all products in another nest are scaled down uniformly, such that the relative diversion ratios are still proportional to relative shares.

proportional to share only for products within the same nest. Products in different nests are potentially more distant substitutes, with diversion rates that are lower than those among products in the same nest. Our model has the following nesting structure, which, among other things, conservatively allows for higher diversion between Sprint and T-Mobile products than between either Sprint or T-Mobile products and products in other nests:

- There is a high-level choice among five nests: postpaid brands controlled by T-Mobile and Sprint; postpaid brands controlled by all other operators; prepaid brands controlled by mobile network operators (MNOs, including AT&T, Verizon, Sprint, and T-Mobile); prepaid brands controlled by MVNOs; and an outside good.
- We allow the outside good to have its own nest to reflect that this is a fundamentally different product from the mobile broadband options.
- We group T-Mobile and Sprint postpaid products into their own nest as a parsimonious way to allow for the possibility that Sprint and T-Mobile postpaid products may be closer substitutes for one another than for other brands. We also allow prepaid brands run by MNOs to be closer substitutes for one another than for MVNO brands (and, as discussed below, calibrate the nesting parameter for this all-MNO prepaid nest to match the diversion ratio between Sprint and T-Mobile in particular). Allowing for greater-than-proportional diversion between Sprint and T-Mobile is an important dimension on which our approach is conservative relative to HBVZ's, which assumes diversions are proportional to shares.

35. A third modification to HBVZ's model concerns treatment of the "outside good" (i.e., the extent to which people will react to changes in quality-adjusted prices by changing the

number of mobile wireless subscriptions that they purchase).[35] As do HBVZ, we account for the degree of substitution between the products at issue and the outside good, but we allow for less substitution with the outside good than do HBVZ, which, all else equal, increases the incentive for the Parties to raise prices post-merger.[36] As do HBVZ, we measure the degree of substitution with the outside good through the industry elasticity of demand, which measures the percentage change in total industry demand in response to a one-percent change in every firm's price. Roughly speaking, a low industry demand elasticity indicates that only a small percentage of consumers reduce or eliminate their purchases of a good in response to a general price increase. The lower is the industry elasticity, the higher are the diversion ratios between suppliers, as fewer consumers opt out of purchasing the good altogether in response to a price increase, relative to those who switch to a different supplier of the good. Conversely, with a relatively high industry demand elasticity, a price increase by a single firm will cause relatively more subscribers to forego purchasing the product (e.g., forego mobile wireless service on an extra device, such as an iPad). In our analysis, we consider a range of industry elasticities that are consistent with those estimated for mobile wireless service in the empirical academic literature and previously adopted by the Commission.[37] In our baseline

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35 As explained above, diversion to the outside good does not mean a person stops using mobile broadband service altogether. Rather, it means she foregoes a mobile broadband subscription that she otherwise would have taken, perhaps choosing to go without a subscription for an iPad, for example.

36 The interpretation of the outside good is somewhat different between HBVZ's model and our modification of it. Specifically, prepaid products are part of the outside good for HBVZ's postpaid segment, and postpaid products are part of the outside good for their prepaid segment.

37 In its evaluation of the AT&T/T-Mobile merger, the Commission Staff considered a range of industry elasticities from 0.0 (assuming no substitution to the outside good) to -0.51, with the

model, we use an industry elasticity of -0.3, which is lower in absolute value than the estimate of -0.55 that HBVZ use, and thus, all else equal, will lead the model to predict larger post-merger price increases. We also consider a highly conservative sensitivity case with an industry elasticity of -0.1, as well a case with industry elasticity of -0.5.

36. Fourth, although HBVZ compute vGUPPIs and argue that the merger will create incentives to raise wholesale prices to MVNOs, they do not integrate their analysis of horizontal (merger simulation) and vertical (vGUPPI) pricing incentives.[38] More generally there are several flaws with their vGUPPI approach. First, HBVZ do not account for upstream network efficiencies when considering wholesale pricing incentives. Reductions in network marginal costs will put downward pressure on wholesale prices, and HBVZ ignore this incentive. Second, HBVZ do not account for the effect of efficiencies, and the induced changes in downstream quality adjusted prices, on MVNO's downstream pricing incentives. To the extent that efficiencies reduce the quality-adjusted prices of retail rivals to MVNOs, such reductions will also put downward pressure on MVNO retail prices even if the MVNO's input costs increase. To properly answer the question of whether the merger affects consumer

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latter estimate drawn from the economic literature. (Staff Analysis and Findings, *In the Matter of Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer Control of Licenses and Authorizations*, WT Docket 11-65, rel. November 29, 2011 (hereinafter *AT&T/T-Mobile Commission Staff Report*), Appendix C, ¶ 15.)

HBVZ use an industry elasticity of -0.55. (*HBVZ Declaration,* n. 67.)

In our analysis below, we use an industry elasticity of -0.3 in our baseline model and consider industry elasticities ranging between -0.1 and -0.5.

38 *HBVZ Declaration,* n. 69.

welfare through wholesale pricing, both effects must be considered. Third, HBVZ made certain technical errors in implementing their vGUPPI calculations.[39]

37. To implement an integrated model of MNO and MVNO competition, we model demand and competitive interactions at the brand level, accounting for underlying ownership and wholesale relationships.[40] As do HBVZ, we treat MVNOs such as TracFone as distinct downstream retail competitors. However, in contrast to HBVZ, we account for the MNO wholesale pricing incentives that arise from the fact that MNOs sell wireless services to MVNO's for resale in retail markets.[41] Specifically, we estimate merger-related changes in MVNO input costs using a vGUPPI that corrects for errors in HBVZ's implementation and also accounts for network marginal cost efficiencies. In doing so, we account for the fact that MNOs will internalize the profits they earn on sales of wholesale network services to MVNOs and any merger-induced change in those incentives. Critically, we embed these effects in an overall model of market equilibrium, thus jointly determining the bottom-line effects on MNO and MVNO pricing and consumer welfare.[42]

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39 *Salop/Sarafidis Reply Declaration*, ¶ 47.

40 See Part B of Appendix I for further details on this modeling.

41 HBVZ separately consider the implications of the relationship between MNOs and MVNOs and the effects of the merger on those relationships outside the framework of their merger simulation.

42 We note that TracFone, the largest MVNO, has concluded that the merger will benefit MVNOs and their customers. (See Comments of TracFone Wireless, Inc., September 13, 2018, at 2 ("TracFone expects that the strong 5G network to be built by the New T-Mobile, with the additional coverage, speed and capacity can only improve the wholesale market for MVNOs and thus TracFone's customers going forward.").)

2. Model Calibration

38. Although we generally rely on the same types of data as do HBVZ, we make several modifications to their calibration, which we describe briefly below and further in Part C of Appendix I below.

39. Our calibration exercise consists of finding values for the value of the following parameters, which together fully pin down our Nested Logit model, such that it determines each brand's share and margin, and diversion ratios between the brands:

- *product-specific "quality parameters"* that capture non-price attributes of each product, such as network quality (i.e., how attractive each product is to each customer, holding price fixed);
- a *price-sensitivity parameter* that specifies how strongly consumers react to price changes and helps to determine firms' equilibrium profit margins; and
- *nesting parameters* that measure the degree of substitutability between products within the same nest and helps determine diversion ratios between carriers.

40. We calibrate the model by choosing values for these parameters such that the values for the following variables generated by the model match the corresponding values observed in our data sources: (i) shares of all specified products, (ii) the average Sprint and T-Mobile margin, and (iii) the average diversion ratio between Sprint and T-Mobile. The intuition behind the calibration is as follows:

- The model chooses product-specific quality parameters such that the predicted shares match observed shares (given values for the other parameters);

- the model chooses the price sensitivity parameter such that the predicted average profit-maximizing Sprint and T-Mobile margins matches the observed margins;[43] and
- the model chooses a nesting parameter common to the two postpaid nests, and a separate nesting parameter common to the two prepaid nests, such that the predicted average diversion ratio between Sprint postpaid and T-Mobile postpaid products and the predicted average diversion ratio between Sprint prepaid and T-Mobile prepaid products match the corresponding average diversion ratios observed in the data.

41. Notably, unlike HBVZ, we explicitly deal with the forward-looking nature of the exercise by using projections of subscriber shares and margins in the relevant time periods (post-integration) to calibrate our model.[44] To understand why this is important, recall that merger analysis compares the predicted industry equilibrium for a world in which the merger is consummated with the predicted equilibrium in a no-merger "baseline" world in which the merger does not occur. In a static industry, the no-merger baseline is often assumed to be the current (pre-merger) state of the industry (HBVZ take this approach). Given the dynamic nature of this industry, however, one must draw inferences about the merger's effects in future time periods. To deal with this, rather than use 2017 share and ARPU data, we calibrate our nested logit model using projected future values of the key variables drawn from the Parties' ordinary course documents and business plans, which utilize data from the Parties' own internal modeling as well as that of third-party industry analysts. This approach

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[43] This profit-maximizing condition is a variant of the Lerner condition (which holds that a firm's own-price elasticity equals the inverse of the firm's margin) for multi-product firms.

[44] Throughout, we use subscribers synonymously with lines.

allows us to incorporate the industry's views about expected future industry trends, thus ensuring that the model is consistent with the views that the Parties and other industry participants hold about the non-merger baseline in future years. In particular, incorporating the Parties' future plans as drawn from their business documents incorporates T-Mobile's and Sprint's standalone plans with regard to 5G and thus addresses the concerns of critics that claimed merger benefits do not credit these standalone plans.[45]

42. Also, unlike HBVZ, who base margins on aggregated data derived from the Parties' financial reports, we use the Parties' ordinary course customer lifetime value (CLV) models to compute margins. The margins computed from these CLV models are conceptually similar to the margins computed by HBVZ, but they incorporate more detailed data from the Parties that are contained in the CLV models but not publicly available. This approach yields lower margins than those HBVZ calculate. For example, whereas HBVZ calculate margins of [redacted] percent and [redacted] percent for Sprint and T-Mobile respectively, we find corresponding values of [redacted] percent for Sprint and [redacted] percent for T-Mobile, with the precise values varying by year.[46]

43. Finally, unlike HBVZ —who use diversion ratios proportional to shares—we calibrate our nested logit model (which allows substitution between the Parties' brands that is more than proportional to share) using information on switching rates from survey data that T-

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45 See, e.g., Petition to Deny of DISH Network Corporation, *In the Matter of Applications of T-Mobile US, Inc., and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations*, WT Docket No. 18-197, August 27, 2018 (hereinafter, *DISH PTD*), §§ III, IV.A.

46 See Table 26 below.

Mobile uses in the ordinary course of business. We describe alternative sources of switching data in Part C.3 of Appendix I, and we test the sensitivity of our conclusions to alternative diversion ratios.

B. THRESHOLD EFFICIENCIES

44. We use the Market Equilibrium Model (either HBVZ's or our alternative version) to compute the break-even efficiencies: the level of efficiencies that, given the impact of the loss of competition between the Parties, would still result in the transaction's having a neutral effect on consumer welfare. The break-even value of efficiencies serves as a threshold for evaluating the merger: If the efficiencies are greater than the threshold, then the merger strengthens competition and benefits consumers. The break-even value of efficiencies also serves as a summary measure of what it means to be conservative. The fact that our alternative merger simulation generates higher threshold efficiencies than do the HBVZ merger simulation models indicates that the alternative assumptions that we make are collectively more conservative than are HBVZ's assumptions in terms of their implications for whether the merger will lead to higher retail prices.

1. Efficiency Thresholds Based on the HBVZ Market Equilibrium Models

45. Table 1 reports the threshold value of efficiencies calculated based on HBVZ's model. These threshold efficiencies are defined such that, if New T-Mobile realizes efficiencies at least this large *with respect to each of the standalone companies,* then the merger will benefit consumers. This threshold value applies to the sum of the improvement in marginal costs and consumers' dollar valuation of increased product quality. As we explain below, the efficiencies that New T-Mobile must realize for the proposed merger to be

procompetitive can be smaller with respect to one standalone company, say Sprint, if they are larger with respect to the other, say T-Mobile. We present a single threshold value (assuming common efficiencies across the firms) in our tables solely to simplify the presentation.

46. Table 1 shows the critical efficiency values based on HBVZ's ALM and PC-AIDS models, separately for their prepaid and postpaid segments, respectively.[47] For comparability with the results from our alternative model—which accounts for projected industry changes over time—we show results by year, even though HBVZ's model is entirely static and accounts for no such changes. For the prepaid segment, the threshold efficiency values range from [redacted] based on HBVZ's ALM demand model to [redacted] based on HBVZ's PC-AIDS demand model. For the postpaid segment, the threshold efficiencies all fall inside this range using either model.[48, 49] Put simply, these figures imply that, *as long as the combination of marginal cost savings and*

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47 As noted above, because HBVZ did not provide backup materials with their declaration, we have had to reverse engineer their results based on the information contained in the declaration. We are able to replicate HBVZ's predicted post-merger prices within 0.2 percent in HBVZ's ALM prepaid and postpaid models and HBVZ's PC-AIDS postpaid model. We have been able to replicate HBVZ's predicted post-merger prices within 2.0 percent in HBVZ's PC-AIDS prepaid model. The results that we report below are based on our reverse-engineered version of HBVZ's merger simulation models.

48 For the purposes of this comparison, we compute the efficiencies relative to the subscriber share-weighted average of T-Mobile's and Sprint's standalone ARPUs. The necessary average efficiency level could be achieved through higher efficiencies for one firm and smaller efficiencies for the other. We explore such combinations in more detail below.

49 HBVZ's ALM merger simulation projects nominal price increases, absent any efficiencies, of $2.33 and $2.17, respectively, for Sprint postpaid and T-Mobile postpaid. (*HBVZ Declaration,* Table 21.) HBVZ's ALM merger simulation projects nominal price increases, absent any efficiencies, of $2.76 and $1.09, respectively, for Sprint prepaid and T-Mobile prepaid. (*HBVZ Declaration,* Table 22.)

quality improvements exceed [redacted]*, the merger is procompetitive and consumer-welfare enhancing.*

Table 1: Critical Efficiencies Based on HBVZ Models

[redacted]

47. We also note that the critical efficiencies do not vary much between the ALM and PCAIDS models. This fact is consistent with the principle that the assumed shape of the demand curve similarly affects both the predicted pass through of upward pricing pressure and the predicted pass through of efficiencies. Because the shape of the demand curve affects the strength of effects running in opposite directions, there tend not to be large differences between the models. In HBVZ's postpaid segment, the estimated critical efficiency thresholds of the PC AIDS and ALM models are within five cents of one another.[50] In HBVZ's prepaid segment, the estimated critical efficiency thresholds of the two models are within 87 cents of one another.[51] In all cases, critical efficiencies are [redacted]

[redacted]

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50 In contrast, HBVZ report estimated price increases, not accounting for efficiencies, that differ by [redacted] for Sprint and T-Mobile. (*HBVZ Declaration,* Tables 21 and 23.)

51 In contrast, HBVZ report estimated price increases, not accounting for efficiencies, that differ by [redacted] for Sprint and T-Mobile. (*HBVZ Declaration,* Tables 22 and 24.)

2. Efficiency Thresholds Based on Our Alternative Market Equilibrium Model

48. Table 2 shows the critical efficiency value for 2021-2024 using our alternative model.[52] In this more conservative merger simulation, a combination of marginal cost and quality efficiencies worth at least [redacted] would be sufficient to make the merger procompetitive and benefit consumers. These values are quite similar from 2021 through 2024; the small differences reflect projected changes in shares, prices, and margins over time.

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52 In the base specification, we assume that the average T-Mobile and Sprint margin predicted by the merger simulation model matches the average T-Mobile and Sprint margin derived from the CLV models described in Part C.2 of Appendix I, that industry elasticity is -0.3, that the nesting parameter is calibrated to switching rates from the Harris Mobile Insights data, that 75 percent of vertical upward pricing pressure is passed through, and that there is no input substitution by MVNOs.

Table 2: Alternative Critical Efficiencies (2021-2024)

49. We also consider several robustness checks to the value of breakeven efficiencies by altering the assumptions underlying the model in Row 1.

- *Diversion Ratios:* Rows 2 through 4 consider alternative diversion ratios based on assuming either diversion rates derived from survey data, diversion proportional to share of gross adds, or diversion proportional to share of subscribers (meaning a logit model with one nest for all inside goods and one for the outside good). The estimated break-even efficiencies in 2021 range from [redacted] across these different diversion rate estimates. In 2024, the corresponding range is [redacted].

- *Industry Elasticity:* Rows 5 and 6 consider alternative industry elasticity assumptions (-0.1 or -0.5). Critical efficiencies in 2021 are [redacted] with an industry

elasticity equal to -0.1 (corresponding to little substitution with the outside good), and [redacted] when using the upper end of the industry elasticity range that the Commission previously used (-0.5, corresponding to greater substitution with the outside good).[53] The corresponding values in 2024 are [redacted].

- *Vertical Upward Pricing Pressure Assumptions:* Rows 7 through 9 consider different assumptions about the effect of vertical upward pricing pressure on wholesale prices to MVNOs. When the pass-through rate is 50 percent, the critical efficiencies range from [redacted]. When vertical upward pricing pressure is fully passed through, critical efficiencies range from [redacted]. Finally, if the calculation of vertical upward pricing pressure accounts for potential input substitution on the part of the MVNOs, the critical efficiencies range from [redacted].

In sum, for the baseline versions of our alternative model, critical efficiencies are all under [redacted], and for a wide range of alternative versions, they are centered around [redacted], ranging from approximately [redacted].

50. An important property of the efficiency threshold approach is that there is a trade-off between the efficiencies that must be realized by the two Parties for the proposed merger to be consumer-welfare neutral; the larger are the realized efficiencies with respect to Sprint, the lower are the threshold efficiencies required with respect to T-Mobile, and vice versa. Figure 2 illustrates this trade-off by showing the "frontier" of Sprint and T-Mobile efficiencies

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[53] See note 37 above.

necessary to make the merger competitively neutral in 2024.[54] Any combination of Sprint and T-Mobile efficiencies that falls to the right of the frontier means the merger is consumer welfare enhancing. As discussed above, using our conservative alternative to HBVZ, if both Sprint and T-Mobile achieve efficiencies of [redacted] in 2024, then the merger would be welfare neutral, but efficiencies of approximately [redacted] for Sprint (and zero for T-Mobile), or [redacted] for T-Mobile (and zero for Sprint) would also achieve this result, as would any other combination of values on the frontier.

[54] At several points in this declaration, we present figures solely for 2024 to illustrate a point. In other cases, we present figures for 2021 and 2024 because 2022 and 2023 represent intermediate cases. We provide a full set of figures in our backup materials.

Figure 2: Trade-Off between Sprint and T-Mobile Efficiencies (2024)[55]

3. Our Approach to Modeling the Market Equilibrium is More Conservative than is HBVZ's Approach

51. Comparison of the results in Table 1 and Table 2 reveals that our alternative model generates larger break-even efficiencies than do HBVZ's merger simulation models. For example, the break-even efficiencies that HBVZ's models imply range from [redacted] In contrast, our baseline break-even efficiencies range from [redacted] The fact that the break-even efficiencies are larger in our alternative

[55] In this figure, we represent critical efficiencies as a weighted average of values for prepaid and postpaid products.

model proves that the combination of alternative assumptions that we make relative to HBVZ are conservative from the perspective of evaluating the merger.

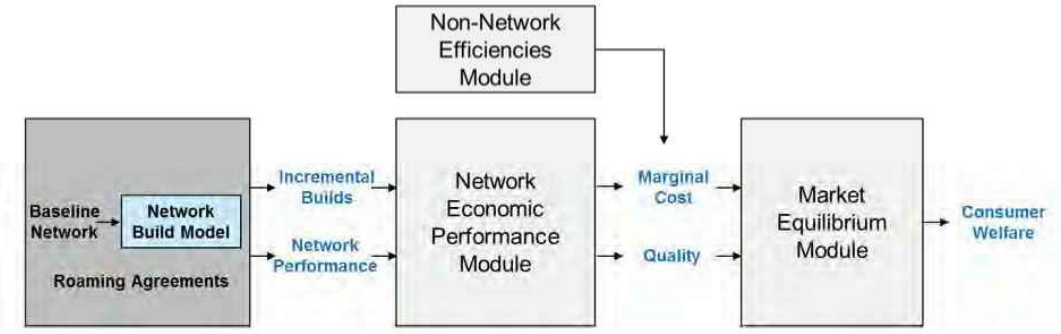
III. NETWORK ENGINEERING PERFORMANCE

52. Efficiencies arising from the integration of the Sprint and T-Mobile networks generate the bulk of the marginal cost savings and quality improvements projected to be realized due to the merger. The Network Engineering Performance Module generates projections of network investment and performance. These projections are, in turn, used by the Economic Performance Module to quantify the network marginal cost savings and quality improvements that will result from the merger. In this section, we describe the Network Engineering Performance Module.

A. OVERVIEW OF THE NETWORK ENGINEERING PERFORMANCE MODULE

53. Figure 3 provides an overview of the Network Engineering Performance Module and its place in the overall merger-assessment framework. The module starts from a baseline network consisting of spectrum deployed on specific sites (there is a separate baseline network for each of the standalone and New T-Mobile networks). Then, for any given traffic forecast, the Network Build Model determines the type and number of incremental builds necessary to accommodate the traffic while satisfying satisfy the relevant network performance planning criteria. Only these incremental builds are considered in the marginal cost calculations that we describe in Section IV.A below. The Network Build Model also computes a user experience throughput measure (in Mbps) that results from the addition of the incremental builds to the initial Baseline Network.

Figure 3: Network Engineering Performance Module as Part of Overall Framework



54. We first describe the Network Build Model and then describe the baseline networks that we use for our analysis.

1. Network Build Model

55. Figure 4 provides a schematic of the Network Build Model, which was developed by T-Mobile in consultation with Sprint.[56] The model has the following inputs: (i) a baseline network plan, and (ii) a traffic forecast, which consists of a projection of the overall traffic level, a forecast of the split of traffic between 5G-capable devices and LTE-only devices, and a forecast of the distribution of traffic across time-of-day and geography. For any given baseline network and traffic forecast, the model identifies congested sectors based on network performance planning criteria.[57] The model is based on a set of "solutions" (e.g., cell splits)

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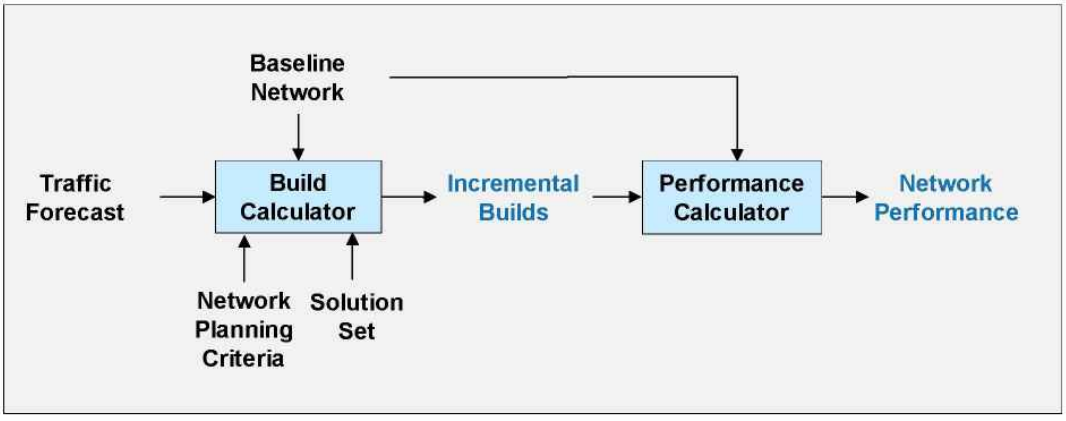
56 T-Mobile submitted the code and documentation for the Network Build Model to the Commission on September 5, 2018. Here, we provide an overview of its approach and functionality. We base our analysis on the revised Network Build Model that T-Mobile submitted to the Commission on September 17, 2018.

57 Where appropriate, the model implements different planning criteria for Sprint and T-Mobile, but in all cases it uses the same criteria for standalone T-Mobile and New T-Mobile. The Parties' respective Chief Technology Officers have stated that the Network Build Model provides a reasonable representation of how each company would operate and invest in its

for alleviating congestion that are placed in a hierarchy from most to least cost-effective.[58] The model then implements these solutions by following the cost hierarchy until the congestion is resolved or until the model runs out of available solutions. For example, practical and engineering constraints place a limit on the number of cell splits that can be performed at a given site in a given period of time.

Figure 4: Schematic of Network Build Model



56. These network solutions have two important implications for the economic modeling. First, as described in Section IV.A below, there are costs associated with each solution, and

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respective network. (*Ray Reply Declaration,* ¶ 2, §§ II.A (describing T-Mobile's ordinary-course-of-business 4G LTE engineering model), and II.B (describing the 5G engineering model that T-Mobile developed based on the fundamental concepts of the existing 4G LTE model); Reply Declaration of John C. Saw, September 17, 2018 (hereinafter, *Saw Reply Declaration*), ¶ 15.)

The code and documentation for the Network Build Model were submitted to the Commission on September 5, 2018 provide additional detail on the relevant planning criteria. T-Mobile submitted a revised version of the Network Build Model to the Commission on September 17, 2018. See also, *Ray Reply Declaration,* §§ II.A-B.

[58] Again, where appropriate, the model uses different solution sets for Sprint and T-Mobile.

these costs represent the marginal costs of handling incremental network traffic while meeting the planning criteria ("marginal network costs"). Second, using the network defined by the baseline network plus all solutions applied by the Build Calculator, the Performance Calculator determines network performance in each sector, where performance is measured as user experience throughput (measured in Mbps). This network performance is driven, at least in part, by network loading, which the Network Build Model calculates for each sector, incorporating both the baseline network and all of the implemented solutions. Network loading for the 5G network is measured as the ratio of carried traffic to offered traffic; network loading for the LTE network is measured as users per 5 MHz of spectrum deployed.[59] In general, higher network loading generates lower performance and lower network loading generates higher performance, all else being equal.

57. As described by T-Mobile's Chief Technology Officer, Neville Ray, T-Mobile created and ran the Network Build Model for the years 2021 through 2024.[60] He explains that the evolution of the New T-Mobile network prior to 2021 will be driven by requirements associated with integrating the Sprint and T-Mobile networks, as opposed to responding to changes in traffic levels.[61] In particular, he states that the 2021 post-integration network would not be altered even if traffic were significantly below the forecasted levels.[62] Consequently, the Network Build Model, which is fundamentally a model of incremental

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59 Offered traffic is a measure of network capacity. (*Ray Declaration,* ¶¶ 17, 55, 57 (describing the capacity of the standalone network based on offered traffic).)

60 *Ray Reply Declaration*, ¶ 17.

61 *Ray Reply Declaration*, ¶ 15.

62 *Ray Reply Declaration*, ¶ 15.

capacity investments motivated by incremental traffic, does not provide an appropriate tool for predicting New T-Mobile's network investments during the integration period. We thus commence our merger assessment at the end of 2021, by which time the integration of the Parties' wireless networks is anticipated to be largely complete and the Network Build Model becomes an appropriate tool for determining network investments.

2. Baseline Networks

58. Our analysis builds on the baseline networks planned by each company. Both Sprint and T-Mobile have developed plans detailing cell site locations and spectrum deployments for the standalone companies over 2021-2024.[63] These plans also include spectrum migration plans that detail the transition of spectrum from LTE to 5G networks.[64] In addition, T-Mobile has developed a baseline network plan for New T-Mobile. The New T-Mobile plan involves re-farming spectrum to its 5G network more quickly than does either the standalone T-Mobile or standalone Sprint plan.[65] The New T-Mobile mobile plan also involves a greater number of 5G cell sites than does either the standalone T-Mobile or standalone Sprint plan.[66]

59. In the economic modeling that we describe in Section IV.A below, we use the planned baseline networks for standalone Sprint and standalone T-Mobile for the entire 2021-2024 period. This approach means that, in the economic modeling described below, we treat any investments planned for the standalone networks over this period as sunk costs, and count as

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63 *Saw Declaration,* ¶¶ 17-22; *Ray Declaration*, ¶¶ 16-20, 40-42; *Ray Reply Declaration*, ¶¶ 14, 16, 33.

64 *Ray Reply Declaration,* Table 1.

65 *Ray Reply Declaration*, Table 1.

66 *Ray Reply Declaration*, Table 7.

marginal costs only the incremental builds above this baseline that are required to meet the network performance planning criteria as traffic grows. By contrast, for New T-Mobile, we treat only the baseline network builds through 2021 as sunk. For all later years, we apply the Network Build Model to the 2021 baseline network, meaning that we treat *all* builds after 2021 for New T-Mobile as marginal costs.[67] Table 3 illustrates the fact that using the 2021 baseline network in 2024 results in more incremental builds and, thus, higher network marginal costs than does using the 2024 baseline network in 2024.

Table 3: The Effect of the Baseline Network Choice on Incremental Solutions Required by New T-Mobile's Network (2024)

60. The implication of our different treatments of the standalone networks and the New T-Mobile network on this dimension is that we are being conservative in our assessment of the proposed merger's benefits: If we applied the same approach to the standalone networks that we apply to New T-Mobile's network, we would project higher marginal costs for the standalone networks, which would increase the magnitude of the proposed merger's marginal

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67 In doing so, we assume that the 5G spectrum described in the refarming plan above is available to the New T-Mobile, but that the costs to deploy the spectrum are incurred only if warranted by the network traffic and the necessity of satisfying New T-Mobile's network planning criteria.

cost savings. In addition, by including all planned builds through 2024 for the standalone networks as part of the baseline, but only including planned builds for New T-Mobile for 2021 as part of the baseline, we are giving the standalone networks—but not New T-Mobile—the benefit of the quality improvements provided by these builds, meaning that our approach is conservative from a network performance and service-quality point of view as well.

B. THE MERGER WILL DRAMATICALLY IMPROVE NETWORK PERFORMANCE

61. In this section, we explain how the network modeling demonstrates that, as a result of the merger efficiencies, the New T-Mobile network would realize substantially lower marginal costs and offer vastly improved product quality along several dimensions relative to the standalone networks.

62. To assess how network performance varies and how network investments are triggered as traffic grows, we run the Network Build Model over a range of increasing traffic levels, using increments equal to ten percent of the baseline traffic associated with 5G-capable devices assumed in the network model.[68]

1. Reduced Necessary Capacity Builds

63. As a result of efficiencies achieved by combining the Sprint and T-Mobile networks, the New T-Mobile network will have capacity substantially greater than the sum of the standalone networks' capacities. One consequence of this increased capacity is that, for any

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[68] Because the model implements "solutions" to expand the network relative to the exogenously specified baseline network, the required network builds at any given assumed traffic level do not depend on the assumed *baseline traffic* level in the model, but rather reflect the required incremental builds to supplement the *baseline network* so as to serve the specified traffic level in a way that meets the network performance planning criteria.

given level of traffic, the New T-Mobile network is less likely than the standalone networks to experience congestion and, thus, less likely to trigger costly builds and/or suffer quality degradation. As a result, the New T-Mobile network will have both higher quality and lower marginal costs than the standalone networks.

64. Table 4 summarizes the number and type of congestion solutions that the model implements for each network to accommodate its baseline projected traffic level in 2024. Reflecting standalone T-Mobile's more limited spectrum holdings, especially those that can be dedicated to 5G, the model indicates that the standalone T-Mobile network would require substantially more builds to solve for congestion than would the New T-Mobile network.[69] The standalone Sprint network would also require more builds than the New T-Mobile network.

Table 4: Incremental Network Builds (2024)

[69] To calculate incremental builds for New T-Mobile, we assume that New T-Mobile maintains usage restrictions and holds the mix of LTE-only and 5G-capable devices fixed at levels projected for the standalone networks.

2. Reduced Roaming Costs

65. As we describe further in Section III.B.3 below, standalone Sprint's network has substantial coverage limitations. Sprint's LTE network currently covers 302 million POPS and 1.0 million square miles.[70] By contrast, Verizon's LTE network covers 322 million POPS and 2.4 million square miles.[71] To address its coverage limitations, Sprint has signed roaming agreements with other carriers—including T-Mobile, Verizon, AT&T, and U.S. Cellular—to provide coverage outside of the Sprint radio network's footprint.[72] Some of Sprint's roaming partners (e.g., [redacted]) offer only 3G roaming coverage, while others (e.g., [redacted] offer LTE roaming coverage.[73, 74]

66. Under these roaming arrangements, Sprint typically pays a per unit fee for the data its customers use while roaming on a partner network. These roaming fees can be substantial. For example, in 1Q FY2018, Sprint estimated that that it would pay an average of [redacted] to its roaming partners for domestic data roaming.[75] Because of these costs, Sprint often

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70 Sprint, "Rural Strategy," March 7, 2018, SPR-FCC-01276622, at 2.

71 Verizon Wireless, "Highest network quality in the U.S.," *available at* https://www.verizonwireless.com/featured/better-matters/, *site visited* September 10, 2018.

72 *Saw Declaration*, ¶ 14.

73 In FY2017, approximately [redacted] percent of Sprint's domestic data roaming was on LTE networks and, by 2020, Sprint expects more than [redacted] percent of its domestic data roaming will occur on LTE networks. (Sprint, "Roaming MQ1 Forecast," March 5, 2018, IKK Exhibit 1, at 10.)

74 Sprint signed an LTE roaming agreement with T-Mobile specifically in conjunction with this transaction, which imposes certain limits on Sprint's usage of T-Mobile's network. (*Saw Declaration*, ¶ 34.) It is our understanding from counsel that there are legal arguments against considering the Sprint-T-Mobile roaming agreement as part of the non-merger but-for world. In our analysis below, we consider Sprint's roaming costs with and without the T-Mobile roaming agreement in place.

75 Sprint, "Roaming MQ1 Forecast," March 5, 2018, IKK Exhibit 1, at 4.

limits the quality and amount of roaming coverage it offers to its customers. For example, Sprint currently limits data throughput to [redacted] on Verizon's network, [redacted] on AT&T's network, and [redacted] on other networks (e.g., rural roaming partners).[76] In sum, Sprint's roaming agreements allow it to provide nationwide coverage, but that coverage is high cost and low quality outside of the Sprint footprint.

67. Table 5 reports Sprint's projected domestic roaming costs with and without the T-Mobile roaming agreement.[77] We assume that Sprint will incur no domestic data roaming costs once it gains access to the New T-Mobile network (including the low-band 600 MHz spectrum that T-Mobile is deploying) post-merger.[78] The elimination of roaming costs will reduce its marginal costs by [redacted] per postpaid subscriber per month in 2021, increasing slightly to [redacted] per postpaid subscriber per month in 2024.[79] In addition, as described in

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76 Sprint, "T-Mobile Domestic Data Roaming Impact," June 6, 2018, SPR-FCC-03783385, at 6. See also *Saw Declaration*, ¶ 14.

77 In the ordinary course of business, we understand that Sprint uses its average roaming cost per postpaid customer in its CLV calculations. We adopt the same approach here.

We also understand that Sprint does not forecast roaming costs out as far as the modeling period in the ordinary course of business, but has provided estimates for FY18-FY24. (See Sprint, Domestic Data Roaming Costs, IKK Exhibit 2 in our backup materials.)

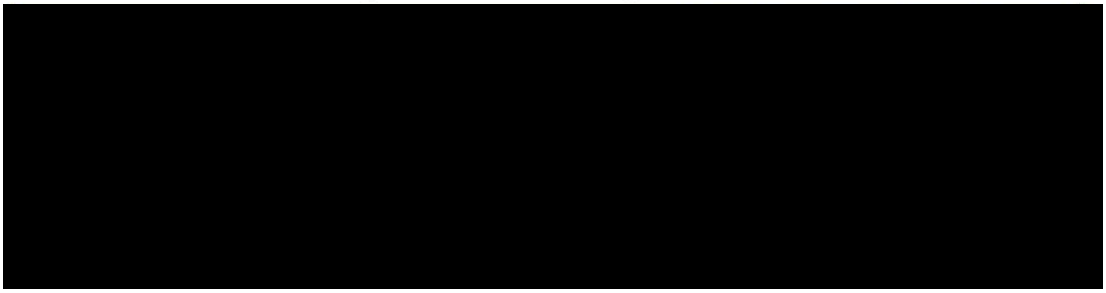
78 By the end of 2018, T-Mobile expects to cover 325 million POPs with its LTE network. It owns licenses to 600 MHz spectrum covering approximately 328 million POPs. (T-Mobile News Release, "T-Mobile Delivers its Best Q2 Ever," August 1, 2018, *available at* https://www.t-mobile.com/news/best-q2-ever.)

Although there would be some costs associated with carrying the traffic on the New T-Mobile network, such costs would be small because (1) New T-Mobile experiences marginal network costs of just [redacted] (see Part D of Appendix I), and (2) roaming traffic accounts for [redacted] of Sprint's overall traffic.

79 Our analysis assumes the roaming agreement with T-Mobile would expire four years following any abandonment of this merger. ("Domestic LTE Roaming Data Services Agreement by and between T-Mobile USA, Inc., Sprint Spectrum L.P., and Sprint Corporation," April 28, 2018, TMUS-FCC-02508420, § 14(a).)

greater detail below, post-merger, Sprint's customers will gain access to the vastly superior New T-Mobile network, which will have full nationwide coverage.

Table 5: Sprint Domestic Roaming Costs (2019-2024)



3. Improved Product Quality

68. In addition to reducing the costs associated with serving any given level of traffic, the efficiencies derived from combining the Sprint and T-Mobile networks increase product quality along several dimensions, including, among others, improvements in throughput, consistency of experience and reduced usage restrictions. In discussing, merger-specific quality improvements, it is important to note that the Network Build Model is, fundamentally, a capacity model designed to assess network performance within the footprint of the network. It is not designed to measure coverage limitations and thus does not fully capture Sprint's disadvantages in this regard. We discuss this point further below.

(a) Increased Throughput

69. We begin by examining user throughput. Figure 5 shows the average 5G user experience throughput on the various networks in 2021 after the model implements

solutions.[80] In this section, we focus on 5G user experience throughput because it is our understanding that 5G services and the 5G network will be the focus of pricing and strategic business decisions by 2021 and that the overwhelming majority of new customers in 2021 and beyond are likely to be customers with 5G-capable devices.[81] However, when we quantify consumer valuation on improved network quality in Section VI.C, below, we account for both 5G and LTE throughput.

70. In this and several subsequent figures, we plot 5G user experience throughput against the sum of standalone 5G-capable device traffic, adjusted for the split of traffic between Sprint and T-Mobile. For example, if Sprint accounts for x percent of combined 5G-capable device traffic g and T-Mobile accounts for $1-x$ percent of total 5G-capable device traffic, at point g on the x-axis, we plot the Sprint throughputs associated with 5G-capable device traffic equal to xg and T-Mobile throughputs associated with 5G-capable device traffic equal to $(1-x)g$. This approach recognizes that network performance is a function of total traffic and allows us to compare the standalone and New T-Mobile networks on an apples-to-apples basis.

71. The New T-Mobile 5G network yields substantial improvements in throughput relative to the standalone 5G networks. For example, at total 5G-capable device traffic of approximately [redacted] (equivalent to the expected sum of Sprint and T-

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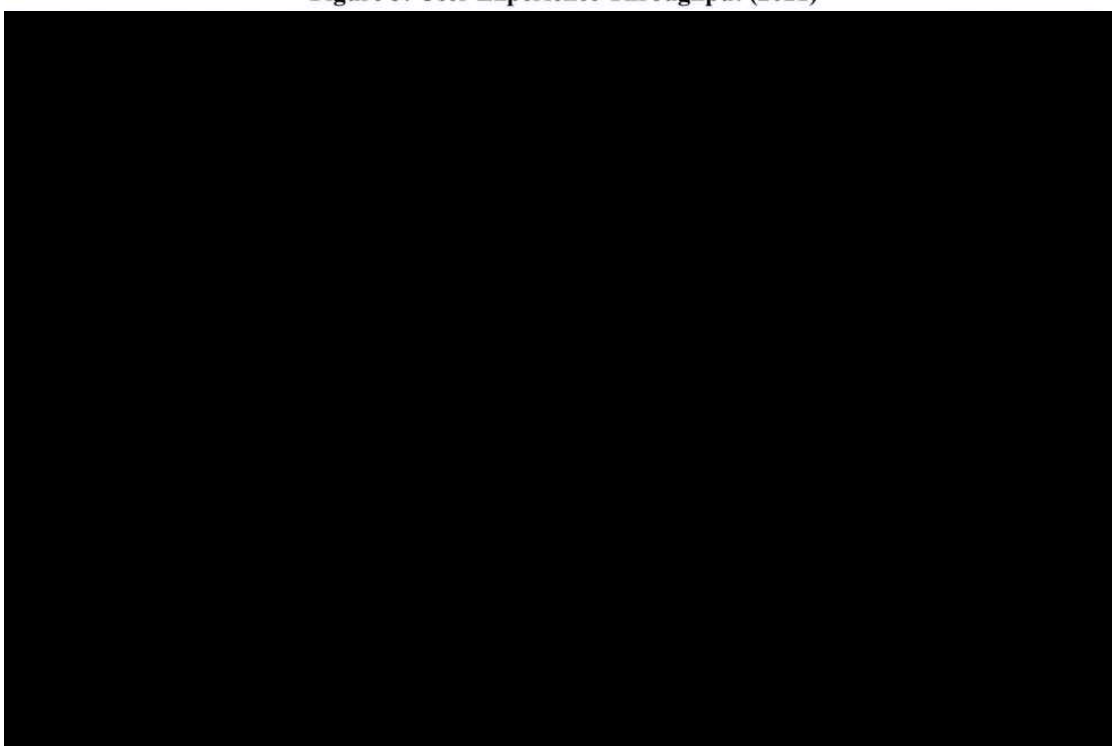
80 The specific measure of user experience throughput that we utilize is the average downlink throughput for a given average level of network traffic. The throughput levels reported by the Network Build Model are calibrated to Ookla speed-test data.

81 Reply Declaration of Peter Ewens, September 17, 2018 (hereinafter, *Ewens Reply Declaration*), ¶ 36; Reply Declaration of Brandon "Dow" Draper, September 17, 2018, (hereinafter *Draper Reply Declaration*), ¶ 12.

Mobile traffic in 2021), the average network-wide 5G throughput is approximately [redacted] on the standalone Sprint network and approximately [redacted] on the standalone T-Mobile network. By contrast, average 5G throughput is approximately [redacted] on the New T-Mobile network, nearly double standalone Sprint's throughput and nearly quadruple standalone T-Mobile's throughput.

Figure 5: User Experience Throughput (2021)



72. Figure 6 shows the average user experience throughput on the various networks in 2024 after the model implements solutions. The New T-Mobile network yields substantial improvements in user experience throughput in the 5G networks compared to the standalone networks. For example, at total 5G-capable device traffic of approximately [redacted]

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(equivalent to the expected sum of Sprint and T-Mobile traffic in 2024), the average network-wide 5G throughput in the New T-Mobile network is approximately [redacted] while the average network-wide 5G throughput is approximately [redacted] in the Sprint network and [redacted] in the standalone T-Mobile. In other words, by 2024, the throughput differential is projected to have grown to the point where New T-Mobile has throughput more than 2.5-times that of standalone Sprint and more than quadruple that of standalone T-Mobile.

Figure 6: User Experience Throughput (2024)

(b) Improved Consistency

73. Sprint's standalone plans indicate that its 5G network will offer limited coverage. For example its plan of record includes sites that will only cover approximately [redacted] POPs

in 2021.[82] Moreover, Sprint plans to focus its 5G deployment on major cities.[83] An implication of this deployment plan is that Sprint customers would frequently be forced to "leak" to Sprint's LTE network or onto the networks of Sprint's roaming partners with the associated losses in network quality.

74. Figure 7 shows the distribution of 5G user-experience throughput for each network in 2021. Because Sprint can deploy 5G on its 2.5 GHz spectrum, it will be able to offer reasonably high-quality 5G where it deploys 5G, but that deployment will cover [redacted] of total POPs. In contrast, T-Mobile's standalone 5G network, which would be deployed largely using its 600 MHz spectrum, offers a relatively consistent user experience covering most POPs, but at lower throughput. New T-Mobile's 5G network is better than the standalones on both dimensions, offering higher throughputs than either standalone network over a much broader geographic area than the standalone Sprint network.

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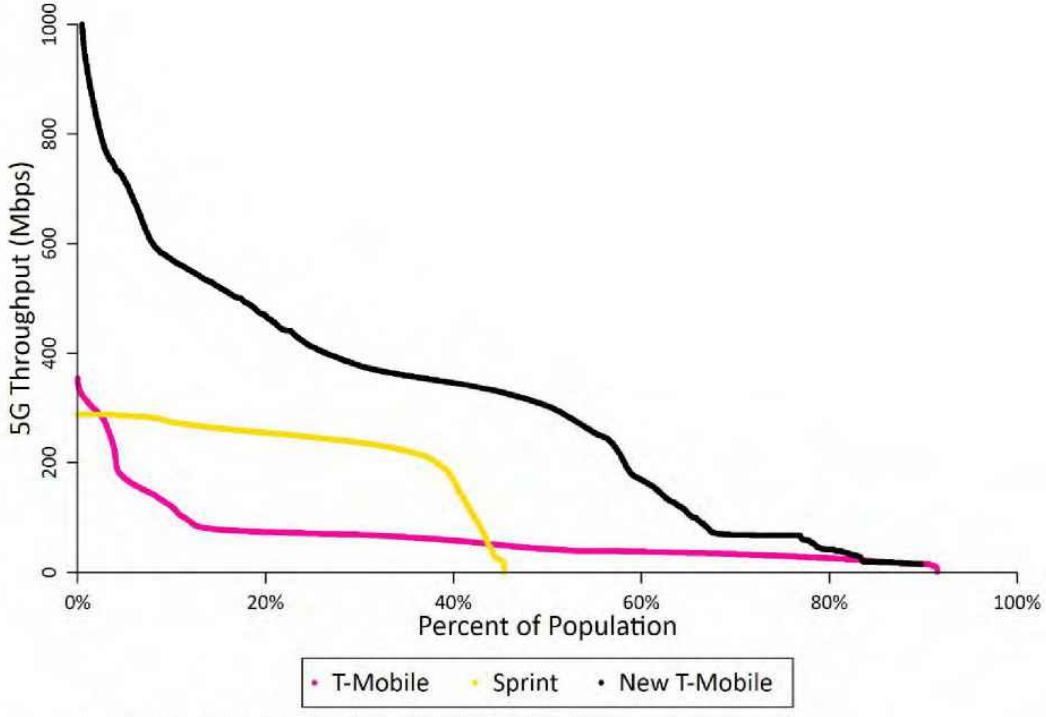
82 *Saw Reply Declaration,* ¶ 6.

83 See also, *Saw Reply Declaration,* ¶ 8 ("5G deployment will be limited to areas in and around major cities").

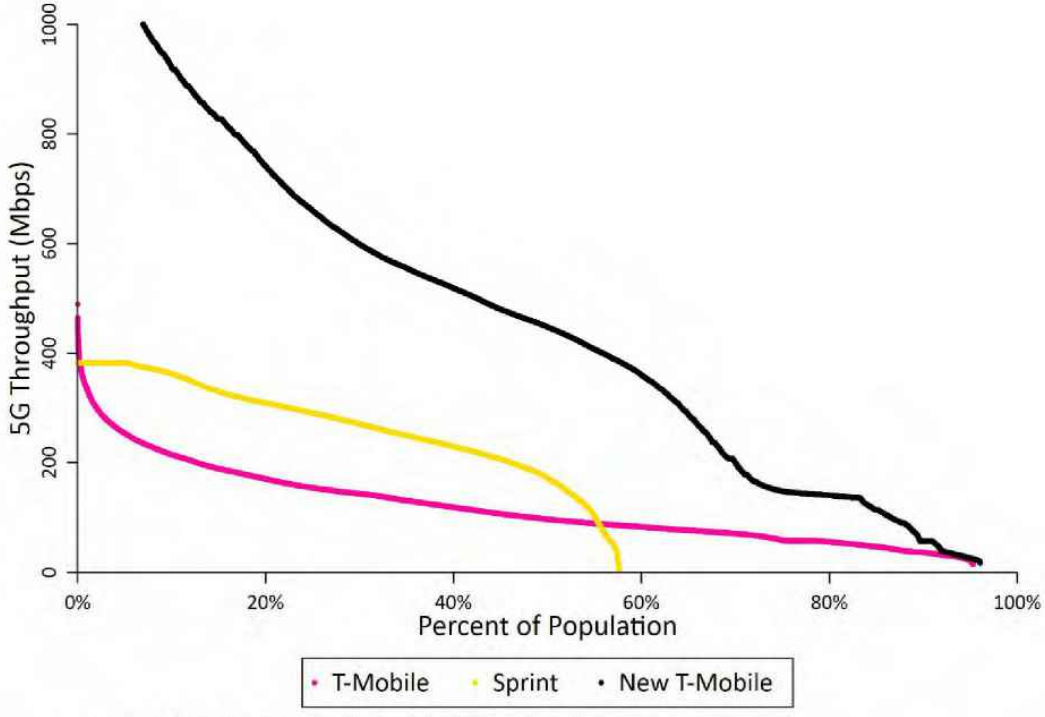
Figure 7: 5G User-Experience Throughput by Covered POPs (2021)



Source: Calculations based on Network Build Model results.

75. Figure 8 demonstrates a similar pattern holds in 2024. Although Sprint projects that it would expand its 5G coverage relative to 2021, its coverage will remain limited relative to New T-Mobile's. Even in 2024, Sprint expects its 5G network to cover at most 60 percent of the population. And New T-Mobile's network continues to dominate the standalone networks on both dimensions, with higher throughput than the standalone networks over a larger set of subscribers the standalone Sprint network.

Figure 8: 5G User-Experience Throughput by Covered POPs (2024)



Source: Calculations based on Network Build Model results.

76. Finally, the fact, discussed above, that Sprint will severely limit the deployment of its 5G network for many years (because the cost of expansion would exceed the benefits to Sprint given its small customer base) has implications beyond just the throughput levels that the Network Engineering Performance Module measures.[84] In particular, the fact that standalone Sprint customers will have to rely on LTE far more often than will New T-Mobile customers deprives the Sprint customers of the full benefit of the lower latency and lower

[84] Sprint customers would also have access to roaming services in many areas, but as discussed in Section III.B.2, these services are generally inferior to 5G service and to Sprint's own LTE service.

power requirements for certain devices. Our analysis does not quantify these additional benefits of expanded access to 5G for Sprint's customers; doing so would lead to even greater merger benefits.

(c) Relaxed Usage Restrictions

77. Sprint's and T-Mobile's current subscriber plans impose various restrictions on data usage.[85] In addition, both Sprint and T-Mobile deprioritize data for certain users during periods of congestion.[86] We understand that Sprint and T-Mobile utilize these tools to manage congestion on their networks.[87] In our base-case analysis, we assume that New T-Mobile will utilize these tools to the same degree in order to achieve the same usage levels as would the standalone networks. However, given the significantly lower marginal costs that

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85 For example, the "T-Mobile ONE" plan imposes throughput constraints such as 480p video streaming and mobile hotspot (tethering) data usage at 3G speeds. The "T-Mobile ONE Plus" plan, which costs $10 more per month than the "T-Mobile ONE" plan, offers ten GB of LTE mobile hotspot data usage and unlimited HD streaming. (T-Mobile, "T-Mobile ONE for Phones," *available at* https://support.t-mobile.com/docs/DOC-36931, *site visited* September 10, 2018.) Similarly, Sprint's "Unlimited Basic" plan includes a 500 MB allowance for LTE mobile hotspot data usage and streams video at 480p, music at up to 500 kbps, and gaming at up to 2 Mbps. Sprint's "Unlimited Plus" plan, which costs an extra $10 per line, per month, includes a 15 GB allowance for LTE mobile hotspot data usage and streams video at 1080p, music at up to 1.5 Mbps, and gaming at up to 8 Mbps. (Sprint, "Unlimited Plus," *available at* https://www.sprint.com/en/shop/plans/unlimited-cell-phone-plan.html, *site visited* September 10, 2018.)

86 See, e.g., Sprint, "Open Internet Information," *available at* https://www.sprint.com/en/legal/open-internet-information.html, *site visited* September 13, 2018; T-Mobile, "Open Internet," *available at* https://www.t-mobile.com/responsibility/consumer-info/policies/internet-service, *site visited* September 13, 2018.

87 See, e.g., Sprint, "Open Internet Information," *available at* https://www.sprint.com/en/legal/open-internet-information.html, *site visited* September 13, 2018; T-Mobile, "Open Internet," *available at* https://www.t-mobile.com/responsibility/consumer-info/policies/internet-service, *site visited* September 13, 2018.

New T-Mobile is projected to have, economic logic predicts that New T-Mobile would relax usage restraints, which would facilitate greater average data usage by its subscribers than by those of the standalone networks. The relaxation of usage restraints and the additional data consumption per subscriber would constitute service quality improvements that would benefit consumers. In our alternative-case analysis, we assume New T-Mobile will fully relax usage restrictions, and we demonstrate that this would further increase consumer valuation of the proposed merger's projected quality improvements.

78. Both Sprint and T-Mobile have developed traffic forecasts for LTE and 5G devices.[88] T-Mobile's traffic forecast model is based on time use surveys and engineering estimates of throughput for different use cases.[89] Specifically, the model considers the amount of time customers with 5G-capable mobile devices are expected to engage in video streaming, web browsing, augmented reality, virtual reality, gaming, IoT, audio streaming, and social media. It then uses engineering estimates to calculate the network traffic associated with each use case and sums these traffic forecasts to arrive at a total estimate of usage per subscriber per month. These usage estimates can be thought of as estimates of unconstrained demand for data, i.e., the amount of data that mobile broadband subscribers would consume in the absence of usage restrictions.[90] As shown in Figure 9, T-Mobile's estimates of unconstrained

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88 SPR-DOJ-04338918 (IKK Exhibit 8) contains Sprint's traffic forecasts. TMOPA_04641354 contains T-Mobile's traffic forecast model.

89 *Ray Reply Declaration,* ¶¶ 22-24.

90 We understand that this forecast assumes some restrictions on usage of the mobile network for in-home broadband substitution or replacement, without which usage could increase to as much as 400-500 GB/subscriber/month.

mobile broadband 5G usage increase from approximately [redacted] GB/subscriber/month in 2021 to approximately [redacted] GB/subscriber/month in 2024.

Figure 9: Sprint and T-Mobile Data Usage Forecasts

79. Sprint's ordinary course traffic forecasts take a different approach. Rather than estimate usage based on a detailed accounting of expected time use and use cases, Sprint projects usage based on growth relative to current usage based on historical growth rates.[91] This approach implicitly reflects both existing usage restrictions as well as network restrictions. For example, the amount of 5G data that a Sprint user could consume is limited

[91] SPR-DOJ-04338918, IKK Exhibit 8, p. 5.

by the coverage of Sprint's 5G network. Sprint's forecasts thus differ in a fundamental way from T-Mobile's forecasts. Rather than reflect estimates of unconstrained data demand, they provide an estimate of the amount of data Sprint customers would actually consume given the limitations of the standalone Sprint Network. As shown in Figure 9, Sprint estimates that mobile broadband 5G usage on its standalone network would increase from approximately [redacted] GB/subscriber/month in 2021 to approximately [redacted] GB/subscriber per month in 2024.[92] Reflecting the limitations of Sprint's network, the implicit growth rate of [redacted] percent per year is [redacted] than both the estimates from T-Mobile's traffic forecast model (29.8 percent per year) and those of third parties such as Cisco (30 percent per year) and Ericsson (40 percent per year).[93]

80. The marginal cost curves that we describe in Section IV.A demonstrate that the standalone networks, especially T-Mobile's, would incur high marginal costs per subscriber at the estimated unconstrained usage levels. At an average usage level of [redacted] GB/subscriber/month, the T-Mobile network model predicts that the marginal network cost per subscriber would be more than [redacted]/subscriber/month. It is our understanding that, as a standalone company, T-Mobile would impose certain restrictions on usage in order to mitigate

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92 SPR-DOJ-04338918, IKK Exhibit 8, p. 9.

93 See TMOPA_04641354; Cisco, "VNI Mobile Forecast Highlights, 2016-2021, *available at* https://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/#~Country (Country = United States), *site visited* September 13, 2018; Ericsson, "Ericsson Mobility Report," June 2018, *available at* https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-june-2018.pdf, *site visited* September 13, 2018, at 15 (projecting North American data traffic to increase from 2.5 EB/month in 2017 to 19 EB/month in 2023).

these high costs.[94] Table 6 demonstrates that, in order to satisfy the financial constraints on its ability to deviate from expected network expenditures forecast in its long-range plans (LRPs), T-Mobile would have to constrain usage below levels that would prevail absent those restrictions.[95] In contrast, we understand that New T-Mobile would be able to serve full traffic demand within its financial constraints.[96]

Table 6: Comparison of Unconstrained and Constrained Traffic in the Standalone T-Mobile Network

81. In our alternative scenario in which New T-Mobile relaxes usage restraints, we measure marginal costs and network quality for each network accounting for the different degrees to which different networks are predicted to impose usage limitations (if at all):

- we measure Sprint's marginal costs and network quality at the usage levels in Sprint's ordinary course documents;

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94 *Ewens Reply Declaration*, ¶ 34.

95 *Ewens Reply Declaration*, ¶ 33.

96 *Ewens Reply Declaration*, ¶ 36.

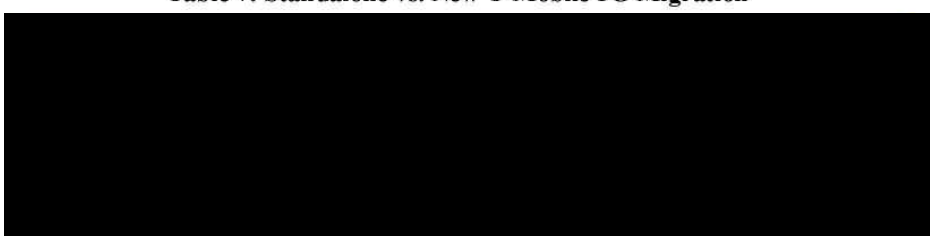
- we measure T-Mobile's marginal costs and network quality at the constrained usage levels described above; and
- we measure New T-Mobile's marginal costs and network quality at the unconstrained usage levels described above.

For this scenario, we account for the value to consumers of relaxing these usage restrictions using the method described in Section VI.C.2 below.

(d) Faster migration to 5G

82. As shown in Table 7 below, New T-Mobile also plans to migrate subscribers to 5G service faster than would the standalone companies.[97] Consumers who would be on LTE in the absence of the merger, but 5G with the merger, will benefits from the increased throughput and other advantages of 5G over LTE discussed above.

Table 7: Standalone vs. New T-Mobile 5G Migration



83. In our baseline scenario, in which we assume New T-Mobile maintains the usage levels of the standalone networks, we also assume that it also maintains the LTE/5G migration paths that the standalone companies would adopt. Doing so allows us to model an all-else-

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97 *Ray Declaration*, ¶ 40 ("Based on past experiences with device penetration, we have estimated that New T-Mobile will be able to drive 5G capable device penetration rates up by 10 percent, year over year (e.g., if standalone T-Mobile would have 50 percent of customers with 5G devices, New T-Mobile would have 55 percent).").

equal case in which New T-Mobile serves exactly the same traffic as would the standalone networks in total, and we ask whether New T-Mobile can do so at sufficiently lower cost and higher quality to make the merger procompetitive. However, in our alternative scenario, in which we account for New T-Mobile's ability to relax usage restrictions given its lower cost 5G network, we also account for its associated ability to accelerate the migration path to 5G.

IV. MARGINAL COST EFFICIENCIES

84. In this section, we analyze both network and non-network marginal cost savings. We focus on the *marginal* cost savings because those are the types of costs recognized by the Commission and federal antitrust agencies[98] as most likely to be passed through to consumers.[99] The specific degree to which marginal cost savings are projected to be passed through to consumers is determined by the Market Equilibrium Model.

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98 *Horizontal Merger Guidelines,* § 10.

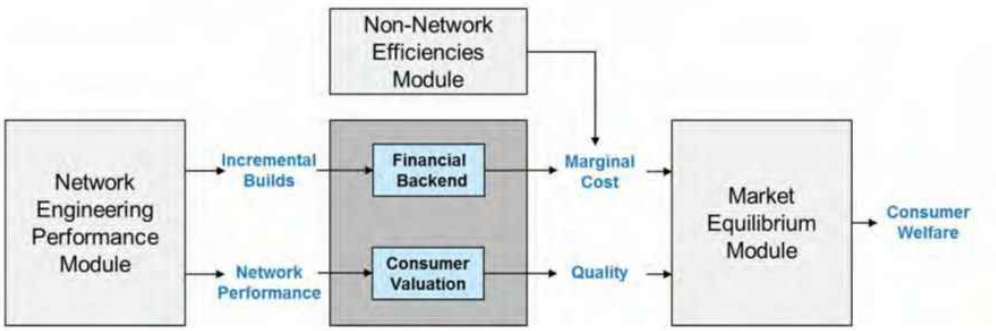
99 It is a well-established principle taught in freshman economics courses that even a monopolist—which New T-Mobile manifestly would not be—has incentives to pass through marginal cost decreases to consumers in whole or in part. (See, e.g., Jeremy I. Bulow and Paul Pfleiderer (1983) "A Note on the Effect of Cost Changes on Prices," *Journal of Political Economy*, **91**(1): 182-85; Paul L. Yde and Michael G. Vita (1996), "Merger Efficiencies: Reconsidering the 'Passing-On' Requirement," *Antitrust Law Journal*, **64**(3): 735-47; Paul Yde and Michael Vita (2006), "Merger Efficiencies: The 'Passing-On' Fallacy," *Antitrust* **20**():59-65, at 62-63; or virtually any microeconomics textbook.) Intuitively, a firm has incentives to pass on portions of marginal cost reductions to consumers in the form of lower prices because doing so generates additional sales that would have been unprofitable at the previous cost level but are now profitable at the new, lower-cost level.

It should also be observed that the conclusion that marginal cost savings will be passed through to consumers is based on the same logic that finds upward pricing pressure from a merger. Under that theory, the upward pricing pressure from a merger is equivalent to that associated with an increase in marginal cost, namely, the "cannibalization cost" associated with sales diverted from the merger partner. (See, e.g., Joseph Farrell and Carl Shapiro (2010), "Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition," *The B.E. Journal of Theoretical Economics*, **10**(1): 1-39.) Hence, any argument that marginal cost changes are not passed-through also logically implies that the upward pricing pressure from the proposed merger will not lead to higher prices.

A. NETWORK MARGINAL COST SAVINGS

85. We first describe how we convert the engineering performance measures into marginal cost measures that we feed into the Market Equilibrium Module, as one piece of our calculation of the merger's effects on consumer welfare. We do so by using a Financial Backend Model that converts incremental capacity builds into marginal costs. Figure 10 illustrates the process, including the quality component that we discuss in more detail below.

Figure 10: Network Economic Performance Module



86. When a network attracts a new subscriber, that subscriber consumes data and places additional load on the network. In order to satisfy network performance criteria, the network operator must deploy additional spectrum and equipment to create incremental capacity to handle the additional load. In the present section, we describe how these incremental deployments translate into the marginal cost of additional subscribers.

87. At a very high level, the structure of our approach is as follows. We first use the Network Engineering Performance Module and a Financial Backend Model to compute the

total incremental costs associated with any given level of traffic.[100] We then trace out a total incremental cost curve from which we derive the marginal cost associated with any given level of traffic, which is expressed as a marginal cost per gigabyte of consumption. Lastly, because mobile broadband service is sold on a subscription basis, we convert the marginal cost per gigabyte into a marginal cost per subscriber, accounting for expected number of gigabytes consumed by each subscriber.

88. As discussed, it is our understanding that 5G services will be the focus of pricing decisions by 2021 and that the overwhelming majority of new customers in 2021 and beyond are likely to be customers with 5G-capable devices.[101] Hence, we model marginal costs associated with incremental traffic generated by customers with 5G-capable devices as the relevant costs for the Parties' pricing decisions. Although we focus on 5G *devices*, we account for the costs that such devices place on both the 5G and LTE *networks* because some traffic from 5G devices may "leak" to LTE networks.

89. Before describing our approach to estimating marginal costs, we note that HBVZ also estimated marginal costs, but their results are inaccurate due to their reliance on poor proxies for the relevant data and their lack of a detailed engineering model.[102]

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100 These "total costs" refer to costs for builds above and beyond the baseline network, but do not include the cost to build the baseline network itself. We thus refer to them as total incremental costs, rather than simply total costs, because they do not account for the sunk costs of the underlying baseline networks.

101 See note 81 above and the associated text.

102 *HBVZ Declaration* at 31-32 and Appendix A.

HBVZ find that, "[o]n a monthly basis, the marginal capital cost portion of the amortized incremental cost of a single subscriber ranges from $1 to $2 across the four MNOs." (*HBVZ*

1. Network Total Incremental Costs

90. We first calculate total incremental network costs by applying a Financial Backend Model to results produced by the Network Build Model. As described in Section III.B.1 above, for any given level of traffic, the Network Build Model determines the solutions beyond the baseline network necessary to satisfy network performance criteria while handling that traffic level. The Financial Backend Model multiplies the unit cost associated with each type of solution (e.g., spectrum overlay or cell split) times the number of incremental solutions of that type and then sums across the different solution types to determine the total incremental costs associated with any given level of traffic.

91. Table 8 below reports the unit costs associated with the different solutions. Each unit cost comprises capital expenditures (capex) and operating expenditures (opex). These unit costs are drawn directly from the Parties' ordinary course cost estimates.[103] We define the cost of a solution per year as the opex plus the levelized annual value of the capex, accounting for the lifetime of the capital and the firm's discount rate.[104] Similar to Sprint's and T-Mobile's ordinary course of business calculations, we amortize capex over the lifespan of the capital investment using Sprint's and T-Mobile's weighted average costs of capital as the

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Declaration, n. 42.) In contrast, we estimate the true marginal network costs to be approximately $[redacted]subscriber/month for T-Mobile and $[redacted]/subscriber/month for Sprint, of which capex account for approximately half. (See Section IV.A.)

103 Data provided by Sprint and T-Mobile through counsel.

104 We amortize the capex in order to account for the fact that it represents a durable investment in assets that are productive for several years. The amortization allocates the costs of the capex over the useful life of the investment. Both Sprint and T-Mobile perform similar calculations in the ordinary course of business. (See, e.g., TMUS-FCC-00708893.) HBVZ perform a similar calculation. (*HBVZ Declaration,* Appendix A.)

discount rates.[105] For the standalone firms, in order to reflect the pricing incentives they would face absent the merger, we use each firm's ordinary course assumptions. For Sprint, we assume a lifespan of [redacted] years and a discount rate of [redacted] percent.[106] For T-Mobile, we assume a lifespan of [redacted] years and a discount rate of [redacted] percent.[107] For New T-Mobile, we use five years and a discount rate of 8.0 percent.[108]

Table 8: Unit Costs for Network Build Solutions

[redacted]

92. Figure 11 shows the total incremental cost curves for each of the three networks in 2021 as a function of total network traffic.[109] Standalone T-Mobile generally experiences the highest costs, reflecting the fact that its more limited spectrum portfolio will require it to

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105 See, e.g., T-Mobile, Standard Cost Model [tab 'Totals – updated'], TMUS-FCC-02478892; TMUS-FCC-00708893, p. 10.

106 Data provided by Sprint through counsel.

107 Data provided by T-Mobile through counsel.

108 Data provided by T-Mobile through counsel.

109 Note that, similar to our treatment of throughput described in Section III.B.3(a) above, we plot total incremental costs against the sum of standalone 5G-capable device traffic, adjusted for the split of traffic between Sprint and T-Mobile.

expend more to build out its network to handle incremental traffic. In contrast, the standalone Sprint and New T-Mobile cost curves are lower and flatter. For example, at total traffic of [redacted] (equivalent to expected total Sprint and T-Mobile traffic in 2021), T-Mobile's incremental total costs above its baseline plan are [redacted] Sprint's incremental total costs above its baseline plan are [redacted], and New T-Mobile's incremental total costs above its baseline plan are $30 million/month.

Figure 11: Total Incremental Costs (2021)

[redacted]

93. Figure 12 shows the total incremental cost curves for each of the three networks in 2024. These curves are similar to those observed in 2021, although the degree to which Sprint's costs are higher than New-T Mobile's is greater over the relevant range of traffic levels. For example, at total traffic level of [redacted] (equivalent to expected total Sprint

and T-Mobile traffic in 2024), T-Mobile's total incremental costs are [redacted] Sprint's total incremental costs are [redacted] and New T-Mobile's total incremental costs are $60 million/month.

Figure 12: Total Incremental Costs (2024)

[redacted]

2. Network Marginal Costs

94. We use the information regarding the total incremental costs associated with different traffic levels to determine marginal costs per unit of traffic. Specifically, we calculate the marginal cost curve as the increase in total incremental costs for a small increase in

GB/subscriber/month, measured at each point on the curve. For example, the marginal cost (expressed in $/GB) associated with a one-unit increment (increase) in traffic is:[110, 111]

$$\frac{TotalCost_j - TotalCost_{j-1}}{Traffic_j - Traffic_{j-1}}$$

where j indexes each traffic increment.[112]

95. When interpreting these marginal costs, it is important to recognize that a conventional marginal cost curve measures costs for a given product (i.e., it holds quality constant). In calculating marginal network costs, the model uses T-Mobile's ordinary-course build rules, which do not necessarily hold network quality constant.[113] When the model implements solutions to handle incremental traffic, it generally does not fully match the quality level that prevailed with less traffic and thus quality generally falls as traffic goes up even after solutions have been applied. Ideally, the impact of this declining quality would be counted as part of marginal cost, but implementing such a calculation is intractable. Our approach of ignoring these quality-degradation effects when computing marginal cost tends to understate

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110 In this case, we define a unit to be equal to ten percent of baseline traffic.

111 These costs can be computed for each incremental unit or over multiple traffic increments starting from some baseline traffic number. For clarity, we refer to the former as "marginal costs" and the latter as "average incremental costs." Average incremental costs depend on the assumed baseline traffic estimate because it affects the traffic levels over which incremental costs are estimated. Although T-Mobile estimates incremental costs in both ways in the ordinary course, we understand that it primarily relies on marginal costs estimated [redacted] (See, e.g., T-Mobile, Standard Cost Model [tab 'Totals – updated'], TMUS-FCC-02478892; TMUS-FCC-00708893, p. 10.)

112 T-Mobile and Sprint perform similar calculation in the ordinary course of business. (See, e.g., TMUS-FCC-00708893, p. 10.)

113 See Section III.A.1 above.

the competitive and consumer benefits of the proposed merger because New T-Mobile has much higher throughput levels than does either of the standalone networks, and the marginal consumer value of incremental throughput generally declines as the level of throughput rises, which means that the marginal decreases in New T-Mobile's throughput have smaller associated dollar values.[114]

96. Because mobile broadband services generally are sold on a monthly subscription basis, the most relevant measure of marginal cost for pricing purposes is the marginal cost *per subscriber per month.* We calculate this marginal cost by multiplying the marginal cost per gigabyte by the average number of gigabytes per month per subscriber.[115] The Network Engineering Performance Module implies that that the merger will generate very substantial efficiencies in the form of lower marginal network costs.

(a) Per-Subscriber Network Marginal Costs if New T-Mobile Maintains Usage Restrictions

97. Figure 13 graphs the marginal network cost per month per subscriber, as a function of the number of subscribers, for each of the three networks in 2021, under the scenario in which New T-Mobile maintains the standalone usage restrictions and LTE/5G device mix. The marginal cost curve for each network is centered around the baseline number of subscribers with 5G-capable devices that the network is projected to serve in this scenario. At [redacted] 5G subscribers using an average of [redacted] (the projected baseline values for standalone T-Mobile), T-Mobile's marginal network costs are approximately

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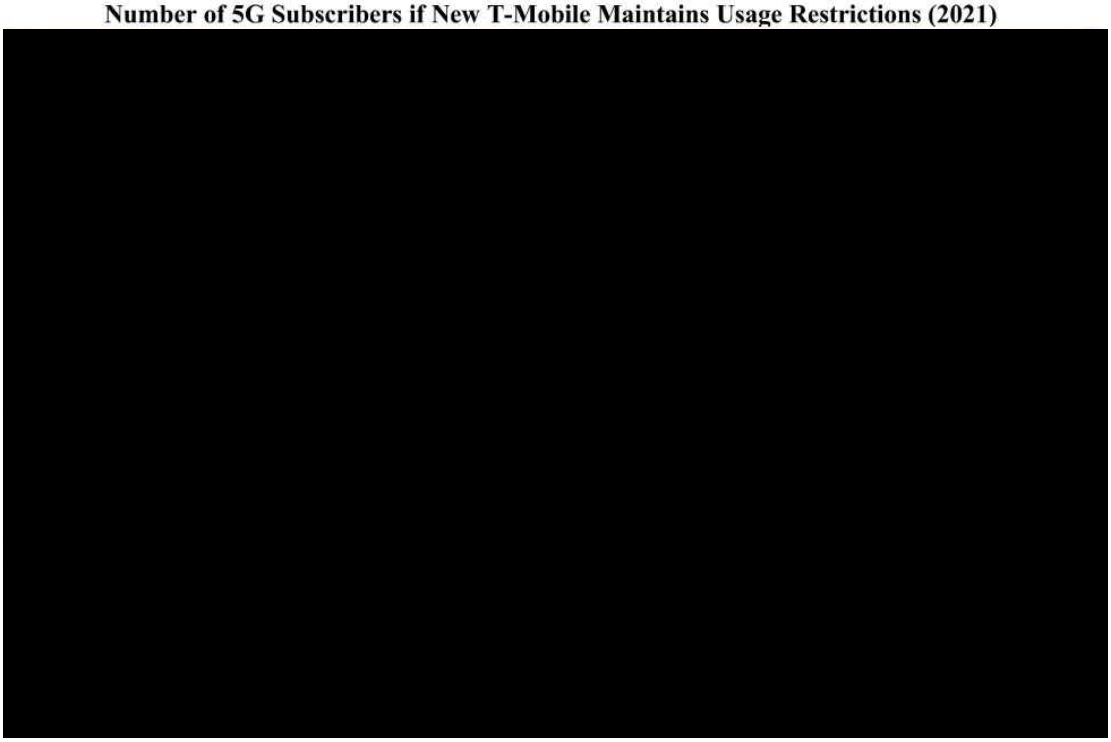
114 For a comparison of throughput levels, see, e.g., Figure 5 and Figure 6 above. For a discussion of the marginal value of additional throughput, see Section VI.C below.

115 We present estimates of the marginal cost per gigabyte in Part D of Appendix I.

[redacted]. At [redacted] 5G subscribers using an average of [redacted] (the projected baseline values for standalone Sprint), Sprint's marginal network costs are approximately [redacted]. Finally, at [redacted] 5G subscribers (the sum of the projected baseline numbers of Sprint and T-Mobile 5G subscribers), New T-Mobile's marginal network costs range from [redacted] for standalone Sprint subscribers to [redacted] for standalone T-Mobile subscribers.[116]

Figure 13: Marginal Network Cost per Subscriber/Month as a Function of the Number of 5G Subscribers if New T-Mobile Maintains Usage Restrictions (2021)

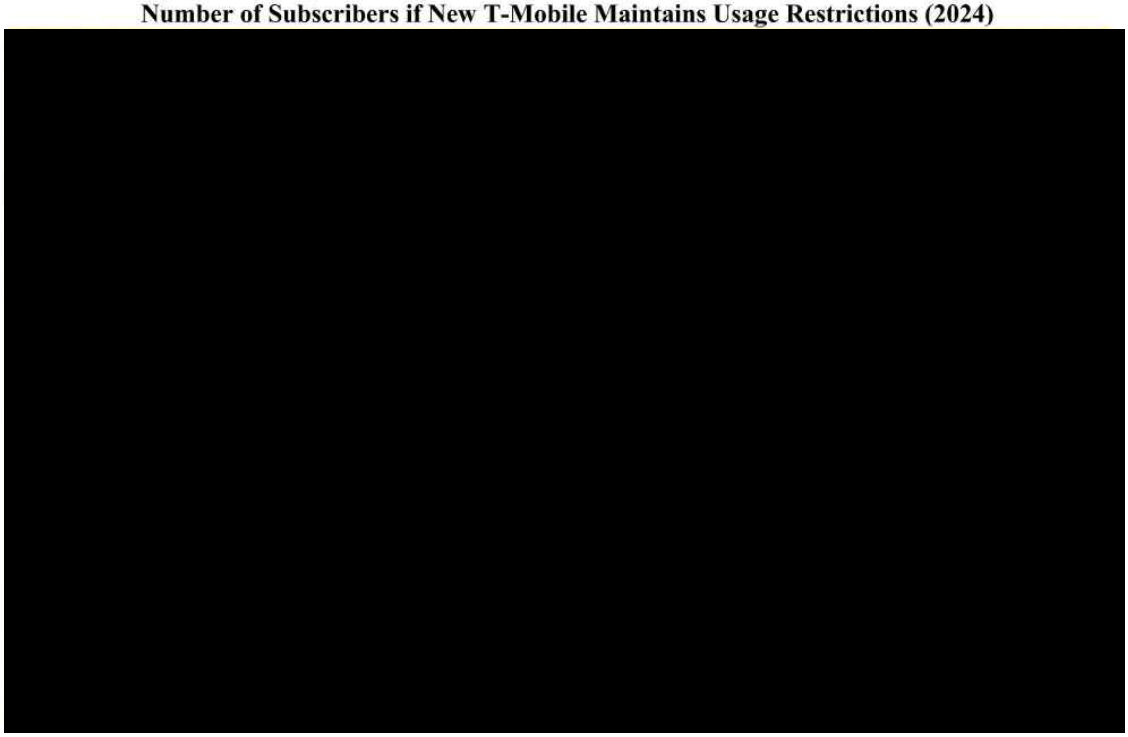


116 These values differ because we assume different usage levels for legacy Sprint and T-Mobile subscribers. For expositional simplicity, Figure 13 presents New T-Mobile costs based on a blended usage rate.

98. Figure 14 graphs the marginal network cost per month per subscriber for each of the three networks in 2024 as a function of total traffic (again for the scenario in which New T-Mobile maintains the standalone usage restrictions and LTE/5G mix). At [redacted] 5G subscribers using an average of [redacted] (the expected values for standalone T-Mobile), T-Mobile's marginal network costs are approximately [redacted]. At [redacted] 5G subscribers using an average of [redacted] (the expected values for standalone Sprint), Sprint's marginal network costs are approximately [redacted]. Finally, at 98.8 million 5G subscribers (the sum of Sprint and T-Mobile 5G subscribers), New T-Mobile's marginal network costs range from [redacted] for standalone Sprint subscribers to [redacted] for standalone T-Mobile subscribers.[117]

[117] For expositional simplicity, Figure 14 presents New T-Mobile costs based on a blended usage rate.

Figure 14: Marginal Network Cost per Subscriber/Month as a Function of the Number of Subscribers if New T-Mobile Maintains Usage Restrictions (2024)



(b) Per-Subscriber Network Marginal Costs if New T-Mobile Relaxes Usage Restrictions

99. As described above, economic logic indicates that New T-Mobile would relax usage restrictions in comparison with the standalone companies. Figure 15 and Figure 16 show the marginal costs per subscriber when New T-Mobile fully removes usage restrictions and implements its accelerated migration to 5G while the standalone companies continue to apply their baseline restrictions and LTE/5G device mix, as described in Section III.B.3(c) above. Figure 15 graphs the marginal network cost per month per subscriber for each of the three

networks in 2021.[118] The costs for standalone Sprint and T-Mobile are the same as described above. Reflecting greater usage, New T-Mobile's costs increase from [redacted] for Sprint subscribers and [redacted] for T-Mobile subscribers to [redacted] for both Sprint and T-Mobile subscribers.[119] Note that, in this case, the New T-Mobile figure is a single value, reflecting the unconstrained usage level, rather than two numbers, one for Sprint's standalone usage and one for T-Mobile's standalone usage.

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118 The Network Build Model is a function of total traffic and results do not depend on whether traffic increases because usage per subscriber increases, holding the number of subscribers constant, or vice versa. In the graphs presented here, we hold the number of subscribers constant at levels projected by Build 8.0 of the financial model.

119 In this case, we assume that all New T-Mobile 5G subscribers use the average of [redacted] predicted by T-Mobile's traffic forecast model.

Figure 15: Marginal Network Cost per Subscriber/Month as a Function of Number of Subscribers if New T-Mobile Relaxes Usage Restrictions (2021)

100. Figure 16 shows the marginal network cost per subscriber per month, in the scenario in which New T-Mobile relaxes usage restrictions, for each of the three networks in 2024. Again, the costs for standalone Sprint and T-Mobile are the same as described above (because the scenario only differs in terms of New T-Mobile's usage restrictions and migration path to 5G). Reflecting greater usage, New T-Mobile's costs increase from [redacted] for Sprint subscribers and [redacted] for T-Mobile subscribers to [redacted] for all subscribers.[120]

120 In this case, we assume that all New T-Mobile 5G subscribers use the average of [redacted] predicted by T-Mobile's traffic forecast model.

Figure 16: Marginal Network Cost per Subscriber/Month as a Function of Number of Subscribers if New T-Mobile Relaxes Usage Restrictions (2024)

101. We observe that, if the standalone networks were to attempt to fully relax usage restrictions, then the cost differentials would be even greater, especially in 2024. For example, at [redacted] in 2024, New T-Mobile's marginal network cost would be [redacted]. By contrast, standalone T-Mobile's marginal network costs would be approximately [redacted] while standalone Sprint's marginal network costs would be approximately [redacted]. The fact these costs are so high relative to New T-Mobile's costs provides further evidence of the benefits of combining the networks.

B. NON-NETWORK MARGINAL COST SAVINGS

102. The Parties expect to achieve run-rate non-network cost savings of approximately $2.4 billion per year by 2024.[121] These savings include cost reductions in sales, service and marketing (including retail distribution, advertising, customer care, equipment costs, repair, and logistics) and back office (including information technology, billing and other G&A). Although the majority of these cost saving constitute fixed cost savings, certain savings, including dealer commissions, device purchases, and device repair insurance, vary with the number of customers that New T-Mobile attracts. In total, these variable costs account for approximately one third of the total estimated non-network cost savings. Because these costs vary with the number of subscribers, the combined firm will experience lower marginal costs, which it will have an incentive to pass through to consumers (at least in part) in the form of lower prices.

103. Table 9 summarizes the estimated non-network efficiencies, separately by category (reductions in dealer commissions, device costs, and insurance costs associated with device repair) and in total.[122] The marginal cost savings per postpaid customer ranges from [redacted] per

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121 Financial Model Build 8.0, TMOPA_08060379_00000001.

122 New T-Mobile's financial plan estimates that customer care costs will be higher for the merged firm relative to the standalone firms. This cost increase is largely due to the fact that T-Mobile incurs higher customer care costs than does Sprint, in part because T-Mobile relies on more live-handled (versus automated) calls and also uses a higher percentage of on-shore call-center workers (See, "New T-Mobile Business Plan – Detailed Assumptions and Methodology," August 2018, TMUS-FCC-02503297, at 11.) It is our understanding that the New T-Mobile plans to continue with T-Mobile's customer care practices. (*Id.* at 10) Doing so would make sense only if the value to consumers exceeded the incremental costs of providing this improved service. An implication is that the *quality-adjusted* costs will remain constant or decline. To be conservative, we assume no net change in customer care costs due to the merger.

month in 2021 to [redacted] per month in 2024; the marginal cost savings per prepaid customer ranges from [redacted] per month in 2021 to [redacted] per month in 2024.

Table 9: Non-network Marginal Cost Savings ($/subscriber/month)

[redacted]

104. Table 10 presents the dealer commission efficiencies. We understand that these savings arise from the benefits of dealer scale. New T-Mobile will consolidate Sprint and T-Mobile dealer locations, resulting in fewer total locations but higher traffic in each location, thereby allowing dealers to reduce the average cost of serving a customer.[123] The Parties expect to save between [redacted] and [redacted] million annually. New T-Mobile will achieve dealer commission on new customers. To calculate average savings per subscriber per month, we divide total cost savings by the projected number of gross additions multiplied by the expected customer lifetime.[124] Savings per subscriber per month range from [redacted] to [redacted].

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123 New T-Mobile will close [redacted] dealer locations, saving monthly commissions of [redacted] per location, for annual savings of approximately [redacted]. In addition, increased traffic at other dealers will increase dealer profitability, allowing new T-Mobile to reduce dealer commission rates by [redacted] percent on the [redacted] billion of annual commissions, resulting in annual savings of approximately [redacted] These numbers account for the fact that New T-Mobile plans to open approximately 600 new stores in rural locations with higher-than-average costs.

124 We allocate total savings between the postpaid and prepaid segments using a "%weight" that is determined by the product of the gross adds for each segment (as obtained from T-Mobile's Build 8 Model) and a "Commissions Weight" (as obtained from T-Mobile's financials and

Table 10: Calculation of Dealer Commission Efficiencies

[redacted]

105. Table 11 presents the projected device efficiencies. The Parties expect greater scale will allow them to obtain a [redacted] percent discount on [redacted] of annual purchases of Android devices resulting in savings of approximately [redacted] per year.[125] As do dealer commissions, these savings apply to new customers. To calculate average savings per subscriber per month, we divide total cost savings by the projected number of gross additions multiplied by the expected customer lifetime. Savings per subscriber per month range from [redacted] to [redacted]

Table 11: Calculation of Device Efficiencies

[redacted]

reflecting the fraction of commissions that are paid on postpaid subscribers versus prepaid subscribers).

125 We understand that the Parties do not anticipate similar savings on iPhones.

106. Sprint and T-Mobile offer their customers insurance that covers the costs of device repairs. The Parties project that, by realizing economies of scale, the merger will reduce insurance program costs by [redacted] percent.[126] The resulting savings are projected to be [redacted] in 2021 and result in a marginal cost reduction of [redacted] per month per postpaid subscriber and [redacted] per month per prepaid subscriber.

V. HBVZ'S MARKET EQUILIBRIUM MODELS INDICATE THAT THE PROPOSED MERGER WOULD PROMOTE COMPETITION AND CONSUMER WELFARE BASED ON THE MARGINAL COST SAVINGS ALONE

107. As described in Sections III.B.3 and IV.A above, the proposed merger is projected to raise the quality of the Parties' products while lowering their marginal costs. In this section, we demonstrate that HBVZ's market equilibrium models imply that the proposed merger would be procompetitive once we incorporate the projected marginal cost savings into them. In other words, their models show the proposed merger would promote competition and consumer welfare even if (counterfactually) it did not generate *any* quality improvements.

108. We compute the marginal cost savings separately for HBVZ's two versions of the Industry Performance Module. For each version, we consider two alternative post-merger scenarios (as described briefly in Sections III.B.3(c) and III.B.3(d) above):

- In our baseline scenario, we start from the point at which New T-Mobile serves the sum of the standalone traffic, meaning that it imposes the same usage restrictions as

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126 "New T-Mobile Business Plan – Detailed Assumptions and Methodology," August 2018, TMUS-FCC-02503297, at 14.

would the standalone networks and maintains the same LTE/5G split as they would as well, albeit while offering higher network quality in terms of speed and coverage.

- In our alternative scenario, we start from the point at which New T-Mobile serves the sum of the standalone networks' subscribers, but incurs higher costs on its 5G network both due to relaxed usage restrictions and faster migration of subscribers to 5G-capable devices. In this case, New T-Mobile offers a higher quality product (greater usage and a higher percentage of subscribers on 5G) at a higher cost.

These two scenarios offer alternative views on the degree to which New T-Mobile would pass through merger efficiencies in the form of lower costs versus higher product quality.

109. We consider both scenarios for the sake of completeness. However, as a general matter, New T-Mobile would have an incentive to relax usage restrictions and accelerate migration to 5G (the second scenario) *only* if consumers value the additional product quality by more than the associated cost. Because New T-Mobile will pass much of the resulting increase in economic surplus on to consumers, this means that, whenever the second scenario arise in practice, consumers will be better off than if New T-Mobile had chosen the first scenario. It follows that, if the proposed merger is procompetitive under the first scenario—as we show that it is—then it must also be procompetitive under the second scenario if that is the one chosen by New T-Mobile.[127]

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[127] It should be noted that, even if (counterfactually) the merger were not consumer-welfare enhancing under the first scenario, it could still be consumer-welfare enhancing under the second scenario because of the consumer benefits of relaxed usage restrictions and accelerated transition to 5G.

A. HBVZ'S MODELS INDICATE THAT THE MERGER'S MARGINAL COST SAVINGS ALONE WOULD OUTWEIGH ANY ADVERSE UNILATERAL COMPETITIVE EFFECTS IF NEW T-MOBILE MAINTAINS USAGE RESTRICTIONS AND THE LTE/5G MIX

110. Table 12 summarizes the marginal cost savings described in Section IV above under our baseline scenario. These savings range from [redacted] to [redacted].

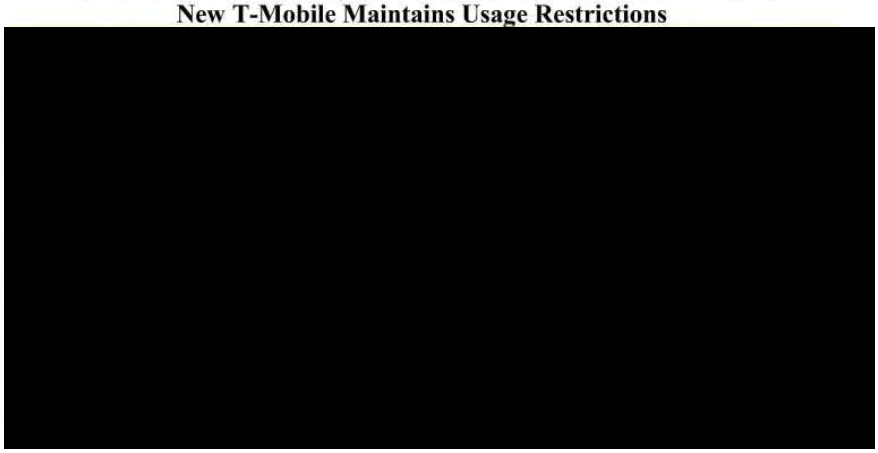
Table 12: Summary of Marginal Cost Savings:
New T-Mobile Maintains Usage Restrictions and LTE/5G Mix

[redacted]

111. Table 13 compares these marginal cost savings with the total efficiencies (i.e., marginal cost savings and quality improvements) necessary to render the proposed merger competitively neutral under HBVZ's market equilibrium models. Specifically, Table 13 reports the results of subtracting the marginal cost savings stated in Table 12 from the values of the overall efficiency thresholds stated in Table 1. As can be seen from Table 13, the

differences are all negative numbers, which indicates that projected marginal cost savings exceed the efficiencies thresholds.[128] In other words, HBVZ's industry equilibrium models imply that the proposed merger would benefit consumers even if (counterfactually) they did not have to place any value at all on the proposed merger's projected quality improvements—the marginal cost savings alone are sufficient to offset the loss of a competitor.

Table 13: Critical Quality Efficiencies Based on HBVZ's Models: New T-Mobile Maintains Usage Restrictions



B. HBVZ'S MODELS INDICATE THAT THE MERGER'S MARGINAL COST SAVINGS ALONE WOULD OUTWEIGH ANY ADVERSE UNILATERAL COMPETITIVE EFFECTS IF NEW T-MOBILE RELAXED USAGE RESTRICTIONS AND ACCELERATED 5G MIGRATION

112. Table 14 summarizes the marginal cost savings described in Section IV above under the assumption that New T-Mobile serves the sum of the standalone subscribers but does so while allowing its subscribers to consume unconstrained usage levels and accelerates the migration to 5G-capable devices. These marginal cost savings range from

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128 Technically, this statement is correct only if the quality effects are non-negative. As discussed in Sections III.B.3 above and VI.C below, the merger is projected to generate substantial quality improvements.

[redacted] to [redacted] Although these marginal cost savings are lower than the scenario in which we hold usage fixed at the non-merger levels, the change in costs is accompanied by greater quality improvements in the form of relaxed usage restrictions and faster 5G migration. Thus, ignoring the quality improvements is even more conservative in this case.

Table 14: Summary of Marginal Cost Savings:
New T-Mobile Relaxes Usage Restrictions

113. Table 15 reports by how much the proposed merger will have to improve quality to be procompetitive under HBVZ's market equilibrium models.[129] The fact that all the numbers in

[129] The entries in Table 15 are calculated by subtracting the estimated marginal cost savings reported in Table 14 from the critical efficiencies reported in Table 1.

the table are negative again demonstrates that, using HBVZ's merger simulation, marginal cost savings alone are sufficient to more than offset the loss of a competitor.

Table 15: Critical Quality Efficiencies Based on HBVZ's Models: New T-Mobile Relaxes Usage Restrictions

VI. QUALITY IMPROVEMENTS ARE MORE THAN SUFFICIENT FOR THE MERGER TO INCREASE CONSUMER WELFARE, EVEN APPLYING OUR MORE CONSERVATIVE MARKET EQUILIBRIUM MODEL

114. In the previous section, we showed that the marginal cost savings from the merger are so large that, even without accounting for quality improvements, the merger is procompetitive in all years using HBVZ's market equilibrium models. In the present section, we apply our more conservative model of market equilibrium and reach the same bottom-line conclusion: the merger will promote competition and consumer welfare.

115. More specifically, we show that:

- In our baseline specification, in which New T-Mobile maintains the usage restrictions and the LTE/5G mix of the standalone firms, the proposed merger is shown to be procompetitive and consumer-welfare enhancing in 2022-2024 based on marginal cost savings alone (i.e., even without accounting for quality improvements). In 2021, the

merger is shown to be procompetitive and consumer-welfare enhancing in our baseline model as long as consumers value the quality improvements from the merger by [redacted] Even in the most conservative model we run, the merger is procompetitive and consumer-welfare enhancing as long as consumers value the proposed merger's projected quality improvements by [redacted]

- In the alternative specification in which we allow new T-Mobile to relax usage restrictions and enable consumers to switch to 5G faster, the proposed merger is procompetitive and consumer-welfare enhancing in 2022 and 2023 even if (counterfactually) consumers place no value on its quality improvements. In this specification, using our baseline model, the merger is procompetitive and consumer-welfare enhancing if its quality improvements are worth at least [redacted] per month to consumers in 2021 and [redacted] per month in 2024. Even under the most conservative model specification we run, the merger is procompetitive and consumer-welfare enhancing if consumer value the quality improvements by at least [redacted] per subscriber per month in 2021 and at least [redacted] in 2024. And in this case, it is critical to remember that, in addition to faster throughput and the other merger benefits, consumers also benefit from faster migration to 5G and from relaxed usage restrictions. Relaxing the usage restrictions leads to increases in the projected average usage across Sprint and T-Mobile 5G subscribers of roughly [redacted] percent in 2021 and [redacted] percent in 2024. Such large increases in usage seem likely to generate significant consumer value.

- Even conservative estimates of consumer valuation on the network quality improvements created by the merger easily exceed these critical levels. And a variety of more qualitative evidence bolsters the conclusion that consumers place high value on network quality improvements. These results demonstrate that the merger is consumer-welfare enhancing in all the years we evaluate.

116. Before turning to the details of our analysis, we stress that consumers will almost surely value network speed and quality more highly in the future than they do today. As David Evans explained at length in his Declaration, the history of the mobile wireless industry demonstrates that, as wireless speeds increase and the application ecosystem evolves to keep up, consumer demand for faster and better networks increases, meaning that consumer willingness to pay for (and thus benefit from) improved network quality—particularly at the high end of what networks can offer—increases substantially.[130] A critical implication of this fact is that *any attempt to utilize unadjusted estimates of the amounts by which consumers currently value network speed and quality to assess how consumers will value the proposed merger's quality benefits will almost surely understate those benefits.* Because of the difficulties in applying estimates based on current and past data to predict future valuations, we are continuing to explore alternative ways to estimate future valuations of network quality, including increased throughput, relaxed usage constraints, and other dimensions of quality. However, even the conservative approach that we take below finds that the proposed merger will enhance consumer welfare in all scenarios.

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130 *Evans Declaration*, § II.

117. The remainder of this section proceeds as follows. In Part A, we identify the quality thresholds necessary for the merger to be procompetitive under our conservative alternative model. In Part B, we present evidence from a variety of sources indicating that consumers generally place high values on the dimensions of quality that the proposed merger will improve. Lastly, in Part C, we use an article recently published in the academic literature to quantify the value consumers place on higher throughput, and we show that the merger is procompetitive and consumer-welfare enhancing in all years and scenarios, even utilizing this conservative estimate of the value of only some of the merger's quality improvements.

A. QUALITY EFFICIENCY THRESHOLDS BASED ON OUR ALTERNATIVE MARKET EQUILIBRIUM MODEL

118. In this section, we use our alternative market equilibrium model and the marginal cost savings described above to derive quality thresholds for the scenarios in which New T-Mobile does, and does not, maintain the standalone usage restrictions and the LTE/5G device mix.

1. Threshold Consumer Valuations of Quality Improvements if New T-Mobile Maintains Usage Restrictions and the LTE/5G Traffic Mix

119. For the first case, in which New T-Mobile maintains the standalone networks' usage restrictions and LTE/5G traffic mix, Table 16 reports the amount by which quality must rise to make the merger procompetitive given the marginal cost savings reported in Table 12 above. Row 1 demonstrates that, even with the conservative assumptions underlying our industry equilibrium model, marginal costs savings alone are sufficient to offset the loss of a competitor in all years except 2021 (negative numbers in the table indicate that realized marginal cost efficiencies exceed the break-even values). Even in 2021, the quality threshold is only [redacted] in our baseline model, rising to [redacted]

[redacted] in the most conservative specification in which the industry elasticity is assumed to be only -0.1, which increases the diversion ratio to all inside goods.[131] In Parts B and C, below, we present evidence from a variety of sources indicating that consumer valuation of the proposed merger's projected quality improvements will easily exceed these thresholds, even using conservative valuations based on historical data.

Table 16: Alternative Critical Quality Efficiencies; New T-Mobile Maintains Usage Restrictions

[redacted]

2. Threshold Consumer Valuations of Quality Improvements if New T-Mobile Relaxes Usage Restrictions and Accelerates 5G Migration

120. We next turn to the case in which New T-Mobile capitalizes on lower costs and increased 5G capacity by relaxing usage restrictions and accelerating the transition of

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131 As described in Section II.B above, we also consider several robustness checks, which are reported in the remaining rows of Table 16.

subscribers to 5G. In Table 17, we consider how much incremental quality is necessary to make the merger procompetitive given the higher marginal costs for New T-Mobile (but also corresponding higher quality benefits) associated with fully relaxed usage restrictions and thus unconstrained usage levels, as well as faster transition to 5G. Row 1 demonstrates that, for our baseline model, even using more conservative assumptions in the merger simulations, marginal costs savings alone are sufficient to offset the loss of a competitor in 2022-2023. In 2021, all that is required is consumer valuation of quality improvements of at least [redacted]; in 2024, all that is required is consumer valuation of quality improvements of at least [redacted].[132] Even using the most conservative specification (industry elasticity of -0.1), average consumer valuation of increased quality of at least [redacted] in 2021 and [redacted] in 2024 is sufficient. As noted above, in this case, these valuations cover all the sources of valuation in the first case, plus the likely substantial benefits of relaxed usage constraints, as well as faster 5G transition. In Sections VI.B and VI.C below, we present evidence from a variety of sources indicating that consumer valuation of the quality improvements from the merger will easily exceed these thresholds.

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132 As described in Section II.B above, we also consider several robustness checks, which are reported in the remaining rows of Table 17.

Table 17: Alternative Critical Quality Efficiencies; New T-Mobile Relaxes Usage Restrictions

121. As also described above, the more valuable are the quality improvements for the consumers of one firm, the lower is the threshold for quality improvements enjoyed by consumers of the other firm. As one illustration of this, Figure 17 illustrates the tradeoff in quality-valuation thresholds for our baseline model in 2024, using the case in which the merged firm fully relaxes usage constraints and accelerates the transition to 5G. Consistent with the table, a valuation of [redacted] for the customers of each firm is sufficient, but so is a valuation of [redacted] for T-Mobile subscribers with none for Sprint subscribers (covering a case in which subscribers who do not value quality choose Sprint) and a valuation of [redacted] for Sprint subscribers and none for T-Mobile subscribers. We will use figures of this form again below to show that the merger is procompetitive and welfare enhancing in all years and even in our most conservative specifications.

Figure 17: Frontier of Critical Quality Improvements if New T-Mobile Relaxes Usage Restrictions (2024)

B. EVIDENCE FROM A VARIETY OF SOURCES INDICATES THAT CONSUMERS PLACE SUBSTANTIAL VALUE ON MULTIPLE DIMENSIONS OF NETWORK QUALITY

122. In this part, we present evidence from a variety of sources that consumers place high value on the types of quality improvements that will be generated by the merger. Then, in Part C, we provide a conservative quantification of the consumer valuation of the specific quality improvements from the merger. Together, this evidence demonstrates that consumer valuations of the projected quality improvements generated by the merger will easily exceed critical values in those years/specifications in which our, more conservative (than HBVZ), market equilibrium model needs more than just marginal cost savings to yield positive

consumer welfare effects. And we stress again that all of this evidence is drawn from current and historical data, before the application ecosystem has evolved to make full use of higher speeds, and thus it provides only conservative measures of the consumer benefits created by the merger-induced improvements in network quality.

1. Evidence from Consumer Surveys

123. Consumer surveys conducted in the ordinary course of business by both Sprint and T-Mobile reveal high consumer valuation of quality improvements of the general type associated with the merger. Both Sprint and T-Mobile conduct surveys of new and deactivating customers to discern information about what aspects of service quality are important to them. Although these surveys do not allow one to estimate a precise dollar value of specific dimensions of network quality, they demonstrate that consumers place substantial value on network quality.

124. Table 18 summarizes the responses given by Sprint customers regarding the reasons for dropping their service. For Sprint consumers who deactivate voluntarily, network quality is cited as the reason by [redacted] percent.[133] Indeed, network quality is given as a reason for departure more frequently than the cost of monthly service or poor customer service. These results reveal substantial room to enhance the welfare of Sprint customers via improvements in network quality and reveal that such improvements might be more important to consumers than modest changes in the level of their monthly bill.

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[133] SPR-FCC-01292280, p. 4.

Table 18: Primary Reason for Deactivation of Service Among Sprint Subscribers

125. Similarly, among T-Mobile postpaid customers who deactivated in Q1 2018, [redacted] percent cited coverage as a major reason for deactivation, and monthly plan cost is cited as a major reason for deactivation by only [redacted] percent of respondents.[134] And in a survey of new T-Mobile customers experiencing one or more issues with T-Mobile, the two most common issues were "coverage or reception problems" ([redacted] percent) and "data speed / performance issues" ([redacted] percent).[135] Further, T-Mobile acknowledged that "coverage remains a leading pain point and a driver of dissatisfaction among our new customers" and "poor network

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134 T-Mobile, Postpaid Deactivation Tracker Q1 '18 Results, April 2018, TMOPA_07187966_00000001, p. 5.

135 T-Mobile, New Customer Research – Brand, Consumer and Market Insights, April 2018, TMUS-FCC-01887354, p. 25.

satisfaction cannot be easily overcome by T-Mobile benefits, features and price/value."[136] Again, these results reveal scope for substantial welfare enhancement via network quality improvements and that such improvements might be more important to consumers than modest changes in the level of their monthly bill

126. More generally in the industry, many customers also cite network quality as an important factor in their initial carrier decision. In a 2014 McKinsey & Company survey, customers were asked to choose the three most important factors in their carrier selection. Four of the five most frequently chosen options were aspects of network quality.[137]

127. Academic research, as well as studies conducted by or for the Parties, further bolster the conclusion that consumers' product choices respond to network quality, which demonstrates that they value it. For example, Sprint, working with the third-party consulting firm Delta Partners, has developed a comprehensive measure of network quality: Quality of Experience (QoE). QoE measures each subscriber's individual mobile wireless experience based on her use of the network. Delta Partners' research finds that Sprint customers with below-average QoE churn away from Sprint at substantially higher rates—as much as [redacted] percent in some areas—relative to consumers with above-average QoE.[138] Sprint customers also respond to changes in QoE: Customers experiencing deteriorating QoE are [redacted]

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136 T-Mobile, New Customer Research – Brand, Consumer and Market Insights, April 2018, TMUS-FCC-01887354, p. 17.

137 "Everywhere, all the time, really fast: The importance of network quality" (December 2015) McKinsey & Company (McKinsey_Everywhere, all the time, really fast_ …pdf).

138 Delta Partners, "Managing Network Quality of Experience (QOE) from a Commercial Perspective," September 20, 2017, IKK Exhibit 3, at 28.

percent more likely to churn than customers experiencing improving QoE.[139] Several academic studies have also shown that network quality is an important determinant of customer satisfaction and choice of broadband and telephony service in a wide variety of contexts.[140] The fact that customers make choices based on network quality reveals that they place significant value on it.

128. In accordance with the importance consumers place on quality, carriers focus their marketing campaigns around various measures of network quality.[141] Along with traditional marketing and advertising, carriers produce press releases touting good performance in recent network quality reports.[142]

129. Ordinary course evidence reveals that it is not just postpaid customers who place high value on network quality; prepaid customers do as well. Sprint recently conducted a survey to

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139 Delta Partners, "Managing Network Quality of Experience (QOE) from a Commercial Perspective," September 20, 2017, IKK Exhibit 3, at 30.

140 See, e.g., Teresa Garín-Muñoz, Covadonga Gijón, Teodosio Pérez-Amara, and Rafael López (2013),"Customer Satisfactin of Mobile-Internet-Users: An Empirical Approximation for the Case of Spain," *Journal of Reviews of Global Economics*, **2**(): 442-454; Takanori Idaa, Shin Kinoshita, and Masayuki Sato (2008), "Conjoint analysis of demand for IP telephony: the case of Japan," *Applied Economics*, **40**(): 1279-1287; Ingy Shafei and Hazem Tabaa (2016), "Factors affecting customer loyalty for mobile telecommunication industry," *EuroMed Journal of Business*, **11**(3): 347-361.

141 Twentieth Report, *In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services*, WT Docket No. 17-69, rel. September 27, 2017 (hereinafter, *20th Annual Report*), ¶ 66.

142 See, for example, Verizon News Release, "RootMetrics ranks Verizon's network #1 in the nation for a record ninth time in a row," February 7, 2018, *available at* https://www.verizon.com/about/news/rootmetrics-ranks-verizons-network-1-nation-record-ninth-time-row, *site visited* September 10, 2108; T-Mobile News Release, "Customers Have Spoken: T-Mobile's Network is Tops – AGAIN," January 21, 2018, *available at* https://www.t-mobile.com/news/opensignal-2018, *site visited* September 10, 2018.

examine the tradeoffs made by current prepaid customers when choosing a carrier. This survey explicitly asked customers about the importance of various factors in choosing a prepaid plan. Coverage "in places you go most" was rated as very important by [redacted] percent of customers, second only to price ([redacted] percent).[143] The carrier's overall reputation for network coverage was also chosen by [redacted] percent of respondents as a very important factor. This value of quality is consistent with trends in usage patterns observed by Sprint and T-Mobile: On average, prepaid customers use approximately the same amount of data per subscriber as postpaid customers, likely because prepaid customers are more likely to use mobile broadband as a substitute for wired broadband—a use case that places a premium on network quality.[144]

2. Evidence from Network Operators' Pricing Decisions

130. The fact that mobile wireless network operators charge substantially higher prices for higher quality plans further confirms that many consumers place high value on network quality today. This follows because network operators' pricing decisions reflect their estimates of consumers' valuation of product quality: the more highly consumers value a dimension of network quality, the more firms will optimally charge for that dimension of quality. Hence, although firms' pricing decisions alone cannot be used to determine consumer willingness to pay for specific aspects of product quality, they do provide useful

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143 Sprint, Prepaid Brand Conjoint Research, IKK Exhibit 4, at 31.

144 SPR-DOJ-04338918, IKK Exhibit 8; T-Mobile Response to FCC Information Request 32.

guidance regarding what network operators believe customers will pay for greater network quality.

131. Although network plans are complex and multidimensional, we can still learn from the prices of plans that differ on certain quality dimensions but are otherwise similar.[145] To this end, Table 19 compares prices and attributes across several postpaid plans offered by Sprint, T-Mobile, Verizon, and AT&T. We observe that:

- The "T-Mobile ONE" plan imposes throughput constraints such as 480p video streaming (supporting SD) and mobile hotspot (tethering) data usage at 3G speeds.[146] In contrast, the "T-Mobile ONE Plus" plan offers ten GB of LTE mobile hotspot data usage for tethering and unlimited HD streaming (effectively meaning greater video throughput) for an extra $10-$15 per line.[147]
- Similarly, Sprint's "Unlimited Basic" plan includes a 500 MB allowance for LTE mobile hotspot data usage and streams video at 480p, music at up to 500 kbps, and gaming at up to 2 Mbps.[148] In contrast, Sprint's "Unlimited Plus" plan includes a 15

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145 T-Mobile internal documents describe the various features of prepaid and postpaid plans offered by mobile carriers, but a summary of plans focuses on a subset of plan characteristics, the amount of data, the number of lines, and the speed of video streaming. ("Pricing and Propositions, T-Mobile and Competitive View, Cheat Sheet," July 2017, TMUS-FCC-01094091.)

146 T-Mobile, "T-Mobile ONE™ for Phones," *available at* https://support.t-mobile.com/docs/DOC-36931, *site visited* September 10, 2018.

147 T-Mobile, "T-Mobile ONE™ for Phones," *available at* https://support.t-mobile.com/docs/DOC-36931, *site visited* September 10, 2018.

148 Sprint, "Unlimited Plus," *available at* https://www.sprint.com/en/shop/plans/unlimited-cell-phone-plan.html, *site visited* September 10, 2018.

GB allowance for LTE mobile hotspot data usage and streams video at 1080p (HD), music at up to 1.5 Mbps, and gaming at up to 8 Mbps, for an extra $10 per-line.[149]

- AT&T and Verizon also charge between $8 and $15 more per line for similar improvements, including greater mobile hotspot tethering usage limits and HD video throughput.

Table 19: Plan Prices and Attributes

Carrier	Plan Name	Key Features	Per Line Price			
			1 Line	2 Lines	3 Lines	4 Lines
AT&T	Unlimited & More	SD Video	$70	$63	$48	$40
	Unlimited & More Premium	HD Video; 15 GB LTE Hotspot	$80	$75	$57	$48
Sprint	Unlimited Basic	SD Video	$60	$50	$40	$35
	Unlimited Plus	HD Video; 15 GB LTE Hotspot	$70	$60	$50	$45
T-Mobile	ONE	SD Video	$70	$60	$47	$35
	ONE PLUS	HD Video; 20GB of LTE Hotspot	$85	$70	$57	$45
Verizon	Go Unlimited	SD Video	$75	$65	$50	$40
	Beyond Unlimited	HD Video; 15 GB LTE Hotspot	$85	$80	$60	$50

Source: TMUS-FCC-01014607; company websites

132. In sum, although there are other differences between each pair of plans offered by a carrier,[150] the price differences are roughly $10 per line when moving from a plan with throughput only sufficient to allow SD streaming (and limited tethering) to one with throughput that allows HD streaming (and greater tethering). Because there are other feature differences between the plans and because not all consumers take the more expensive plans, one cannot say that the valuation of the higher throughput and relaxed usage (tethering)

149 Sprint, "Unlimited Plus," *available at* https://www.sprint.com/en/shop/plans/unlimited-cell-phone-plan.html, *site visited* September 10, 2018.

150 By comparing prices within each carrier's plans, we hold constant differences across carriers, such as network breadth, that may affect prices.

restrictions is $10, but these variations do show that network operators view many customers as placing considerable value on these quality improvements.

C. CONSUMER VALUATION OF INCREASED THROUGHPUT AND RELAXED USAGE RESTRICTIONS

133. To develop one quantitative estimate of the quality benefits of the proposed merger, we turn to estimates of the valuations of increased throughput and relaxed usage restrictions in the academic literature.[151] Most relevant for present purposes is a paper by former DOJ Deputy Assistant Attorney General for Economic Analysis Aviv Nevo and coauthors, who analyze, among other questions, customers' willingness to pay (WTP) for increased throughput.[152]

134. Before turning to the specifics of our quantification, we note that the quantification of valuations of quality improvements developed from *Nevo et al.* is likely quite conservative for at least three reasons. First, *Nevo et al.*'s results are based on data from 2012 and, thus, likely do not capture the continuing increase in consumer valuation of higher network speeds even as of today, let alone for 2021-2024. This problem is partially ameliorated by the fact that the paper analyzed wired broadband networks, which have much higher levels of speed and per-subscriber usage than do mobile wireless networks today. As a result, valuations based on

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151 Beyond the specific article on which we rely for our quantification, we note that the academic papers that have studied the topic have generally found high consumer valuation on various aspects of network quality, including throughput, coverage, and usage limits. (See, e.g., Yu-Sin Liu, Jeffrey Prince, and Scott Wallsten (2018), "Distinguishing Bandwidth and Latency in Households' Willingness-to-Pay for Broadband Internet Speed," unpublished manuscript; Kyle Wilson (2018), "Does Public Competition Crowd Out Private Investment? Evidence from Municipal Provision of Internet Access," unpublished manuscript.)

152 Aviv Nevo, John L. Turner, and Jonathan W. Williams (2016), "Usage-Based Pricing and Demand for Residential Broadband," *Econometrica,* **84**(2): 411-443 (hereinafter, *Nevo et al.*).

wireline networks may capture some of the increased benefits on speed on future wireless networks. But given that *Nevo et al.*'s findings are based on data that are now several years old, and given the huge increases in network performance associated with 5G, these estimates are still likely to underestimate the valuation that consumers in future years, with a more developed application ecosystem, will place on the proposed merger's throughput increases.

135. Second, our approach does not fully capture the benefits that the merger will generate for subscribers with 5G-capable devices. For example, the quantification does not account for the fact that Sprint customers will have broader geographic access to other benefits of 5G, such as lower latency and better device power performance. Nor does our quantification account for improvements in signal strength or reductions in time spent roaming by Sprint customers in particular.

136. Third, our quantification focuses primarily on consumer valuation of throughput, rather than valuation of other quality improvements, such as relaxed usage restrictions. As noted above, the size of the usage increases in our alternative scenario that allows for relaxed usage restrictions by New T-Mobile are very large. For example, usage is nearly [redacted] for New T-Mobile as for the standalone firms in 2024. We are continuing to investigate ways to use the estimates in *Nevo et al.* or other approaches to value the relaxation of usage restrictions. Here, we simply note that, given the extent to which the standalone firms are projected to constrain usage below the projected unconstrained levels, consumers' valuations of relaxing these restrictions are likely to be large.

1. Consumer Valuations of Quality Improvements if New T-Mobile Maintains Standalone Usage Restrictions and LTE/5G Traffic Mix

137. As described above, our baseline scenario compares a case in which New T-Mobile does not relax the usage restrictions imposed by the standalone firms or change the mix of LTE/5G traffic relative to the standalone firms. To compute consumer valuation on increased throughput in this case, we first compute the weighted average throughput for each sector—weighting the 5G and LTE throughputs by the traffic on each sector—for each of the standalone networks and new T-Mobile. We then use the *Nevo et al.* results to determine the consumer valuation of this weighted average throughput at each sector.[153] We weight the resulting sector-level valuations up to the network level by using the sector traffic levels as weights. Finally, we compute consumer valuation of the merger-induced improvements in network quality by taking the difference between the valuation of the New T-Mobile network and that of each standalone network.

138. As a first approach to determining the relevant consumer valuations, we apply the quality-valuation parameters from *Nevo et al.* with no adjustments for likely differences

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153 In running the model from *Nevo et al.*, we assume consumers do not face explicit usage constraints. This approach simplifies the model substantially by removing the dynamic aspect of the usage decision, which means that the consumer's expected optimal usage and expected valuation are characterized by closed-form expressions. In the unadjusted runs, we select the most common consumer type from *Nevo et al.* for each parameter, as described in the article's supplemental appendix on page 11, and compute the valuations using the closed form solution. In the adjusted runs, we start from these most common consumer types, but we then re-calibrate the model so that the usage predicted by the model matches that in the Network Build Model for the New T-Mobile network. We do so by finding the value of μ, the main parameter governing the consumer's average value of content, such that the *Nevo et al.* model predicts expected monthly usage on the New T-Mobile network equal to that in the Network Build Model. For example, our calibrated values of μ for the case where New T-Mobile relaxes usage restrictions are [redacted] in 2021, [redacted] in 2022, [redacted] in 2023, and [redacted] in 2024. The increasing values reflect increasing usage over time. Additional details can be found in our backup materials.

between mobile broadband consumers in 2021-2024 and the consumers in *Nevo et al.*'s sample (clearly a highly conservative approach). The results are presented in Table 20. As can be seen from the bottom two rows of the table, this method yields valuations per subscriber per month that are well over [redacted] for T-Mobile subscribers in every year, and over [redacted] for Sprint subscribers in every year but 2021— when the value is [redacted] per sub-per month.

Table 20: Valuation of Throughput Improvements:
No Usage or Mix Change, Unadjusted *Nevo et al.* Estimates

[redacted]

139. Using our baseline model, these valuations for consumers of both firms are well above the threshold quality levels (reported in Table 17 above) for all years and all model specifications, which indicates that the proposed merger is procompetitive and consumer-welfare enhancing.

140. Shifting all the way to the most conservative case—which has a quality valuation threshold of [redacted] per subscriber per month in 2021, but negative thresholds in 2022-2024—the T-Mobile quality valuation is far above the threshold, while the Sprint quality valuation is slightly below it. For this extreme case in 2021, we plot the critical quality

frontier, showing all combinations of T-Mobile and Sprint valuations that imply the proposed merger is procompetitive and consumer-welfare enhancing. As seen in Figure 18, the actual consumer valuations implied by the unadjusted *Nevo et al.* values are well above the critical quality frontier, implying that the merger is procompetitive even in this most conservative case.

Figure 18: Unadjusted *Nevo et al.* WTP Compared to Critical Quality Frontier: No Usage or Mix Change (2021)

141. As a second approach to using *Nevo et al.* to determine the relevant consumer valuations, we do a version of the calculation that adjusts for the fact that the throughput and usage levels in our data are different from those in *Nevo et al.* In particular:

- Before applying the *Nevo et al.* valuations, we rescale the throughputs observed in our data so that the weighted average throughput experienced by standalone T-Mobile and Sprint customers in our data match the mean throughput in *Nevo et al.* This rescaling is equivalent to interpreting the *Nevo et al.* quality valuations as capturing the value placed on percentage improvements relative to the mean, rather than absolute throughput improvements. For example, if the average throughput is 25 Mbps for one set of consumers at one point in time and 50 Mbps for another set of consumers at another point in time, then our assumption is that the value of doubling throughput from 25 Mbps to 50 Mbps in the first case has the same value as doubling throughput from 50 Mbps to 100 Mbps in the second case.

- We change the parameter in the *Nevo et al.* model that determines data usage per subscriber per month so that the data usage implied by the model matches the usage in our simulation analysis (the constrained usage for both the standalone firms and New T-Mobile in this scenario). We allow this parameter to differ for T-Mobile and Sprint so that we match the projected usage for each brand.[154]

142. The results for this case are presented in Table 21. Starting in 2022, this method yields valuations over [redacted] per subscriber per month and growing for Sprint customers and over [redacted] for T-Mobile customers. In 2021, when the average throughput gaps between the

[154] We must specify a throughput level to do this calibration. We use throughput at the combined firm, which yields slightly lower valuations than if we were to use throughputs at the standalone firms.

networks are smaller, valuations are somewhat lower: [redacted] for T-Mobile customers and [redacted] for Sprint customers.

Table 21: Valuation of Throughput Improvements:
No Usage or Mix Change, Adjusted *Nevo et al.* Estimates

[redacted]

143. Once again, using our baseline model, these valuations *for consumers of both firms* are well above the threshold quality levels for all years and all model specifications (most of which are negative), meaning that the average consumer valuation of quality improvements must be above the critical threshold, and thus the merger is procompetitive and welfare enhancing.

144. Shifting all the way to the most conservative case—which has a quality valuation threshold of [redacted] per subscriber per month in 2021, but negative thresholds in 2022-2024—the T-Mobile quality valuations are far above the relevant thresholds, while the Sprint quality valuation is below the threshold in 2021. Once again, we plot the critical quality

frontier for this extreme case in 2021, showing all combination of T-Mobile and Sprint valuations that mean the merger is procompetitive and consumer-welfare enhancing. As seen in Figure 19, the consumer valuations implied by the adjusted *Nevo et al.* values are far above the critical quality frontier, implying that the merger is procompetitive even in this most conservative case.

Figure 19: Adjusted *Nevo et al.* WTP Compared to Critical Quality Frontier: No Usage or Mix Change (2021)

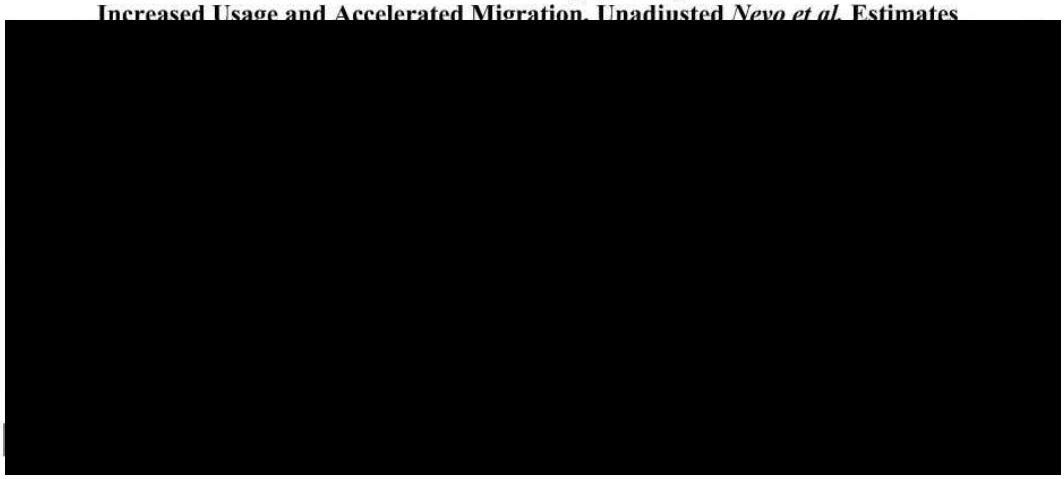
2. Consumer Valuations of Quality Improvements if New T-Mobile Relaxes Usage Restrictions and Accelerates Migration to 5G

145. We next consider an alternative scenario in which New T-Mobile uses its reduced 5G network costs and expanded 5G capacity as a way to relax the usage restrictions and

accelerate customer migration from LTE to 5G. In this case, marginal cost savings are slightly lower (because New T-Mobile has to incur greater costs to serve the additional traffic on its 5G network triggered by relaxing usage restrictions and accelerating user migration), so the critical network valuations are slightly higher, as shown above. However, the quality improvements are larger: They incorporate not just throughput improvements but also relaxed usage restrictions and greater numbers of consumers enjoying the benefits of 5G, which together likely generate substantial consumer valuation, as explained above.

146. First, consider the throughput increases. We again apply the two methods (unadjusted and adjusted *Nevo et al.* estimates) described above. Applying the unadjusted *Nevo et al.* results yields the results in Table 22. The valuations in this case are generally slightly higher than those in the first scenario, shown above.

Table 22: Valuation of Throughput Improvements:
Increased Usage and Accelerated Migration, Unadjusted *Nevo et al.* Estimates



147. Next consider the adjusted version of *Nevo et al.* In this case, our adjustment of the average throughput level to match that in *Nevo et al.*'s data stays the same as described for our base scenario, above. However, we adjust *Nevo et al.*'s usage parameter to match the

unconstrained usage level (rather than the constrained level) in each year for each standalone network.[155] This allows for the fact that the higher usage levels in this case allow consumers to enjoy New T-Mobile's increased throughput over a greater amount of data usage. Table 23 shows the results. Not surprisingly, the valuations go up significantly relative to the unadjusted case, due to the benefit of increased throughput over a greater amount of usage. By 2024, for example, consumer valuation of the throughput improvements is more than [redacted] per subscriber per month for T-Mobile subscribers, and more than [redacted] per subscriber per month for Sprint subscribers.

Table 23: Valuation of Throughput Improvements:
Increased Usage and Accelerated Migration, Adjusted *Nevo et al.* Estimates

[redacted]

[155] As before, we do this calibration at the throughput of the combined firm, which yields lower valuations than if we were to calibrate this value at the throughput of the standalone firms.

148. Notably, for both the unadjusted and adjusted *Nevo et al.* results in this scenario, the value of increased throughput for customers of both firms is greater than the critical value for all years, even for the most conservative version of our model. This means that the average value of the increased throughput is necessarily greater than the critical level for all years for all model specifications.

149. In summary, in this expanded usage/faster-migration-to-5G case, the proposed merger is necessarily procompetitive and consumer-welfare enhancing even before considering the value on the increased usage (other than indirectly through its effect on the value of higher throughput) or the value of faster migration to 5G. And this result follows even though the valuation of those unaccounted-for dimensions of quality improvement are likely to be substantial. Table 24 below shows the projected usage levels in the restricted-usage case (matching the standalone firms) and the expanded-usage case. The increases in usage are substantial. For example, for the two years in which any quality improvements are ever required for the merger to be procompetitive—2021 and 2024—the average usage increases are roughly [redacted] percent and [redacted] percent, respectively. If consumers would pay even [redacted] percent more for those substantial usage increases, the additional value would be more than [redacted], pushing the quality improvement that much farther beyond the critical threshold.[156] Notably, the total monthly cost of this alternative case (in levelized capex and opex) is less than [redacted] per subscriber in all years, making it highly likely that New T-Mobile will pursue this case with its large consumer benefits.

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156 As noted above, we continue to work on developing quantitative estimates of the value on this expanded usage.

Table 24: Usage by Network and Year

150. In sum, once one accounts for the proposed merger's projected quality improvements, it is clearly procompetitive and consumer-welfare enhancing in all years and for all specifications of our market equilibrium model. In 2022 and 2023, the merger's projected marginal cost savings alone are enough to render the merger procompetitive. In 2021 and 2024, only small quality improvements are required in addition to the marginal cost savings to render the merger procompetitive, and, in some model specifications, the marginal cost savings alone are sufficient for the merger to be procompetitive. Consumers' valuation of the merger's projected quality improvements will easily surpass the quality thresholds even when failing to account for some important dimensions of quality improvements. Moreover, these results hold even using estimates for quality based on historical data, which very likely substantially understate the benefits consumers will realize from improved network quality over this time period.

151. Finally, our findings on the relative qualities of the standalone and New T-Mobile networks demonstrate that substantial consumer benefits from the merger are likely to persist, or even grow, in the years after 2024. Several factors support this conclusion:

- The gap between the usage per subscriber that the standalone firms can support—based on projections of standalone usage trends by Sprint and projections based on financial constraints by T-Mobile—and the unconstrained consumer demand for usage

is increasing over time, as seen in Table 24. In 2021, the unconstrained demand is projected to be roughly [redacted] percent of the constrained usage served by the standalone firms; by 2024 the unconstrained demand is projected to be roughly double the constrained usage served by the standalone firms. And even as the unconstrained demand grows dramatically from 2022-2024, the usage that standalone T-Mobile can support—given its financial constraints—is roughly flat. In contrast, as explained above, New T-Mobile can support the unconstrained usage within its financial constraints and doing so would likely generate large consumer benefits.

- Even in the scenario in which New T-Mobile serves the unconstrained usage per subscriber, while the standalone networks fall further behind, the relative throughput gap between New T-Mobile and the standalone firms grows from 2021 to 2024. As seen in Table 22, in the scenario in which New T-Mobile relaxes usage constraints, the relative throughput of the combined network goes from [redacted]-times standalone T-Mobile in 2021 to [redacted]-times standalone T-Mobile in 2024, and from [redacted]-times standalone Sprint in 2021 to [redacted]-times standalone Sprint in 2024. These comparisons provide further evidence that the gap between the networks will grow over the time period we have studied.

- The Sprint 5G coverage gap relative to new T-Mobile is also very unlikely to go away given the fact, explained above, that standalone Sprint cannot profitably invest in closing the coverage gap given its current scale.

- Finally, as explained above, consumer valuation of these elements of network quality will surely increase over time, as the application ecosystem expands to make fuller use of the capabilities of 5G networks.

In sum, the combination of persistent large gaps in permitted usage, network throughput, and coverage, coupled with growing consumer valuation of network quality, implies persistent, or even growing, consumer benefits from the network enhancements created by the merger.

VII. CONCLUSION

152. In this declaration, we have applied a rigorous analytical framework that uses standard merger-analytic economic tools to assess the effects of the proposed merger from 2021 onward, accounting both for the loss of Sprint as an independent network operator and for the marginal cost savings and network quality improvements projected by the Parties' business plans and Network Build Model. This analysis clearly demonstrates that the projected combination of lower marginal costs and higher network quality would prevent any adverse unilateral competitive effects. In short, the merger will strengthen competition and benefit consumers.

APPENDIX I: TECHNICAL APPENDIX

A. FORMAL DESCRIPTION OF THE MARKET EQUILIBRIUM MODEL

153. As described in Section II.A, we use a nested logit model to model consumer demand for wireless products. Formally, we assume that are J wireless products together with an outside good on the market that can be assigned to G exhaustive and mutually exclusive nests. In this model, consumer i who chooses wireless product j in nest g receives the following indirect utility

$$u_{ij} = \delta_j - \alpha p_j + \left(\zeta_{ig} + (1 - \sigma_g)\epsilon_{ij}\right)$$

where

- δ_j is the product-specific quality parameter that captures non-price attributes of wireless product j;
- α is the price-sensitive parameter that measures consumers' marginal utility of income and how strongly consumers react to changes in price of wireless product j, p_j;
- σ_g is a nesting parameter that measure the degree of substitutability between wireless products within nest g; and
- ϵ_{ij} is an extreme value random variable, and for consumer i, the variable ζ_{ig} is common to all products in nest g and has a distribution function that depends on σ_g, with $0 \leq \sigma_g < 1$. Collectively, the term $\zeta_{ig} + (1 - \sigma_g)\epsilon_{ij}$ is the "error-term" in the model that characterizes the idiosyncratic taste of each consumer.

We assign the $J + 1$ products into the following five nests: (i) postpaid brands controlled by T-Mobile and Sprint; (ii) postpaid brands controlled by all other operators; (iii) prepaid brands

controlled by mobile network operators (MNOs); (iv) prepaid brands controlled by MVNOs; and (v) an outside good.

154. We assume that there is a nesting parameter σ_1 that is common for the two postpaid nests and that there is another nesting parameter σ_2 that is common for the two prepaid nests. Without loss of generality, we can normalize the product-specific quality parameter and the nesting parameter for the outside good to be 0. Under these assumptions, the nested logit demand model can be fully characterized by the $J + 3$ parameters $(\delta_1, \delta_2, \dots, \delta_J, \alpha, \sigma_1, \sigma_2)$, and the market share of wireless product j in nest g can be expressed as

$$s_j(p) = \frac{\exp\left(\frac{\delta_j - \alpha p_j}{1-\sigma_g}\right)\left(\sum_{k\in g}\exp\left(\frac{\delta_k - \alpha p_k}{1-\sigma_g}\right)\right)^{-\sigma_g}}{\sum_{g'=0}^{G}\left(\sum_{l\in g'}\exp\left(\frac{\delta_l - \alpha p_l}{1-\sigma_{g'}}\right)\right)^{1-\sigma_{g'}}}$$

155. Similar to HBVZ, we use a differentiated Bertrand model to analyze carriers' pricing decisions. Unlike HBVZ, however, our model explicitly allows for upstream wholesale pricing incentive to affect downstream retail pricing decisions. Specifically, we assume that the expected profit of carrier f takes the following form

$$\pi_f(p) = \sum_{j\in J_f}(p_j - c_j)s_j(p) + \sum_{l\in L_f} M_l^U s_l(p)$$

where

- J_f is the set of downstream retail wireless products controlled by carrier f;
- L_f is the set of downstream retail MVNO products (if any) operating on carrier f's network;
- c_j is the downstream marginal cost to serve an additional subscriber of product j; and

- M_l^U is the upstream wholesale markup that carrier f receives on each subscriber of MVNO product l.

156. Given the prices set by other carriers and its upstream wholesale margin, carrier f chooses a price p_j for each $j \in J_f$ to maximize its expected profit. The optimal price p_j must satisfy the following profit maximizing first-order necessary condition:

$$\frac{\partial \pi_f(p)}{\partial p_j} = s_j(p) + \sum_{k \in J_f} (p_k - c_k) \frac{\partial s_k(p)}{\partial p_j} + \sum_{l \in L_f} M_l^U \frac{\partial s_l(p)}{\partial p_j} = 0$$

The Nash equilibrium of this model is a vector of prices $p = (p_1, p_2, \ldots, p_J)$ such that the above first-order condition is satisfied for each of the J products. This system of J equations can be written in matrix notation as

$$s(p) + H \cdot (p - c) + F \cdot M^U = 0$$

where H is a $J \times J$ matrix whose ij^{th} component is equal to $\partial s_j(p)/\partial p_i$ if both product i and product j are controlled by the same carrier and it is equal to 0 otherwise, and F is a $J \times J$ matrix whose ij^{th} component is equal to $\partial s_j(p)/\partial p_i$ if product j is an MVNO product operating on the network of the carrier that controls product i and it is equal to 0 otherwise.

157. The parameters of the market equilibrium model are calibrated as follows:

- The J product-specific quality parameters $(\delta_1, \delta_2, \ldots, \delta_J)$ are chosen such that the model predicted market shares match the observed market shares;
- The price sensitive parameter α is chosen such that the predicted average margin across all Sprint and T-Mobile products matches their average margin observed in the data;

- The postpaid nesting parameter σ_1 and the prepaid nesting parameter σ_2 are chosen such that the predicted average diversion ratio between Sprint postpaid and T-Mobile postpaid products and the predicted average diversion ratio between Sprint prepaid and T-Mobile prepaid products match the corresponding average diversion ratios observed in the data;[157]
- Finally, the share of the outside good is chosen such that the predicted industry elasticity of demand matches our assumed values of industry elasticity (see Section II.A.1 for a discussion of industry elasticities).

158. Once these parameters are calibrated, the market equilibrium model provides an analytical mapping between the observed prices and shares and the unknown marginal costs $c = (c_1, c_2, \ldots, c_J)$. To see this, note that the system of equations characterizing the equilibrium can be rearranged as

$$c = p - H^{-1} \cdot (s(p) + F \cdot M^U)$$

and we use this expression to recover the downstream marginal costs that are consistent with observed data and the market equilibrium model.

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157 We compute the diversion ratio from Sprint postpaid to T-Mobile postpaid as the fraction of all Sprint postpaid subscribers diverted to any T-Mobile postpaid product as a result of an increase in the prices of all Sprint postpaid products by the same percentage. That is, let A be the set of Sprint postpaid products and let B be the set of T-Mobile postpaid products. The diversion ratio from Sprint postpaid to T-Mobile postpaid is calculated as

$$Div_{AB} = -\frac{\sum_{j\in B}\sum_{k\in A}\frac{\partial}{\partial p_k}\left(\frac{s_j}{1-s_0}\right)}{\sum_{j\in A}\sum_{k\in A}\frac{\partial}{\partial p_k}\left(\frac{s_j}{1-s_0}\right)} = -\frac{\sum_{j\in B}\sum_{k\in A}\left(\frac{\partial s_j}{\partial p_k}\right)+\sum_{j\in B}\sum_{k\in A}\frac{s_j}{1-s_0}\left(\frac{\partial s_0}{\partial p_k}\right)}{\sum_{j\in A}\sum_{k\in A}\left(\frac{\partial s_j}{\partial p_k}\right)+\sum_{j\in A}\sum_{k\in A}\frac{s_j}{1-s_0}\left(\frac{\partial s_0}{\partial p_k}\right)}.$$

The diversion ratio in the other direction, as well as the diversion ratios for prepaid products, are calculated similarly.

B. FORMAL DESCRIPTION OF OUR TREATMENT OF MVNO PRICING INCENTIVES

159. We rely on KPMG StreamShare data to obtain estimates of current MVNO subscriber counts.[158] KPMG StreamShare data provide estimates of subscriber counts for TracFone and for an agglomeration of MVNOs that purchase wholesale network service from Sprint that is collectively referred to as "Sprint Resellers" in the data. We model TracFone as a multi-product firm that controls three distinct retail products that are dependent on the wholesale network services provided by AT&T, Verizon, and T-Mobile, respectively.[159] We divide the subscribers of TracFone based on a T-Mobile document estimating the relative shares of traffic on the three networks: [redacted] percent to Verizon, [redacted] percent to AT&T, and [redacted] percent to T-Mobile.[160] We model Sprint Resellers as a single firm and conservatively assume that Sprint Resellers do not have an option to substitute away from Sprint in the event that Sprint raises its wholesale price post-merger.

160. Our alternative Market Equilibrium Model integrates our analyses of horizontal and vertical pricing incentives in three ways. First, as discussed in Section II.A.1 above and Part

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158 KPMG Streamshare Data, IKK Exhibit 5.

159 These are modeled as wholly owned TracFone products and are only associated with the MNOs through their wholesale agreements.

In the data, we refer to these products as AT&T TracFone, Verizon TracFone, and T-Mobile TracFone. In practice, TracFone maintains several consumer brands that largely correspond to the network on which they run. For example, we understand that Straight Talk and Total Wireless run mainly on the Verizon network; Net 10 runs mainly on the AT&T network; and GoSmart, Walmart Family Mobile, and Simple Mobile run exclusively on the T-Mobile network. (T-Mobile, "TracFone Payload Contribution," May 30, 2018, TMOPA_02814121_00000001; *HBVZ Declaration* §VII.A.)

160 T-Mobile, "TracFone Payload Contribution," May 30, 2018, TMOPA_02814121_00000001.

A of Appendix I below, MNOs internalize their wholesale margins when setting their retail prices: an MNO realizes that when raising its retail price, some of the departing subscribers will divert to an MVNO served by its network and the MNO will capture the associated wholesale margin. Second, we correct for several technical errors that HBVZ made in their vGUPPI calculations and implement the vGUPPI calculations for T-Mobile TracFone and Sprint Resellers using inputs that are consistent with our alternative Market Equilibrium Model.[161] We then apply a pass-through rate to the calculated vertical upward pricing pressure (vUPP), and increase the marginal costs of the affected MVNOs post-merger by the resulting amount. Third, our model allows MNOs to pass through a share of the merger-specific network marginal cost savings, which is a function of the strength of competition that they face. Unlike HBVZ, our model recognizes that network marginal cost efficiencies will put downward pressure on wholesale prices.

161. To compute the vGUPPIu, we first calibrate our alternative Market Equilibrium Model in the absence of the merger. Each of the components of the vGUPPIu is an input into the model, or can be directly inferred from the calibrated model. We define the vGUPPIu, under the assumption of no input substitution, as:[162]

$$vGUPPIu \text{ without input substitution} = DR_{UD} \times M_D \times P_D / W_R$$

Using T-Mobile TracFone as an example, DR_{UD} is the diversion ratio from T-Mobile TracFone to Sprint controlled products and wholesale partners, M_D is the percentage margin

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161 See Section II.A.1 of this Declaration.

162 *See* Serge Moresi & Steven C. Salop (2013) "vGUPPI: Scoring Unilateral Pricing Incentives in Vertical Mergers," *Antitrust Law Journal,* **79**(1): 185-214.

Sprint makes on each of those products, and P_D is the price Sprint charges per subscriber of each of those products. Thus, $DR_{UD} \times M_D \times P_D$ is the value of sales diverted to Sprint from T-Mobile TracFone. Because Sprint is a multi-product firm, we compute this value as the sum of diverted profit margins across all—both retail and wholesale—Sprint products. The last term, W_R, is the wholesale input price T-Mobile charges TracFone. We repeat this calculation for Sprint Resellers with respect to profit margin recapture among T-Mobile retail and wholesale products.

162. Following HBVZ, we also calculate a version of vGUPPIu that allows for input substitution by TracFone (as noted above, we conservatively assume that Sprint Resellers do not have the option to substitute away from Sprint). In response to an increase in the T-Mobile wholesale price, TracFone can adjust retail prices to shift consumers away from the T-Mobile network and toward the AT&T and Verizon networks, which affects the extent of vertical upward pricing pressure. This version of vGUPPIu is defined as:

$$vGUPPIu \text{ with input substitution} = \frac{vGUPPIu \text{ without input substitution}}{1 + M_R \times E_{SR} \,/\, E_P}$$

where M_R is T-Mobile TracFone's retail margin, E_{SR} is the percentage change in T-Mobile TracFone's share of total TracFone subscribers in response to a percentage change in the wholesale price, and E_P is the percentage change in T-Mobile TracFone's retail price in response to a percentage change in the wholesale price. The T-Mobile TracFone retail margin can be inferred directly from the calibrated model. We estimate E_{SR} and E_P in our model by artificially increasing the input price to T-Mobile TracFone, simulate the new equilibrium,

and then compare the product shares and retail prices in the new equilibrium to those observed in the data.

163. In the alternative merger simulation model, we assume the vUPP implied by the vGUPPI is passed through to the MVNO at some rate ([redacted] percent in our baseline case). We also model the effect of merger efficiencies on the pricing incentives of MVNOs and MNOs. If the merger causes network marginal costs to fall, the MNOs will have an incentive to pass through some share of those marginal cost savings to MVNOs via lower wholesale prices. The network model implies reductions in network marginal cost savings per GB, which we multiply by the standalone usage rate per subscriber for each of the affected MVNOs to get a per-subscriber wholesale marginal cost reduction. We assume this efficiency is passed through at the same rate as the vGUPPI.

164. The MVNO's marginal cost increases by the vUPP less efficiencies, times the pass-through rate. On net, the MVNO's marginal cost may increase or decrease. Therefore, the merger may put upward or downward pressure on MVNO retail prices, which we explicitly model. At the same time, the MNO's wholesale dollar margin increases by the vUPP times the pass-through rate, plus the wholesale marginal cost efficiency multiplied by one minus the pass-through rate. This makes an MVNO subscriber on the MNO's network more valuable to the MNO, creating an incentive for the MNO to raise its retail prices post-merger. These various wholesale and retail pricing incentives are explicitly accounted for in the alternative merger simulation model, and the net effect on consumers is computed in the post-merger equilibrium.

C. MERGER SIMULATION CALIBRATION DATA

165. Calibrating the key parameter of the Market Equilibrium Model requires the following key data points:

- Pre-merger shares
- Pre-merger prices
- Pre-merger margins
- Diversion ratios
- Industry elasticities.

As described further below, we calibrate the model using projected future values of these parameters drawn from the Parties' ordinary course documents and business plans.

166. By using projections of the post-integration shares and margins to calibrate our model, our merger analysis compares the predicted industry equilibrium for a world in which the merger is consummated with the predicted equilibrium in a world in which the merger does not occur. This approach allows us to incorporate the industry's views about expected future industry trends, thus ensuring the model is consistent with the views that the Parties and other industry participants hold about the non-merger baseline in future years.

1. Shares and Prices

167. Table 25 reports shares and prices for each mobile wireless brand that we model. We derive these values from the Parties' ordinary course standalone business plans. Specifically, we derive these values using the information contained in Build 8.0 of the Parties transaction

model.[163] This model incorporates information from the Parties ordinary course standalone business plans and other competitive analysis.[164] It therefore reflects the best estimates of what the industry would look like in future years in the absence of the merger.

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163 It is our understanding that Build 8.0 reflects the Board-approved plan, while Build 9.0 explores additional revenue opportunities. For the variables for which we rely on the financial model, Builds 8.0 and 9.0 are identical. We therefore cite to Build 8.0 throughout this declaration.

164 To compute these shares, we use the estimated present and future subscriber counts contained in the Build 8.0 model for the Parties' own brands and those in the T-Mobile Competitive Intelligence database (TMUS-DOJ-00045329) for brands owned by AT&T, Verizon, and US Cellular. We also rely on KPMG StreamShare data to obtain estimates of present MVNO subscriber counts. (See IKK Exhibit 5 in our backup materials.) We apply the projected industry growth rates in Build 8.0 to the present total subscriber base to estimate the growth of the total subscriber base, which then allows us to impute future subscriber counts for brands for which we do not have estimates.

Table 25: Shares and ARPU[165]

168. We use average revenue per user (ARPU) as a proxy for price in the model. Although ARPU is not literally the price that any specific user pays, it represents the revenue that mobile wireless plans derive from selling services to customers. Moreover, the Parties use

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165 We include Virgin in the Sprint Prepaid category and Cricket in the AT&T Prepaid category. We also note that we generally use lower shares for MVNOs than do HBVZ, which makes our analysis conservative on that dimension. Specifically, HBVZ assume that there are 43 million MVNO subscribers in 2017. (*HBVZ Declaration,* Table 13.) By contrast, the data we use to calculate shares reports 33 million MVNO subscribers in 2018 and 30 million in 2021. (See backup materials for details.) These share estimates may understate future competition from cable providers.

ARPU in their CLV models (described further in Part C.2 of Appendix I) from which we calculate margins, as we describe in the next section. Thus, the model uses consistent assumptions about price and margin.[166]

169. As Table 25 shows, the Parties expect ARPU to be [redacted] over the next several years.[167] These projections reflect a continuation of recent industry experience. For example, Figure 20 demonstrates that while postpaid ARPU has [redacted] in recent years, this is largely a function of [redacted] ABPU, which accounts for both subscription and device costs has been [redacted] Similarly, prepaid ARPU has been [redacted] over the past few years.

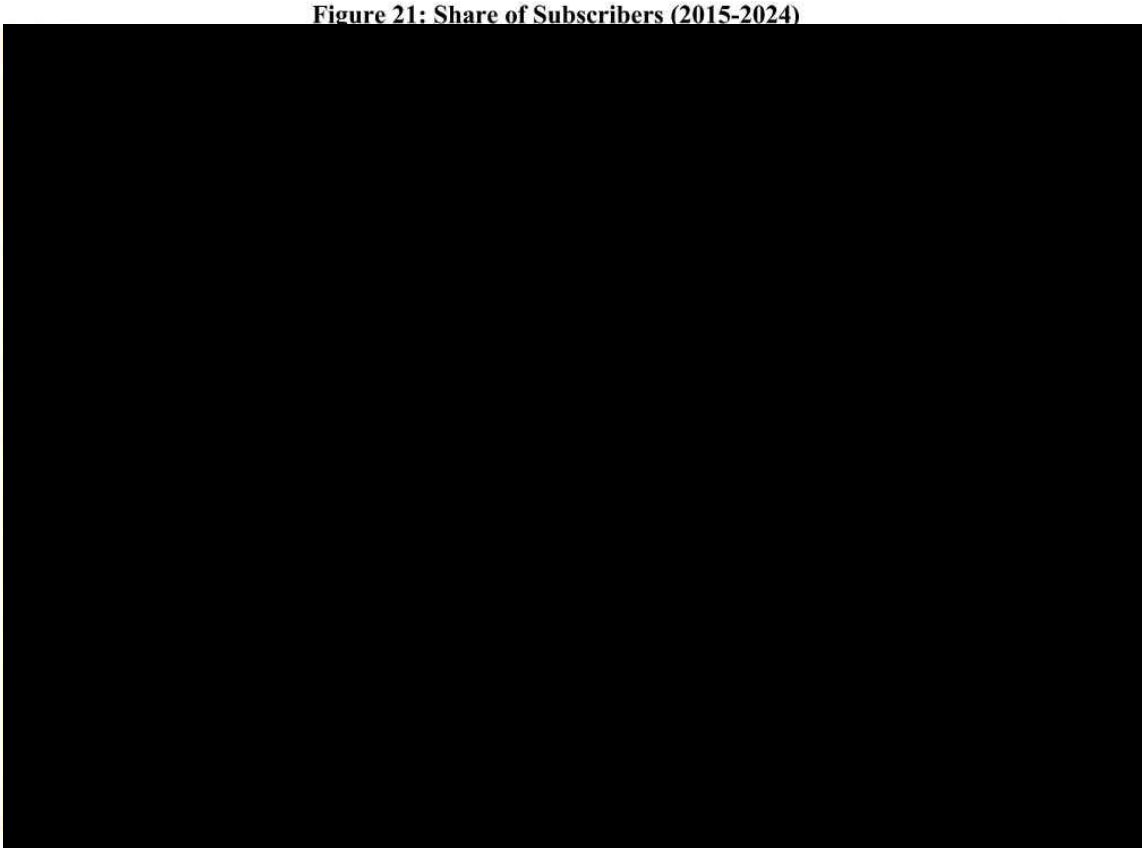
166 ARPU does not include revenues associated with leasing devices. We understand that the Parties do not earn substantial profits on device leasing. For example, the Parties lose money when leasing iPhones. As such, revenues and costs associated with device leasing are treated as a net cost in calculating margins. If one were to include device leasing revenue into the relevant price, e.g., by using average billings per user (ABPU), one would also need to make corresponding changes to the relevant margin calculations.

167 We use the projected ARPUs contained in Build 8.0 for the Parties' own brands and those in the T-Mobile Competitive Intelligence database (TMUS-DOJ-00045329) for brands owned by AT&T, Verizon, and US Cellular. We use the ARPU reported in América Móvil's 2018Q2 financial report for TracFone and other MVNOs (América Móvil News Release, "América Móvil's second quarter of 2018 financial and operating report," July 17, 2018, *available at* http://www.americamovil.com/sites/default/files/2018-07/2q18-report.pdf, *site visited* September 10, 2018).

Figure 20: ARPU and ABPU (2014-2022)

170. Figure 21 shows the trends in shares. The Parties' ordinary course documents project continuing increases in T-Mobile's shares. They also predict modest increases in Sprint's share. Our merger simulation model accounts for these projections by calibrating the model in each year to the relevant values for the year.

Figure 21: Share of Subscribers (2015-2024)



2. Margins

171. To compute margins, we use each Party's ordinary course of business customer lifetime value (CLV) model.[168] These models calculate the net present value of each customer accounting for the expected lifetime of the subscriber, the revenue over that lifetime, and

[168] T-Mobile, Unit Economics, May 2018, TMOPA_04647889_00000002; SPR-FCC-01965935; IKK Exhibit 6; Sprint FCC Information Request, Response 31 – Exhibit 21; Sprint FCC Information Request Response 31 – Exhibit 18.

incremental costs over that lifetime.[169] Incremental costs include customer acquisition and upgrade costs, non-network recurring costs that include customer care and billing costs, and incremental network costs.[170]

172. To calculate margins for use in the merger simulation model, we adjust each Party's CLV model, which is based on current data, to incorporate predicted future revenue, non-network costs, network costs, and churn. Specifically, we use future projected ARPU, non-network costs, acquisition and upgrades costs, and churn drawn from Build 8.0 of the financial model.[171] In addition, we use the standalone marginal network costs per subscriber derived from the network model that we describe in more detail in Section IV.A. Table 26 reports the CLV margins for each Sprint and T-Mobile brand for 2021 through 2024.

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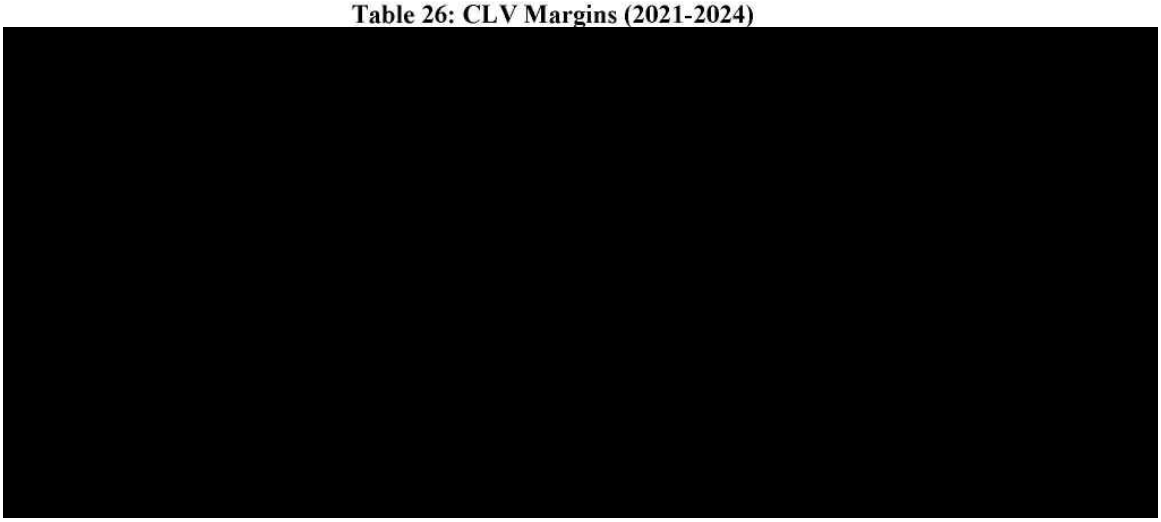
169 We follow the Parties' ordinary course practice of assuming a customer lifetime equal to [redacted] months. Consistent with Build 8.0, we assume that T-Mobile's weighted average cost of capital (WACC) is [redacted] percent and Sprint's WACC is [redacted] percent.

170 CLV is equal to the net present value of recurring monthly margin minus incremental network cost minus subscriber acquisition and upgrade costs. The present value of the recurring monthly margin is equal to monthly ARPU minus monthly non-network recurring costs multiplied by the discounted present value of customer lifetime.

171 Financial Model Build 8.0, TMOPA_08060379_00000001.

We adjust these ARPU estimates to account for the fact that the ARPU in the financial model is averaged over all subscribers, while the ARPU in the CLV model is averaged over gross adds.

Table 26: CLV Margins (2021-2024)



3. Diversion Ratios

173. Diversion ratios are a common measure of the extent of direct competition between merging firms. A diversion ratio measures the fraction of the total unit sales that Firm A loses when it raises its price or lowers its product quality that divert (i.e., switch) to Firm B. In previous mobile telecom merger reviews, the Commission estimated diversion ratios using porting data; porting data tracks all users who port their numbers when switching from one mobile network operator to another. Although the Commission has used porting data to estimate diversion ratios, it recognizes that there are several potential problems with this approach.[172]

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172 For a discussion of potential issues with the use of porting data to estimate diversion ratios, see *AT&T/T-Mobile Commission Staff Report*, Appendix C, ¶¶ 9-10.

For other examples of the use of porting data to review wireless telecom mergers, see Memorandum Opinion and Order and Declaratory Ruling, *In the Matter of Applications of Deutsche Telekom AG, T-Mobile USA, Inc., and MetroPCS Communications, Inc. for Consent to Transfer of Control of Licenses and Authorizations*, WT Docket No. 12-301, rel. March 12, 2013, n. 115; Memorandum Opinion and Order, *In the Matter of Applications of Cricket*

174. First, diversion ratios theoretically capture customer switching in response to changes in price or quality, but porting customers may switch for other reasons and the data do not contain any indication of the reason for a switch. It is widely recognized by antitrust practitioners that porting data will provide biased estimates of diversion ratios when switching behavior (which carrier the customer switches to) is different depending on the reason for the switch.[173] However, we find that porting rates following pricing promotions by Sprint and T-Mobile (which should be influenced by price changes) generally are similar to the porting rates immediately before the promotions (which are not influenced by price changes).[174] This finding supports the conclusion that diversion ratios based on porting data are not systematically biased as a result of the reasons for porting.[175]

175. A second problem with using porting data to infer diversion ratios is that not all customers port their numbers when switching mobile network operators, and those who do port may not be representative of all switchers. We show below that this latter fact is present in the Local Number Portability ("LNP") porting data, which causes those data to overstate switching rates between Sprint and T-Mobile. Consequently, any merger analysis based on LNP porting data will overestimate the competitive effect of the merger.

License Company, LLC, et al., Leap Wireless International, Inc., and AT&T Inc. for Consent To Transfer Control of Authorizations Application of Cricket License Company, LLC and Leap Licenseco Inc. for Consent to Assignment of Authorization, WT Docket No. 13-193, ¶ 70.

173 See, e.g., Yongmin Chen and Marius Schwartz (2016), "Churn vs. Diversion: An Illustrative Model," *Economica*, **83**(332): 564-583.

174 We provide details of this analysis in our backup materials.

175 Commission Staff came to a similar conclusion when analyzing the proposed merger between AT&T and T-Mobile. (*AT&T/T-Mobile Commission Staff Report*, ¶ 55, n. 160.)

176. We show that the LNP porting data are unreliable for purposes of computing diversion ratios in several ways. First, LNP porting data account for only a small percentage of total gross additions and deactivations. In the second half of 2017, the LNP data report [redacted] port-ins and port-outs, which is just [redacted] percent of the [redacted] total gross additions and deactivations in the same time period.[176] Second, the LNP porting systematically overstate Sprint and T-Mobile switches relative to total gross additions and deactivations. Table 27 below shows that, although Sprint accounts for [redacted] of gross adds and [redacted] percent of switch-ins in the Harris survey data that T-Mobile uses internally, Sprint accounts for [redacted] percent of port-ins in the LNP data. Similarly, T-Mobile accounts for [redacted] of port-ins in the LNP data ([redacted] percent) than its share of gross adds ([redacted] percent) or switch-ins in the Harris survey data ([redacted] percent).[177]

176 T-Mobile, Industry GA estimates based on carrier financials. See our backup materials for details.

177 With respect to the comparison of gross deactivations and port-outs, Sprint's share of deactivations is [redacted] percent while its share of port-outs is [redacted] percent and T-Mobile's share of deactivations is [redacted] percent while its share of port-outs is [redacted] percent.

Table 27: Comparison of Gross Adds, Switch-Ins, and Port-Ins

177. Finally, Sprint and T-Mobile offer incentives to customers to port their numbers when switching to the firms' prepaid brands, while MVNOs such as TracFone do not offer such incentives.[178] Porting data, which only capture the switchers who port their numbers, thus likely over-represent diversion between Sprint and T-Mobile. In particular, TracFone, which accounts for approximately 31 percent of prepaid subscribers and runs primarily on AT&T's and Verizon's networks, is likely under-represented in the LNP data because it does not offer incentives to subscribers to port their numbers while switching to TracFone.[179] Because the

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178 T-Mobile, 2017 May Cheat Sheet, TMUS-DOJ-01053322; TMUS-FCC-01014607.

179 T-Mobile estimates that approximately [redacted] percent of TracFone traffic runs on AT&T's and Verizon's networks with the remainder on the T-Mobile network. (T-Mobile, "TracFone Payload Contribution," May 30, 2018, TMOPA_02814121_00000001.)

LNP data attribute MVNO ports to the facilities-based carriers, porting activity for AT&T and Verizon is under-represented in these data relative to the activity for Sprint and T-Mobile causing diversion rates between Sprint and T-Mobile based on LNP data to be overestimated.

178. Table 28 below compares porting-based estimates of diversion ratios to several alternative methods for assessing diversion ratios, including:

- Assuming diversion is proportional to either the average of the share of gross additions and gross deactivations or the share of subscribers.[180]
- Estimating diversion ratios from survey data and reflecting the average of switch-in and switch-out rates.[181]

We find that porting-based diversion ratios between Sprint and T-Mobile are substantially larger than those derived from share and survey data. Generally, diversion ratios assumed to be proportional to average of the shares of gross activations and gross deactivations are similar in magnitude to diversion ratios derived from the survey data, while diversion ratios proportional to shares of subscribers are lowest among all sources. T-Mobile relies on the survey data for gaining insights into the overall switching patterns in the industry.[182]

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180 Under the assumption that diversion is proportional to shares, the diversion ration from product A to product B is: $Div_{AB} = \frac{S_B}{1-S_A}$.

181 We use two sources of survey data: (a) Sprint Brand IQ survey, which contains questions identifying previous, current, and future carriers for respondents, and (b) Harris Mobile Insights survey, which contains questions identifying previous and current carrier for recent switchers. (Sprint, Brand IQ survey, IKK Exhibit 7; Harris Mobile Insights survey, TMUS-DOJ-00001173.)

182 See, for example, T-Mobile's Q1 2018 Switchers Summary Report, which relies on data from Harris Mobile Insights survey to show the origin and destination of T-Mobile's gross addition and deactivations. (T-Mobile's Q1 2018 Switchers Summary Report, TMOPA_04879063_00000001.)

Table 28: Diversion Ratio Estimates

4. Industry Elasticity

179. An important dimension of substitution is subscribers entering or leaving the marketplace.[183] This margin of substitution can be captured through the industry elasticity. The industry elasticity measures the percentage change in total industry output given a one percent change in every firm's price. Higher industry elasticity implies lower diversion ratios between firms. With a relatively high industry elasticity, a price decrease by a single firm will cause some subscribers to switch from rival firms, but it will also cause some subscribers

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183 Although wireless penetration already exceeds 100 percent, ordinary course documents project continuing increases in the wireless penetration rate (defined as total wireless subscribers divided by total U.S. population). For example, T-Mobile documents project the wireless penetration rate to increase from [redacted] percent in 2018 to [redacted] percent in 2022. (TMUS-DOJ-00045329 ['IndustrySummary'].) Although this increase alone is not sufficient to calibrate an industry elasticity, it does demonstrate that substitution with the outside good is a relevant dimension of substitution.

to consume more of the product (data services in this case).[184] In our analysis, we consider a range of industry elasticities that are consistent with those estimated in the empirical academic literature as well as those used by the Commission in prior reviews of wireless mergers.

180. There is a large empirical literature in economics that has estimated industry elasticities for the wireless services in the U.S. and other countries. Estimates of industry elasticities for the U.S. range from -0.3 to -1.8.[185] In its review of the AT&T/T-Mobile merger, the Commission used an elasticity range of 0.0 (no substitution to the outside good) to -0.51 for its economic modeling.[186, 187] As described further in Section II.A.2, we use an

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184 See, for example, Serge Moresi and Hans Zenger (2017), "Aggregate Diversion and Market Elasticity," unpublished manuscript (hereinafter, *Moresi and Zenger*).

185 Caves obtains 2SLS and 3SLS estimates of elasticities between -1.6 and -1.8. (Kevin Caves (2011), "Quantifying Price-driven Wireless Substitution in Telephony," *Telecommunications Policy*, 35(11): 984-998, Table 2 and Table 3.) Hausman derives estimates of industry elasticity between -0.95 and -1.05. (Jerry Hausman (2011), "Consumer Benefits of Low Intercarrier Compensation Rates," Attachment 4 to Letter from Robert W. Quinn, Jr., AT&T, et al., to Marlene H. Dortch, Federal Communications Commission, *In the Matter of Connect America Fund*, WC Docket No. 10-90, filed July 29, 2011, at 12.) Ingraham and Sidak obtain a 2SLS estimate of -1.3. (Allan Ingraham and Gregory Sidak (2004), "Do States Tax Wireless Services Inefficiently? Evidence on the Price Elasticity of Demand," *Virginia Tax Review* 24(2): 249-261, Table 5.) Rodini, et al. estimate industry elasticities between -0.39 and -0.6. (Mark Rodini, Michael Ward, and Glenn Woroch (2003), "Going Mobile: Substitutability between Fixed and Mobile Access," *Telecommunications Policy*, 27(5-6): 457-476, Table 4.)

186 Commission Staff referenced the Rodini, Ward, and Woroch (2003) article in support of its range of –0.36 to –0.51 for industry elasticity. (*AT&T/T-Mobile Commission Staff Report*, Appendix C at C-7.)

187 *Moresi and Zenger* derive a relationship between industry elasticity and aggregate diversion ratio. For the case of symmetric aggregate diversions (*i.e.*, each firm losing the same proportion of sales to the outside good), the relationship is: *Aggregate Diversion Ratio = 1 – average industry margin × industry elasticity*. Assuming average margin of 50 percent and an industry elasticity of -0.36 (-0.51), implies an aggregate diversion ratio of 82 percent (75 percent).

industry elasticity of -0.3 in our baseline merger simulations. As a robustness check, we also consider industry elasticities of -0.1 and -0.5.

D. NETWORK MARGINAL COSTS PER GIGABYTE OF TRAFFIC

181. Figure 22 below shows the marginal cost curves for each of the three networks in 2021.[188] The ranking for marginal costs matches that for incremental total costs, with standalone T-Mobile the highest, Sprint substantially lower, and new T-Mobile near zero. For example, at [redacted] (the expected combined usage of the standalone networks), T-Mobile's marginal network costs are approximately [redacted], Sprint's marginal network costs are approximately [redacted], and New T-Mobile's marginal network costs are approximately [redacted].

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188 Network capacity is added in discrete increments. This lumpiness results in cost curves that are extremely non-linear and non-monotonic at low levels of traffic but more regular at relevant levels. Because these extreme non-linearities occur at traffic levels well below projected levels, they do not affect the analysis.

Figure 22: Marginal Costs per GB (2021)

182. Figure 23 below shows the marginal cost curves for each of the three networks in 2024. Again, the two standalone networks have higher marginal costs than does New-Mobile's network. The ranking of the three networks remains the same: At [redacted] (the expected combined usage of the standalone networks), T-Mobile's marginal network costs are approximately [redacted], Sprint's marginal network costs are approximately [redacted], and New T-Mobile's marginal network costs are approximately [redacted].

Figure 23: Marginal Costs per GB (2024)

APPENDIX II: QUALIFICATIONS

A. MARK ISRAEL

183. My name is Mark A. Israel. I am a Senior Managing Director at Compass Lexecon, an economic consulting firm where I have worked since 2006. From 2000 to 2006, I served as a full-time member of the faculty at Kellogg School of Management, Northwestern University. I received my Ph.D. in economics from Stanford University in 2001.

184. I specialize in the economics of industrial organization—which is the study of competition in imperfectly competitive markets, including the study of antitrust and regulatory issues—as well as applied econometrics. At Kellogg and Stanford, I taught graduate-level courses covering topics including business strategy, industrial organization economics, and econometrics. My research on these topics has been published in leading peer reviewed economics journals including the American Economic Review, the Rand Journal of Economics, the Review of Industrial Organization, Information Economics and Policy, and the Journal of Competition Law and Economics.

185. My work at Compass Lexecon has focused on the application of economic theory and econometric methods to competitive analysis of the impact of mergers, antitrust issues including a wide variety of single-firm and multi-firm conduct, class certification, and damages estimation. I have analyzed these competition issues on behalf of a wide range of clients, including private companies and government entities. I have testified in Federal court, multiple state courts, and in many regulatory and arbitration proceedings in the U.S. and around the world. I have presented my findings to both US competition agencies on dozens of occasions. I have also submitted expert reports, declarations, and affidavits to government agencies and Federal and state courts.

186. As one example of my work that is relevant to this case, I testified on behalf of the Federal Trade Commission in its successful lawsuit to enjoin the merger of Sysco Corp. and US Foods, two national broadline food distributors, in 2015.

B. MICHAEL L. KATZ

187. My name is Michael L. Katz, and I am the Sarin Chair Emeritus in Strategy and Leadership at the University of California at Berkeley. I hold a joint emeritus appointment in the Haas School of Business Administration and in the Department of Economics. I have also served on the faculties of the Department of Economics at Princeton University and the Stern School of Business at New York University. I received my A.B. from Harvard University *summa cum laude* and my doctorate from Oxford University. Both degrees are in Economics.

188. I specialize in the economics of industrial organization, which includes the study of antitrust and regulatory policies. I am the co-author of a microeconomics textbook, and I have published numerous articles in academic journals and books. I have written academic articles on issues regarding the economics of network industries (including telecommunications), systems markets (*i.e.*, markets in which consumers use multiple goods or services together to derive benefits, such as a mobile phone and wireless service), and antitrust policy enforcement. I am a co-editor of the *Journal of Economics and Management Strategy* and serve on the editorial board of *Information Economics and Policy*.

189. In addition to my academic experience, I have held several positions in government. I am currently a Senior Fellow in the Office of Healthcare Transformation in the Ministry of Health of Singapore. From January 1994 through January 1996, I served as the Chief Economist of the Federal Communications Commission. From September 2001 through

January 2003, I served as the Deputy Assistant Attorney General for Economic Analysis at the U.S. Department of Justice. My title as Deputy Assistant Attorney General notwithstanding, I am not an attorney.

190. I have consulted on the application of economic analysis to issues of antitrust and regulatory policy. I have served as a consultant to the U.S. Department of Justice, Federal Trade Commission, and Federal Communications Commission on such issues, and I have served as an expert witness before state and federal courts. I have also provided expert testimony before state regulatory commissions and the U.S. Congress.

C. BRYAN KEATING

191. My name is Bryan Keating and I am an Executive Vice President at Compass Lexecon. I received my Ph.D. in Economics from Stanford University in 2007.

192. I specialize in the study of industrial organization and applied econometrics. My research has been published in several journals, including the *Journal of Law and Economics*, the *Review of Industrial Organization*, and the *Review of Network Economics*. I have also contributed chapters to several books, including a chapter (with Mark Israel, Dan Rubinfeld, and Robert Willig) on the Delta-Northwest merger to the Antitrust Revolution, a chapter (with Robert Willig) on unilateral effects analysis to the forthcoming Oxford Handbook on International Antitrust Economics, and a chapter (with Chris Cavanaugh and Mark Israel) on Econometrics and Regression Analysis to the ABA Section of Antitrust Law, Proving Antitrust Damages, 3rd Ed.

193. I have been a consulting economist with Compass Lexecon since 2007. While at Compass Lexecon, I have conducted economic and econometric analysis in matters related to

antitrust litigation, arbitration/settlement discussions, regulatory matters (including telecommunications) and mergers. I have substantial experience designing and implementing complex econometric models using large-scale databases, especially in industries that involve differentiated products. I have analyzed issues relating to market definition, competitive effects, welfare analysis and merger simulation in a wide variety of industries including telecommunications, consumer products, computer software and hardware, airlines, health care, payment cards, and sports.