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March 18, 2019

By ECFS

Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, WT Docket No. 18-197

Dear Ms. Dortch:

In a letter filed March 11,¹ T-Mobile and Sprint (together, the “Applicants”) accuse DISH of going “out-of-bounds” in a further effort to distract from persistent questions about the claimed benefits of their proposed merger. In a second, more incendiary letter, filed March 14, the Applicants level false and baseless accusations against the Brattle Group’s estimate of consumer income in Cornerstone’s Nielsen Mobile Performance (“NMP”) data set.² But:

- Brattle’s income estimates are more realistic than those used by Cornerstone, which simply assumes that all consumers in the same zip code have the same income. Astoundingly, the Applicants try to tarnish Brattle’s work by observing that 76.9% of the incomes estimated by Brattle for consumers who reported an income range fell outside that range. Not only is this statistically unsurprising and consistent with standard statistical procedure, but Brattle actually scores *better* than Cornerstone: ***Cornerstone’s income estimates fall outside the range for 80.7% of those consumers. Further,***

¹ Letter from Nancy Victory, Counsel for T-Mobile, to Marlene H. Dortch, FCC, WT Docket No. 18-197 (March 11, 2019) (“T-Mobile March 11 Letter”).

DISH has denoted with **{{BEGIN HCI END HCI}}** information that is deemed to be Highly Confidential Information pursuant to the *Protective Order*. A public, redacted version of this filing is being filed with the Commission. Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, *Protective Order*, WT Docket No. 18-197, DA 18-624 (June 15, 2018).

² Letter from Nancy Victory, et al., Counsel for T-Mobile, to Marlene H. Dortch, FCC, WT Docket No. 18-197 (March 14, 2019) (“T-Mobile March 14 Letter”).

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Cornerstone's income estimates fall outside the range for a full 96.5% of those who reported income in the lower bracket.

- Brattle's method for estimating income (based on the income brackets reported by the majority of consumers in Cornerstone's NMP data set, as well as other data set characteristics) *was accurately and explicitly disclosed*. Cornerstone, on the other hand, only tersely described, and never explained, its false assumption that everyone in Manhattan or any other area of the nation has the same income; and
- Brattle's method leads to a reasonable result that subscribers leaving Sprint's prepaid brand, Boost, will disproportionately go to T-Mobile's prepaid brand, Metro PCS. This, in turn, means that the two are each other's fiercest competitors, and that the merger will eliminate that competition, leading to significant price increases. Cornerstone's method, by contrast, leads to the illogical result that prepaid subscribers leaving Boost will disproportionately go to Verizon's and AT&T's *postpaid* brands and that these brands are much closer competitors to Boost than MetroPCS.

The Applicants state there are limits to aggressive advocacy. There are. But the Applicants are casting stones from inside a fragile house. DISH has remained focused on the substantive issues and has ignored the Applicants' rapidly escalating and unseemly ad hominem attacks. But the Applicants have reached a low: *they grossly misrepresent what DISH's experts did*. They want the Commission to believe that it is better to assume that every person in the same zip code has the same income than to estimate each person's income based on the income ranges most of them reported. They hope to convince the Commission of the truth of an obvious falsehood—that the fiercest competitor of Sprint's prepaid service, Boost, is Verizon's postpaid service, rather than T-Mobile's prepaid Metro PCS service. Importantly, this dispute over the complexities of the NMP data further illustrates why using porting data, which the Commission and the Applicants themselves have relied upon, remains the best method for calculating customer diversion.

In the March 11 letter, the Applicants attempt to chastise DISH for stating that T-Mobile and Sprint have concluded that their merger will produce price increases.³ The reason, according to the Applicants, is that their economists have found the “exact opposite—the merger creates net downward pricing pressure.”⁴ The problem for the Applicants is that this is *not* the exact opposite—the sleight of hand is in the word “net.” Even if *all* of the Applicants' claims about diversion rates, marginal cost savings, and consumers' willingness to pay more for supposed quality improvements are accepted, prices for millions of customers will still increase, and most

³ T-Mobile March 11 Letter at 2.

⁴ *Id.*

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of the two companies' customers would not be willing to pay for the increases.⁵ *This is true regardless of the income estimate dispute out of which the Applicants are irresponsibly trying to create a sideshow.*

Response to the Applicants' March 15 Letter—Income Estimates

For all of Cornerstone's proclamations about its NMP "rich" data set,⁶ that data set is not rich in information about diversions. Porting data tell us with precision how many consumers leaving and porting their numbers went to each carrier, a crucial question that determines the extent of competition between the Sprint and T-Mobile brands—competition that will be lost with the merger. Cornerstone, however, points to no such information in its data set. Instead, Cornerstone estimates diversion ratios between the carriers.

Cornerstone's estimates are both drastically inconsistent with porting data and counter-intuitive. Cornerstone estimated that people leaving a prepaid brand would flock disproportionately to postpaid brands, rather than favoring another prepaid brand. Thus, consumers leaving Sprint's Boost were estimated by Cornerstone to switch primarily to Verizon **{{BEGIN HCI END HCI}}** and AT&T **{{BEGIN HCI END HCI}}** with only **{{BEGIN HCI END HCI}}** switching to T-Mobile's prepaid brand, MetroPCS. This is convenient for the Applicants, as it downplays the competition between their prepaid brands. But it sounds wrong. And, Brattle has confirmed that it is.

As explained in the accompanying report,⁷ Brattle tested this sharp divergence of Cornerstone's estimates from both porting data and common sense. It discovered one reason for it. Cornerstone simply assumed that each consumer in the same zip code has the same income—an assumption to which it assigned a few terse words and no explanation in its report.⁸ Brattle

⁵ See Coleman Bazelon, Jeremy Verlinda, and William Zarakas, *Reply to Cornerstone's Response to DISH and CWA Comments* at 10 (Feb. 19, 2019) (attachment A to letter from Pantelis Michalopoulos, DISH Counsel, to Marlene Dortch, WT Docket No. 18-197) ("Brattle Cornerstone Surreply"); DISH Network Corporation, Comments in Response to Public Notice Regarding Cornerstone Report, WT Docket No. 18-197, at 17-20 (Dec. 4, 2018).

⁶ See e.g., John Asker, Timothy F. Bresnahan, and Kostis Hatzitaskos, *Response to DISH's February 19 and 25 Submissions* ¶ 40, attached to T-Mobile March 14 Letter ("Cornerstone March 14 Report").

⁷ Coleman Bazelon, Jeremy Verlinda, and William Zarakas, *Reply to Cornerstone's "Response to DISH's February 19 and 25 Submissions"* (March 18, 2019) ("Brattle March 18, 2019 Report").

⁸ See John Asker, Timothy F. Bresnahan, and Kostis Hatzitaskos, *Economic Analysis of the Proposed Sprint/T-Mobile Merger* ¶ 201 (Nov. 6, 2018), Attachment A to Letter from Nancy Victory, Counsel for T-Mobile, to Marlene Dortch, FCC, WT Docket No. 18-197 ("Cornerstone (Continued...)

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then noted that this assumption was both arbitrary and unnecessary, because most of the consumers in the data set actually reported their income.⁹ Brattle decided to use that reported information in order to re-estimate the diversions flowing from Cornerstone’s model. The Applicants and Cornerstone dispute none of this.

Because consumers in Cornerstone’s data set reported that their income was within a range rather than reporting an income amount, and because the minority of the consumers *did not* report any income, Brattle had to estimate income amounts for each consumer. To that end, it employed an “interval” regression. Brattle was explicit and transparent about its method. It stated that “NMP panelist reported income is recorded as income intervals...necessitating use of interval regression techniques for the income estimation model.”¹⁰ Brattle’s backup materials, provided to the Applicants and the Commission, included all of the associated analysis and code needed to replicate their results.

That method made more sense of Cornerstone’s data than Cornerstone’s model had. Brattle concluded that “the diversions from non-premium brands to premium brands are significantly greater in the original model than in the model with estimated panelist income. Similarly, the diversions from non-premium brands to non-premium brands are significantly lower in the original model than in the model with estimated panelist income.”¹¹

Based on this re-estimation, Brattle explained that, even using Cornerstone’s flawed model, Boost and MetroPCS prices are likely to rise steeply—by **{{BEGIN HCI**
END HCI}} respectively.¹² DISH has invited the Applicants to remove their excessive confidentiality designations, which would allow DISH to place these percentages, from which no genuine confidential information can be gleaned, in the public record. The Applicants have so far failed to do so. Once again, DISH calls on the Applicants to withdraw their excessive confidentiality designations and permit the public to assess the price estimates made by all parties’ experts.

Contrary to what the Applicants intimate, *it is standard statistical procedure to use an interval regression in order to estimate unknown income based on all of the information*

Report”) **{{BEGIN HCI**

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⁹ Brattle Cornerstone Surreply at 22-28.

¹⁰ *Id.* at 25 n. 63.

¹¹ *Id.* at 28.

¹² *Id.*

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available, and not just a single, overly aggregated value (as Cornerstone has done).¹³ The Applicants nevertheless criticize Brattle’s method for imputing income outside the reported range for most of the consumers who reported such a range. In other words, to take a hypothetical range of \$10-20,000 (even the income brackets have been designated by the Applicants as highly confidential), the interval regression is invalid according to the Applicants because it would estimate an income of \$22,000. This criticism ignores the fact that Cornerstone’s own model treats income as a continuous variable, and requires specific individual amounts as inputs. To avoid altering the model, Brattle sought to use an informative, reliable continuous variable that takes into account the respondents’ individual characteristics to represent income. These characteristics included reported income range, but also brand choices, census demographics, and other respondent information in the NMP data set (*e.g.*, daily data usage). Moreover, Brattle’s goal was not just to convert reported income ranges into specific income amounts. Rather, Brattle also needed to estimate specific income amounts for the non-respondents. This meant that a “restricted” or “conditional” regression that would have forced specific incomes into ranges was not suitable. It would make the estimated incomes “lumpy”—clustered around specific values within the reported ranges for respondents and non-respondents alike. It would also create the potential for introducing bias in estimated income differences between premium and non-premium subscribers for the two sets of respondents.¹⁴ Brattle thus used an estimated unconditional expectation of income (*i.e.*, income amounts were not necessarily restricted to fall within a specified bracket) for both respondents and non-respondents.

Of course, Cornerstone fails to mention that its own estimates do a far worse job of describing the reported income.¹⁵ Specifically, census income values lie outside of the respondent’s reported income bracket for more than 80.7% of all respondents, and for a full 96.5% of those who reported income in the lower bracket, as shown in the figure below.

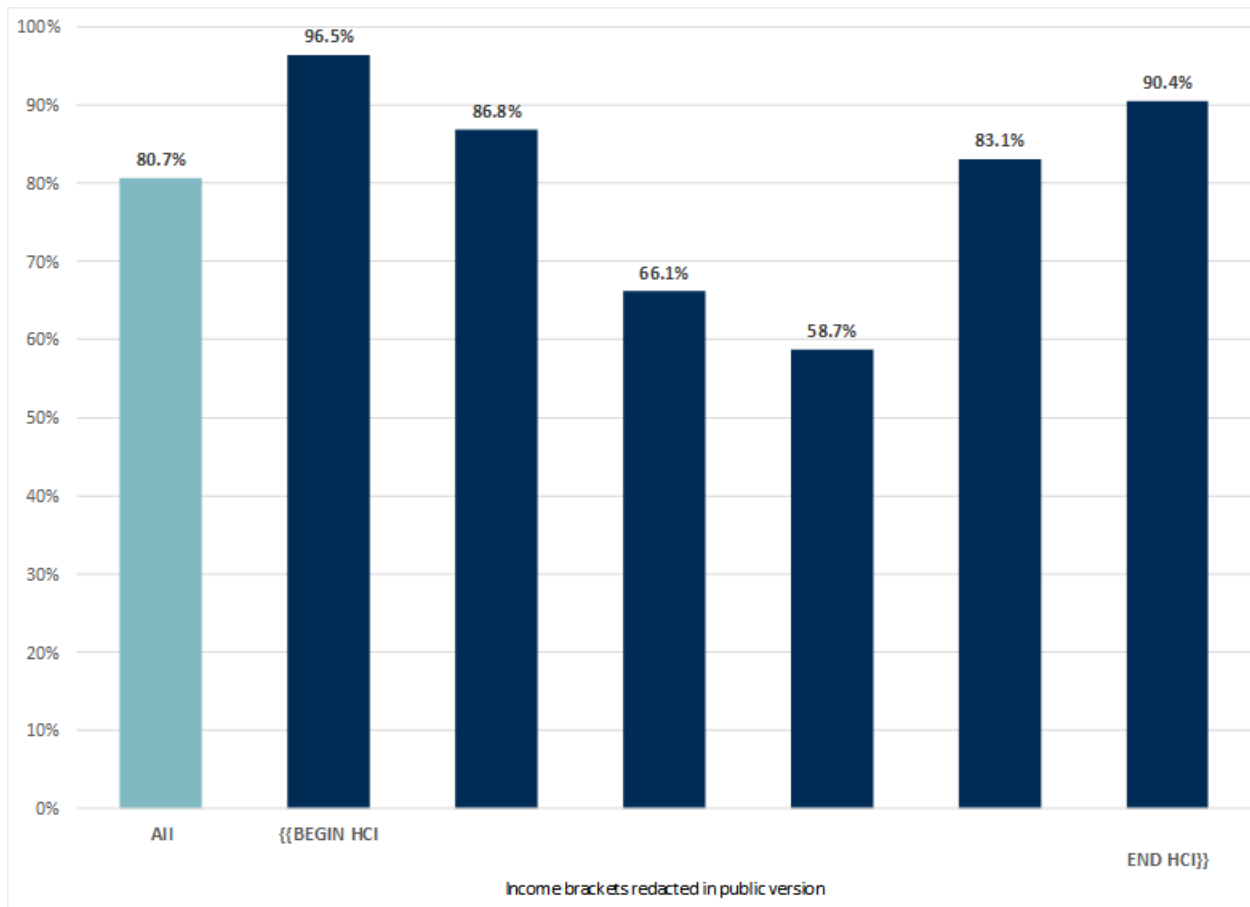
¹³ See Mark B. Stewart, *On Least Squares Estimation When the Dependent Variable is Grouped*, *The Review of Economic Studies* 50, No. 4 at 737-753 (1983); Cheng Hsiao, *Regression Analysis With a Categorized Explanatory Variable*, in *Studies in Econometrics, Time series, and Multivariate Statistics* at 93-129, Academic Press (1983); Jeffrey Wooldridge, *Econometric Analysis of Cross Section and Panel Data*, MIT Press at 783-785 (2010).

¹⁴ Brattle March 18, 2019 Report at 7. Cornerstone now arrives at yet another new set of diversion estimates by making fundamental changes to its model. See Cornerstone March 14 Report at Exhibits 15 and 16. Thus, for example, Cornerstone introduces dummy variables for each income bracket and allows each of these variables to interact with each brand, an approach that, at minimum, fails adequately to address the income distribution differences for non-respondents. Brattle will study and respond to this new diversion estimate in due course.

¹⁵ *Id.* at 24-25.

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Figure 1: Share of Cornerstone’s Census Median Income Values Falling Outside of Reported NMP Survey Income Brackets



Source: Brattle calculations, NMP survey data, and Cornerstone backup materials.

In addition, Brattle has shown that the census income values exhibit, incorrectly, virtually no differences between premium and non-premium subscribers. This is in sharp contrast to the NMP respondents’ reported incomes, which show that premium brand subscribers tend to have higher incomes while non-premium-brand subscribers have much lower incomes.¹⁶

Just as important, Exhibit 5 to Cornerstone’s own March 14 Declaration reveals that, despite the divergence, *the reported income ranges still contradict Cornerstone’s fiction that large numbers of low income consumers flock to postpaid Verizon and AT&T services.* Cornerstone compares the ratio of the premium and non-premium customers who belong to each income range to the corresponding ratio derived from Brattle’s regression. But the ratio based on the low income range data (rather than the more statistically sound interval regression method

¹⁶ Brattle Cornerstone Surreply at 24-25.

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based on those data) is not helpful for the Applicants. It shows that a full **{{BEGIN HCI
END HCI}}** of non-premium customers and only **{{BEGIN HCI END HCI}}** of premium customers are in the low income bracket.¹⁷ This is hardly consistent with the idea that more than half **{{BEGIN HCI END HCI}}** of customers leaving Boost go to AT&T and Verizon.¹⁸ Most low income customers may patronize premium brands of service in Cornerstone’s world. Many fewer of them do in reality.

Response to the Applicants’ March 11 Letter—the Applicants’ Admission of Price Increases

To repeat DISH’s prior showings about price increases and marginal cost savings: prices for Sprint customers still increase under *both* Cornerstone’s and Compass Lexecon’s analyses *even if*: one assumes that *all* of the Applicants’ 5G claims were accurate; one were to accept the multi-year ramp (through 2024) that the Applicants claim they need; and one were to ignore the additional price increases due to coordinated effects that would result from the merger.¹⁹ And, as DISH said about the merger’s supposed quality improvements, most **{{BEGIN HCI END HCI}}** customers would be unwilling to pay the price increases Cornerstone predicts even if one accepts the LTE efficiencies claimed by Compass Lexecon.²⁰

T-Mobile slanders DISH, but does not, and cannot, deny these facts. The Applicants’ experts do claim that the merger creates “net downward pricing pressure,”²¹ but T-Mobile’s trickery is in the word “net.” Even if all of the Applicants’ 5G savings claims were accurate, the Applicants’ experts claim *only* that they will offset price increase pressure for *T-Mobile* customers. Their own analysis shows that their efficiency claims are not enough, and that prices will rise, for *Sprint* customers—currently at 54 million.

And, the picture becomes even dimmer for the Applicants, since their claimed savings are shown to be inflated, unverifiable, speculative, remote in time, and not merger specific. For example, DISH has shown that the claimed savings would be cut by more than half if each of the Applicants acquires millimeter wave frequencies, as each needs to do and T-Mobile **{{BEGIN HCI END HCI}}** plans to do.²² Indeed, at the recent House Judiciary hearing,

¹⁷ Cornerstone March 14 Report at 10, Exhibit 5

¹⁸ Cornerstone Report at 35, Exhibit 12.

¹⁹ See Brattle Cornerstone Surreply at 10.

²⁰ See Letter from Pantelis Michalopoulos, Counsel for DISH, to Marlene Dortch, FCC, WT Docket No. 18-197 at 4 (Feb. 19, 2019).

²¹ T-Mobile March 11 Letter at 2.

²² See Letter from Pantelis Michalopoulos, Counsel for DISH, to Marlene Dortch, FCC, WT Docket No. 18-197 at 2 (Feb. 4, 2019).

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T-Mobile's CEO essentially admitted that point: asked if T-Mobile is "planning on buying more spectrum as a result of this merger," Mr. Legere stated that there will "be a lot more spectrum that's needed in addition to what we're going to get with . . . these two companies" and that there "will continually, as 5G advances, be a need to buy" additional spectrum.²³ Why then did the Applicants not take such future acquisitions into account in their calculations of marginal cost savings? The Applicants do not explain, and they have never challenged DISH on that point. In fact, a newly produced document shows that Compass Lexecon identified **{{BEGIN HCI
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Nor have the Applicants rebutted any of the other ways in which DISH's experts pointed out their marginal cost saving claims are inflated and speculative: (1) the spectral efficiency assumption for stand-alone Sprint is too low; (2) the costs for the same solutions are assumed to be higher for Sprint than for New T-Mobile; (3) standalone Sprint's speed for the transition to 5G is too sluggish;²⁵ and (4) Cornerstone has artificially boosted marginal cost savings by reducing usage estimates.²⁶ And the Applicants likewise have not rebutted DISH's key point that the Applicants' own revised engineering model predicts virtually no congestion for either

²³ C-SPAN, T-Mobile/Sprint Proposed Merger, House Judiciary Committee (March 12, 2019), <https://www.c-span.org/video/?458695-1/sprint-mobile-executives-testify-impact-proposed-merger>. See also, Monica Allevan, FierceWireless, *New T-Mobile Will be in the Market for More Spectrum: Legere*, (March 13, 2019), <https://www.fiercewireless.com/wireless/new-t-mobile-will-be-market-for-more-spectrum-legere>.

²⁴ TMUS-FCC-08089886 at 08089906 **{{BEGIN HCI
END HCI}}**. See also, TMUS-FCC-07977298 **{{BEGIN HCI**

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²⁵ This is especially so given Sprint's recent announcement at the Mobile World Congress: the company stated that it plans to bring 5G to four cities in May 2019 (Chicago, Atlanta, Dallas and Kansas City) and another five cities (Houston, Los Angeles, New York City, Phoenix and Washington, D.C.) in the first half of 2019. Touting these developments, Sprint's CTO explained that "wireless customers are soon going to have their first mobile 5G experience with Sprint, and it won't be limited to their home or a millimeter wave hotspot." And Sprint's CEO said the service is "not just for five customers, it's for millions of customers." Linda Hardesty, *Sprint to Launch Commercial 5G in 4 U.S. Cities in May*, FierceWireless (Feb. 25, 2019), <https://www.fiercewireless.com/wireless/sprint-to-launch-commercial-5g-4-us-cities-may>.

²⁶ Reply Declaration of Joseph Harrington, Coleman Bazelon, Jeremy Verlinda, and William Zarakas at 34-36 (Exhibit 1 to Reply of DISH Network Corp., WT Docket No. 18-197) (Oct. 31, 2018); DISH Reply at 100-102.

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standalone company, even as the supposed avoidance of congestion is at the heart of the proposed merger's rationale.²⁷

In sum, the Applicants' two letters deploy inappropriate rhetoric and false accusations to prop up two ideas. The first idea is that the main competitors of their prepaid brands today are the postpaid brands of Verizon and AT&T, not one another. The second idea is that the Commission should ignore the price increases the Applicants' *own* model estimates for tens of millions of Sprint customers, even though the Applicants' experts have piled on their model understated diversion numbers, over-inflated efficiencies, and the claim that consumers are willing to pay dollars more for a speed increase of a fraction of one megabit per second. They want the Commission to expunge these price increases in the name of the "net" effects that their experts have found based on the same flawed premises. Both ideas are wrong, and the Commission should reject them.

Respectfully submitted,

/s

Pantelis Michalopoulos

Counsel to DISH Network Corporation

²⁷ See DISH Reply at 77-78 ("Each Applicant is capable of delivering full 5G without experiencing any, or almost any, congestion during the duration of the model's life.").

**Reply to Cornerstone’s “Response to DISH’s February 19 and 25
Submissions”**

Coleman Bazelon
Principal, The Brattle Group

Jeremy Verlinda
Principal, The Brattle Group

and

William Zarakas
Principal, The Brattle Group

As we have shown in our January 28 and February 18 filings, the diversion ratio estimates that come out of Cornerstone’s demand model are unreliable and inaccurate. In our earlier responses, we have shown that Cornerstone’s methodological approach has proven unable to identify market segmentation that is abundantly evident elsewhere in this proceeding. Cornerstone, in effect, funnels an information set through its demand model that has no data about actual subscriber switching behavior, no information on pricing differences, and overly aggregated demographic data that is, at best, at odds with actually observed demographic information. The information that Cornerstone uses is insufficient to the task of updating Cornerstone’s demand model to allow it to change its baseline assumption of share-proportional diversion.

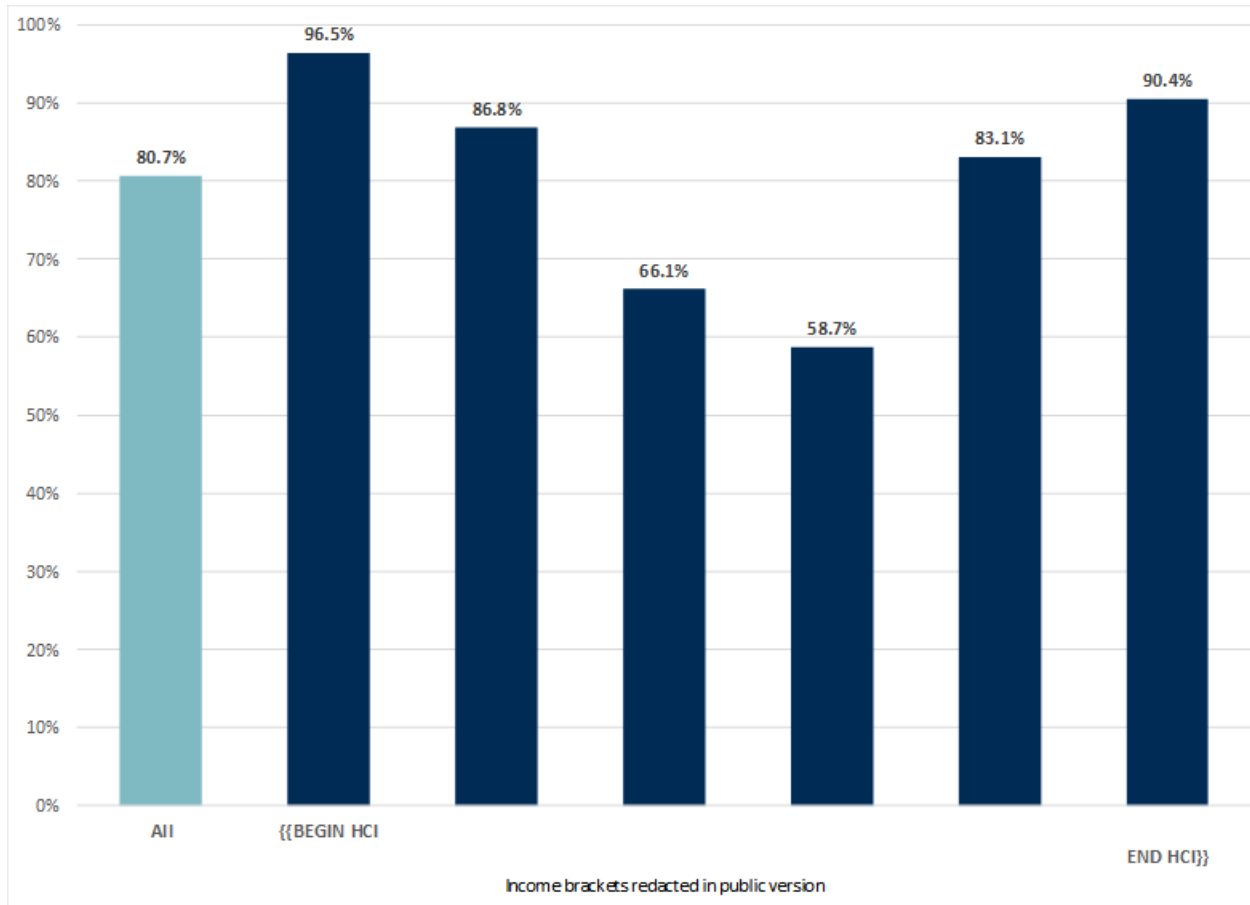
In its March 14 filing “Response to Dish’s February 19 and 25 Submissions,”¹ Cornerstone takes issue with the criticisms above, and in particular criticizes our use of estimated income information to illustrate how Cornerstone’s use of certain demographic data masks the observed segmentation in brand preferences for wireless services. We address those criticisms in the discussion below. Notwithstanding that Cornerstone is incorrect in its allegations about the use of estimated income information, correcting for the income information in the Cornerstone model does not fix the overall problems with its model. Even after incorporating the additional income information as we do, the Cornerstone model continues to be an unreliable vehicle to estimate subscriber preferences for wireless services, diversion ratios, or the effects of this merger.

It is surprising that the Applicants cast aspersions at our estimation of income given that Cornerstone itself estimates income for NMP respondents by using median income information from the census for *all* respondents in the NMP data set. This zip-code based income is, plainly and simply, an *estimate* of the respondent’s true income. It is a very blunt estimate that treats all individuals in a zip code as having the same income. As we showed in our report, and which Cornerstone has not refuted, the census median income data is entirely inconsistent with the respondent’s self-reported incomes. To further illustrate this point, Figure 1, below, provides a

¹ Response to Dish’s February 19 and 25 Submissions by John Asker, Timothy F. Bresnahan, and Kostis Hatzitaskos. *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, March 14, 2019 (henceforth “March 13 Cornerstone Response”)

chart showing the share of respondent incomes that Cornerstone “gets wrong” by its use of census median income data.²

Figure 1: Share of Cornerstone’s Census Median Income Values Falling Outside of Reported NMP Survey Income Bracket



Source: Brattle calculations, NMP survey data, and Cornerstone backup materials.

As shown in the figure, the census income values lie outside of the respondent’s reported income bracket for more than 80% of respondents. Of even greater concern, using the census income data to estimate respondents’ incomes masks the differences among low income and high income subscribers. Specifically, using the NMP panelists’ reported income information, non-premium brand subscribers are significantly more likely to have low incomes than are premium brand

² Cornerstone presents a similar chart for the estimated income values that were used in our analysis. Comparison of these charts shows that the census median income estimates less accurately reflect the NMP panelists’ reported income. See March 13 Cornerstone Response at Exh. 3.

subscribers. In contrast, by using the census income estimates, Cornerstone reaches the false conclusion that low income subscribers are just as likely to choose premium as non-premium brands.³ Consequently, the census income data cannot be relied upon as the sole source of income information for respondents.

It is important to be clear about what we are correcting in the Cornerstone analysis. Cornerstone assumed that every subscriber in a given zip code has the exact same income—the median income for that zip code. In other words, Cornerstone *replaced* the income data for all respondents with an estimate of the respondent’s income, where the estimate is the median income of the respondent’s zip-code. This method clearly misses the variation in incomes within a zip code. Cornerstone’s analysis showed less negative impact on lower income subscribers because it averaged those subscribers with their higher income neighbors. We used accepted statistical techniques to take the subset of subscribers in the NMP sample who reported their income (in ranges), and estimated specific, individual income for all subscribers in the sample (respondents *and* non-respondents). This estimate of income takes into account the individual characteristics of the respondents, unlike simply using the median income of the zip-code in which they reside.

Correcting Cornerstone’s analysis is important because of the misleading implications from not taking into account individual variation in income within a zip code. Cornerstone’s analysis suggests that if a subscriber were to switch plans (for example in response to New T-Mobile raising prices), and that subscriber is a low income individual who subscribes to a pre-paid plan, then, according to Cornerstone, that subscriber is just as likely to choose a high priced post-paid phone plan as would their richer neighbor in the same neighborhood. What our analysis shows is that the low income individual subscribing to a pre-paid plan is much more likely to switch to another lower cost pre-paid plan than they are to switch to a higher cost post-paid plan. Given Sprint and T-Mobile’s dominance in serving the lower income markets, combining their networks would disproportionately harm lower income individuals.

³ See Reply to Cornerstone “Response to Dish and CWA Comments” by Coleman Bazelon, Jeremy Verlinda, and William Zarakas *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, February 19, 2019 (henceforth “Brattle Feb 19 Response”), at Figures 1 and 2 and accompanying text at pp. 24-25.

More specifically, our analysis incorporated income information that was reported by a majority of NMP panelists, which was provided in income range brackets (such as income from \$10,000 to \$20,000). In contrast, the Cornerstone model relied upon median household income for the entire zip code in which the respondent lived, attributing the same income value to any respondents located in the same zip code. This median income information was incorporated into the Cornerstone model as specific values (e.g., \$28,431), rather than in income range brackets. Importantly, Cornerstone treats income as a “continuous” variable that cannot simply be swapped out with the bracket or missing NMP respondent information without altering the structure of Cornerstone’s demand model. Hence, in order to use the NMP respondent income information within Cornerstone’s demand model *without changing the model’s structure*, it is necessary to calculate estimated, continuous income data. This is precisely what we have done, and, as explained above, it is standard statistical procedure to do so.

In order to use the NMP income data, Cornerstone would have needed to address two issues. The first issue is that not all of the respondents reported their income, which would leave much of the NMP data set unused if the analysis were restricted to only individuals who reported income data. The second issue is that, while the NMP respondents that directly reported income did so in ranges (or brackets), Cornerstone’s model treats income as a “continuous” variable and requires specific individual income levels as inputs. Cornerstone set aside these issues and ignored the income data provided by the 55% of respondents who reported income data. Instead, Cornerstone opted for the crude approach of estimating individual incomes based on the median income in a zip code.

In contrast to Cornerstone, we chose to address the two problems with the NMP dataset – unreported income for 45% of respondents and the fact that the income data was reported in ranges. To do so, we followed standard, academically accepted methodology by using interval regression.⁴ Our approach used the income information that is included in Cornerstone’s own model without having to alter the structure of Cornerstone’s merger simulation model. Our

⁴ Interval regression is described in Stewart, Mark B. "On least squares estimation when the dependent variable is grouped." *The Review of Economic Studies* 50, no. 4 (1983): 737-753; Hsiao, Cheng. "Regression analysis with a categorized explanatory variable." In *Studies in econometrics, time series, and multivariate statistics*, pp. 93-129. Academic Press, 1983; and Wooldridge, Jeffrey M. *Econometric analysis of cross section and panel data*. MIT press, 2010, at 783-785.

methodology estimates the unknown income values for the non-respondents (which allows for the entire set of panelists used by Cornerstone to be included) and translates the NMP income information of respondents into specific values rather than income range brackets. It is entirely appropriate to use an interval regression in order to estimate incomes when presented with income bracket information and missing data, as we have done in our analysis.

Cornerstone protests that the estimated income values that we used exhibit limited direct overlap in the NMP reported income brackets. Notwithstanding that Cornerstone's own much cruder estimates of respondent incomes exhibit even less overlap with the NMP reported income brackets, such concerns are misplaced. Since Cornerstone's model treats income as a continuous variable, and requires specific individual amounts as inputs, we sought to use an informative, reliable continuous variable that takes into account the respondents' individual characteristics to represent income. Thus, we estimated incomes for each respondent based on a regression equation that maps information on brand choices,⁵ census demographics, and other respondent information in the NMP data (e.g., daily data usage). Moreover, our goal was not only to convert reported income ranges into specific income amounts. Rather, we also needed to estimate specific income amounts for the non-respondents.

⁵ While Cornerstone suggests that we err by including brand choices in the estimation procedure, this concern is also misplaced. Academic research has shown that omission of the brand choices would incorrectly underestimate the influence of income on brand choice. See Sterne, Jonathan AC, Ian R. White, John B. Carlin, Michael Spratt, Patrick Royston, Michael G. Kenward, Angela M. Wood, and James R. Carpenter. "Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls." *Bmj* 338 (2009): b2393, finding that (emphasis added):

Often an analysis explores the association between one or more predictors and an outcome but some of the predictors have missing values. In this case, *the outcome carries information about the missing values of the predictors and this information must be used*. For example, consider a survival model relating systolic blood pressure to time to coronary heart disease, fitted to data that have some missing values of systolic blood pressure. When missing systolic blood pressure values are imputed, individuals who develop coronary heart disease should have larger values, on average, than those who remain disease free. *Failure to include the coronary heart disease outcome and time to this outcome when imputing the missing systolic blood pressure values would falsely weaken the association between systolic blood pressure and coronary heart disease*.

See also Moons, Karel GM, Rogier ART Donders, Theo Stijnen, and Frank E. Harrell Jr. "Using the outcome for imputation of missing predictor values was preferred." *Journal of clinical epidemiology* 59, no. 10 (2006): 1092-1101.

This meant that a “restricted” or “conditional” regression that would have forced specific incomes into ranges was not suitable. It would have made the estimated incomes “lumpy”—clustered around specific values within the reported ranges—for both respondents and non-respondents. It would also have created the potential for introducing bias into the estimates, including for estimated income differences between premium and non-premium subscribers across the two sets of respondents. As noted, our approach more accurately reflects income differences across brands than does Cornerstone’s approach. In Cornerstone’s model, consumers select brands based on the relative differences in their incomes, not the absolute level of income for any given panelist. Figure 2, below, provides the distribution of estimated incomes by brand type.

Figure 2: Distribution of Estimated NMP Incomes, by Brand Type

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END HCI}}

Source: Brattle calculations, NMP survey data, and Cornerstone backup materials.

The figure above shows that there is substantial overlap in estimated incomes between premium and non-premium brands. Hence, Cornerstone is mistaken in its claim that the use of estimated income somehow makes it so that low income subscribers are always tied to non-premium brands, and high income subscribers are tied to premium brands. Moreover, these relative differences in estimated income values mirror the underlying distributional differences observed in the NMP respondents' reported income brackets, where non-premium brands are observed to have lower incomes than premium brands.⁶ In addition, the distribution of the estimated income values exhibits considerably more distributional differences between premium and non-premium brands than does the zip code median income values that Cornerstone relies upon for its estimates of panelists' incomes.⁷ Thus, our estimates, which use the estimated *unconditional* expectation of income (i.e., they are not necessarily restricted to fall within a specified bracket) for both respondents and non-respondents, more accurately reflect the observed market segmentation than do Cornerstone's zip code based median income estimates.

Finally, contrary to the Applicants' claims, our methodology and analysis was entirely transparent. As we explained in our report, we "estimate[d] a regression model of panelists' reported income as a function of other information observed across the Cornerstone sample" and then "use[d] the regression results to estimate income for *all* panelists."⁸ In the accompanying footnote, we explained that we used "interval regression techniques for the income estimation model."⁹ Our backup materials, provided to the Applicants and the Commission, included all of the associated analysis and code needed to replicate these results.

The Applicants are trying to find fault in our analysis to create the false impression that low-income consumers are not harmed by the merger. But any such conclusion is simply incorrect.

⁶ Brattle Feb 19 Response at Figure 2.

⁷ Brattle Feb 19 Response at Figure 1.

⁸ Brattle Feb 19 Response at pp. 25-26, emphasis added.

⁹ Brattle Feb 19 Response at p. 25, footnote 63.