poorly designed or used as a single test it would let pass without further scrutiny transactions that in fact will harm the public interest.

6. A screen that does a better job of measuring the capability of different spectrum bands to deliver mobile broadband will obviously do a better job of measuring competitive impact. A value-based screen, rather than the current raw-MHz screen, would do a better job of measuring the capability to deliver mobile broadband, by taking into proper account the substantial differences among the bands—which does not occur under the screen as currently designed. In particular, the value-based screen accounts for the superior capability of low-band spectrum (spectrum below 1 GHz) to that of high-band spectrum (above 1 GHz), a superiority that the FCC and countless other industry authorities and participants have recognized.

The logic of the current MHz screen rests on faulty assumptions.

7. Professor Katz attempts to defend the current screen by presenting an example where a MHz screen would in fact be appropriate (Katz Declaration, ¶ 69). But the real world does not conform to his example. The example assumes that any MHz of spectrum is perfectly substitutable for any other and that wireless service is a homogeneous good. In such a world the MHz of spectrum would indeed be the correct measure of competitive impact, because the capability to provide wireless service would in fact exactly correspond to the MHz of spectrum held (and the relative allocation of cost among the different inputs—spectrum and equipment—producing these equivalent outputs would be immaterial). However, Professor Katz's hypothetical world bears little relationship to the real world, and ignores both the economic and engineering realities of providing wireless service.

8. First, the different bands are *not* perfectly substitutable. Low-band spectrum has great advantages for providing coverage, both depth (inside buildings) and breadth (in less populated areas), while build-out in high-band spectrum is more cost intensive. One cannot

replicate the coverage of low-band spectrum (especially in-building) with high-band spectrum simply by increasing network spend—which is the unspoken assumption behind Professor Katz' example. This fact alone renders Professor Katz's example irrelevant.

9. Second, wireless service is *not* a homogeneous good; rather it is a complex differentiated product. Consumers place a high value on coverage, speed, reliability, value added services and access to the latest handsets. The ability of a carrier to deliver each of these attributes depends on the carrier's spectrum holdings. For example, the ability to provide good coverage is greatly enhanced with low-band spectrum. This fact too would be enough by itself to render Professor Katz's example irrelevant.

10. To be sure, it is not easy to assess relative competitive impact. Imperfect substitution across bands together with non-homogenous wireless services makes assessing competitive impact difficult. Professor Katz suggests that we should therefore simply throw up our hands and not even make the attempt. But he ignores the fact that the current screen *already* makes a competitive assessment that all spectrum has an *equal* competitive impact. Yet if there is one thing we know for sure, it is that the assessment built into the current screen is wrong because all spectrum is *not* created equal for purposes of providing wireless broadband. Even if it is difficult to precisely quantify the relative value of spectrum, perpetuating the current screen would precisely quantify the relative values of all spectrum as 1 for 1—and this we know to be grossly incorrect.

11. As discussed in my initial Declaration, one glaring respect in which the current raw-MHz screen is a poor proxy for competitive impact is that it would provide safe-harbor for one carrier to acquire *all* the spectrum below 1 GHz. Such an allocation would severely undermine competition, since it would give one carrier an overwhelming advantage in providing coverage, a key source of value for consumers.

12. In contrast, a value-based screen of the type I propose, by putting greater weight on the low-band spectrum, would correctly trigger the screen to prevent one carrier from attempting to acquire a disproportionate amount of low-band spectrum. Moreover, excessive ownership of low-band spectrum would be further discouraged under a value-based screen because it would limit the carrier's ability to acquire high-band spectrum.

A value screen reflecting input scarcity better measures competitive impact.

13. The goal of the screen is to provide the most accurate possible measure of the competitive impact of alternative spectrum holdings. Clearly the existing MHz screen falls way short of that goal as the example above illustrates. Ignoring major differences across bands leads to a poor measure of competitive impact.

14. The value-based screen appropriately corrects this shortcoming by weighting the bands by market price. The relative price reflects the differential contribution of the different bands in providing the various components of wireless service. Excessive concentration of the scarcest inputs (the low-band spectrum) in the hands of a single provider creates a larger competitive concern than accumulation of the less scarce (high-band) spectrum.

15. Weighting the bands by price is equivalent to weighting them by scarcity, since the market price is how economists measure scarcity (a worthless input available in small quantity is not scarce). The relative prices in effect reflect the relative contributions of each band to wireless service. The higher price of the low-band spectrum reflects the fact that consumers value coverage and that the low-band spectrum contributes more to this valuable component of output. In contrast, high-band spectrum contributes less to output and therefore the market price of high-band spectrum is less. In other words, in weighting the spectrum by scarcity, the value-based screen reflects the fact that the input prices reflect the input's contribution to outputs

valued by consumers.[1] Excessive concentration of scarce inputs means less competition in the output market for wireless services.

16. My argument does not confuse harm to competition with harm to competitors, as asserted in the Katz Declaration (¶ 66). Spectrum is an essential input for wireless service licensed by the FCC to wireless carriers. Different spectrum bands contribute to wireless service in different ways and propagation characteristics are a primary (though not the only) factor in determining the relative prices of the spectrum bands. Excessive concentration of these scarce inputs harms *competition*—not merely competitors—in the output market (wireless service). This fundamental result is the very motivation for the screen and plainly states the competitive concerns that underlie my proposed spectrum weighting approach: greater concentration of scarcer inputs raises greater concerns about competition.

A value-based screen is easy to construct.

17. To implement a value-based screen the FCC must of course make a reasoned judgment about the relative values of the various bands. Professor Katz suggests (Katz Declaration, ¶ 67) that such a judgment is problematic because there are many factors that influence price and that within-band price variation illustrates this difficulty. He gives the auction prices from Auction 73 (700 MHz band) as an example. However, much of the within band price variation in that auction was due to the auction structure and the limited substitution

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[1] I note that Dennis Roberson, in his Declaration being submitted along with this one by T-Mobile, arrives at slightly different weighting factors than mine in measuring spectral efficiency of existing uses. This is because his analysis focuses specifically on propagation characteristics that affect the spectrum use measures he is analyzing, while by using price, mine includes *all* factors that go into making the spectrum more or less scarce from an economic point of view (which obviously include, but are not limited to, propagation characteristics) and is therefore a better measure of the *economic* effect on competition of this transaction. However, as can be seen, the relative numeric weights assigned by his method and mine are generally comparable.

allowed by the auction design between the C block and the A and B blocks.[2] Thus, Auction 73 fails to prove Professor Katz's point. The variance in price in Auction 73 reflects the inability of that particular auction to successfully match value with price, as well as some peculiar features of the 700 MHz band plan.

18. In fact, the relative value differences across bands are well-understood by market participants and industry experts and are reported in investment banking studies that analyze the competitive advantages to the holders of the different bands.[3] The differences are supported by recent competitive auctions and arms-length secondary market transactions.[4]

19. It is unavoidable that the FCC must make a reasoned judgment in selecting weights for the screen. But equal weights, as reflected in the current screen are patently *un*reasonable. The absurdity of equal weights (the status quo) is seen when one performs the following thought experiment. Which is apt to have the greater competitive impact: an increase to spectrum supply of 2x20 MHz of 700 MHz spectrum or an increase of 2x20 MHz of 2.5 GHz

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[2] The problem of limited substitution in the 700 MHz auction is analyzed in Peter Cramton, "Spectrum Auction Design," Working Paper, University of Maryland, 2009. The substitution problem arose because the C block was offered in large regions (six in the continental US), whereas the other bands were offered in much smaller regions. Further, AT&T and Verizon Wireless were the only two national carriers to participate in the auction and as a result of pre-auction transactions it made sense for AT&T to focus on the B block and Verizon Wireless to focus on the C block. Since the C block regions were too large for the regional players, Verizon Wireless faced less competition on the C block and the price was lower. Moreover, the C-block was subject to certain "open access" conditions, which did not apply to other 700 MHz spectrum, and may have further reduced demand for that block.

[3] For example, J.P. Morgan, "Spectrum Valuation Overview – Carrier by Carrier Base-Case Spectrum Value Across Wireless Industry," Telecom Services and Towers, North American Equity Research, 30 November 2011.

[4] For example, the recent multi-band auctions in Germany and Italy are highly relevant, as are the two most recent major U.S. spectrum auctions (AWS-1 in 2006 and 700 MHz in 2008). Additional market information can be gleaned from secondary market transactions, although care must be taken in evaluating these transactions, since they often are limited to particular regions and it is well-known that spectrum prices vary widely across regions. For some recent transactions see Deutsche Bank, "Key Updates on Major Spectrum Deals," US Telecom Services, Market Research, 5 February 2012.

spectrum? Anyone with knowledge of the industry would immediately say that the additional 700 MHz spectrum would have a far larger impact in increasing industry competition. This is obvious (and correct).

20. Yet the logic of the unweighted MHz screen wrongly concludes that the competitive impact is independent of the band. In contrast, the value-based screen draws the right conclusion by recognizing that some bands are better able to address the challenges of wireless service. These bands are especially scarce. Their scarcity (as reflected in their market price) limits competition. A proper screen must take input scarcity into account, since it is input scarcity that limits competition.

21. In my initial Declaration, I constructed a particular value-based screen to illustrate how it would work. I showed the results for the top-25 markets (Cellular Market Areas). I found that Verizon Wireless, after the transactions with SpectrumCo and Cox, violates the one-third screen in 12 of the top-25 markets. To show that the problem is not limited to the top-25 markets, I extend the analysis to the top-50 and top-100 markets. Figure 1 shows the results of the one-third value-based screen for Verizon Wireless before and after the transactions with SpectrumCo and Cox for the top-50 markets; Figure 2 shows the screen for the second-50 markets. From this we can see that the problem extends to the smaller markets. After the transactions with SpectrumCo and Cox, Verizon Wireless violates the one-third screen not only in 12 of the top-25 markets, but also in 24 of the top-50 markets, and in 46 of the top-100 markets. Thus, the frequency of violation is similar irrespective of market size. However, violations are especially common in the largest markets: Verizon Wireless violates the screen in 8 of the top-10 markets.

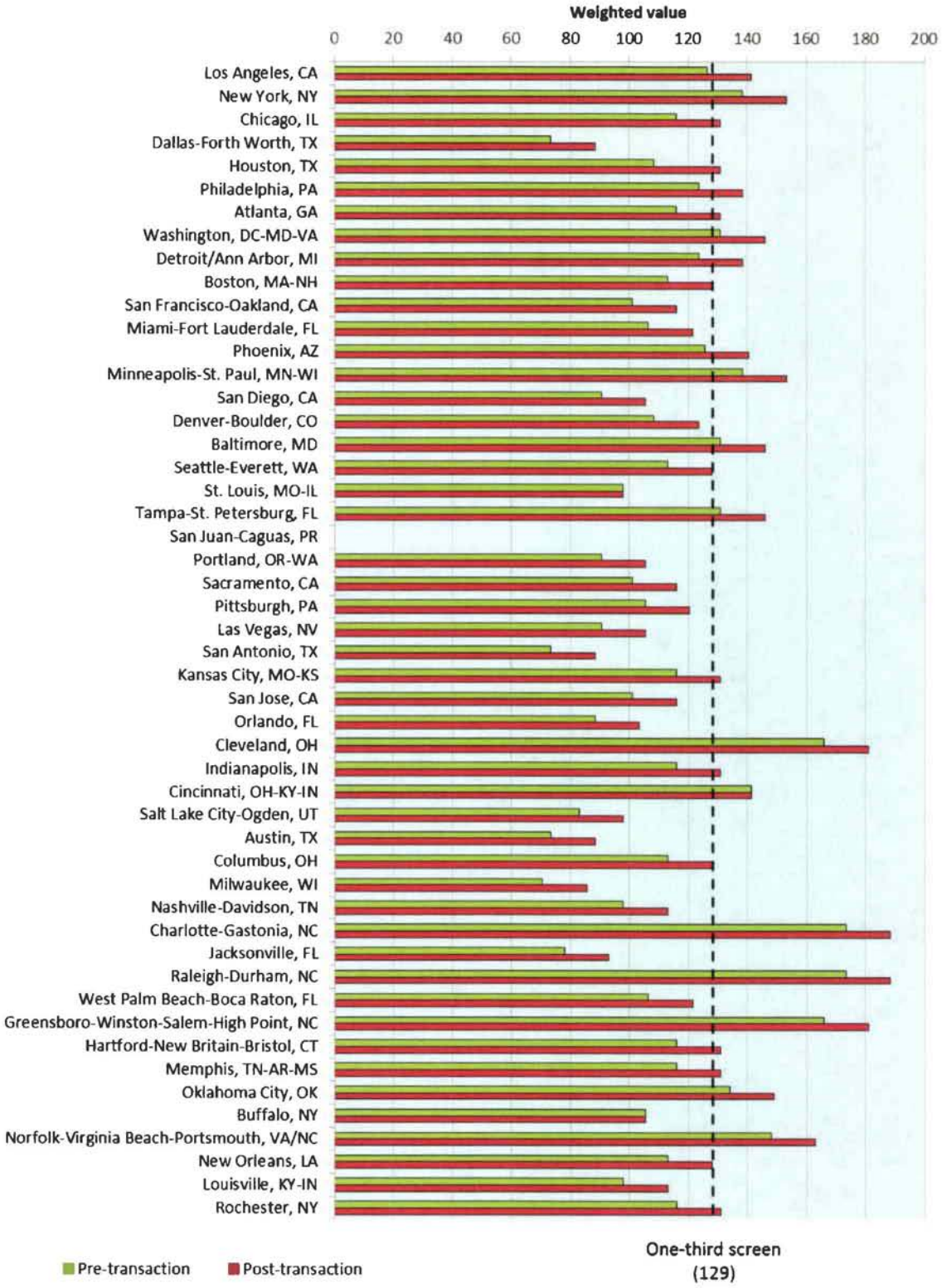

Figure 1. Screen applied to Verizon Wireless holdings before and after transactions with SpectrumCo and Cox in the top-50 markets.

Note: Verizon Wireless post-transaction holdings *pro forma* SpectrumCo, Cox, and Leap transactions.

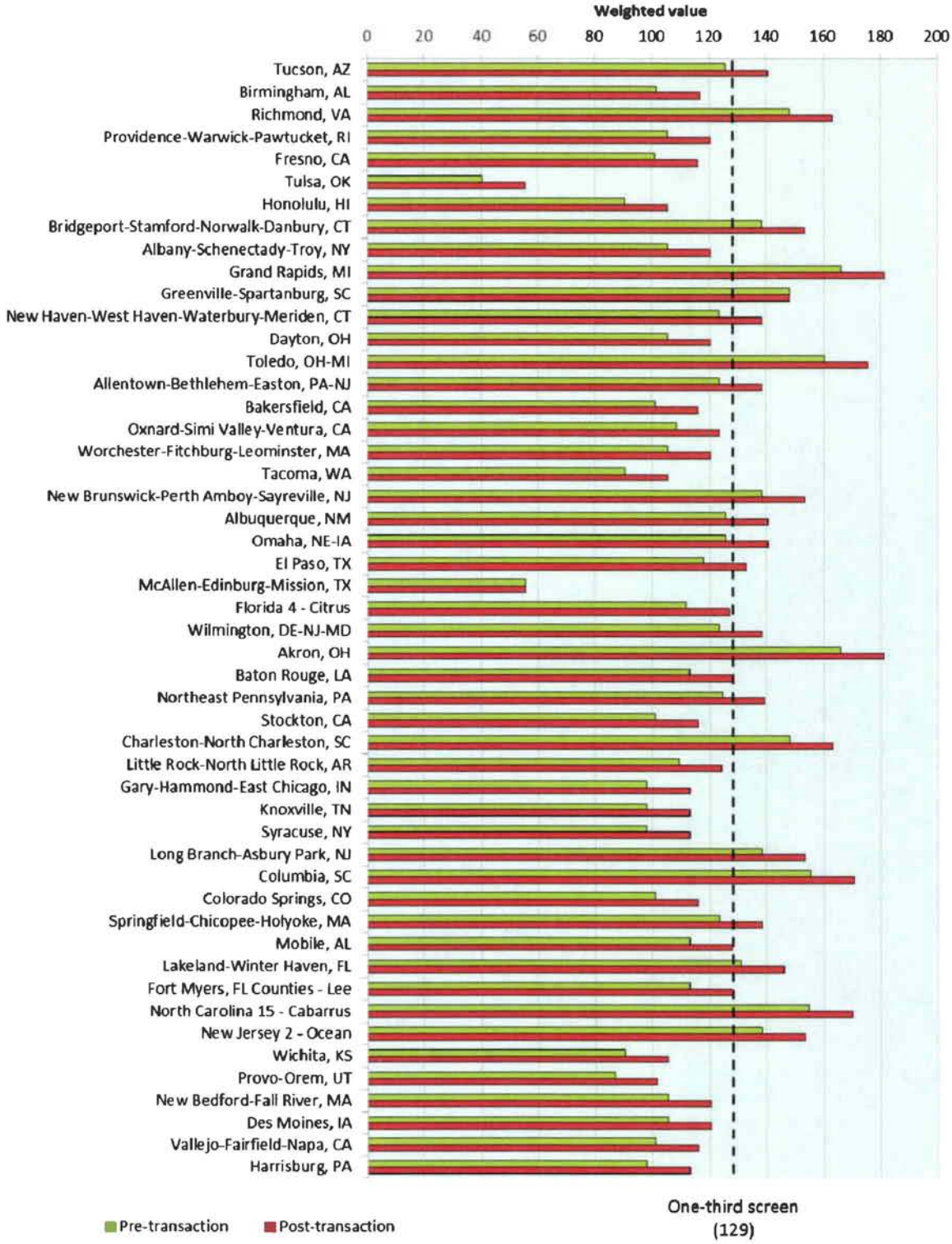

Figure 2. Screen applied to Verizon Wireless holdings before and after transactions with SpectrumCo and Cox in the second-50 markets.

Note: Verizon Wireless post-transaction holdings *pro forma* SpectrumCo, Cox, and Leap transactions.

Conclusion

22. The arguments given by the Applicants and their experts for maintaining the current screen are weak. Professor Katz attempts to justify the existing MHz screen by assuming that spectrum across bands is perfectly substitutable and that wireless service is a homogeneous good. These assumptions are false and so is the conclusion. Rather the competitive impact of a spectrum transaction depends on the scarcity of the spectrum input. As in all markets scarcity is best measured by price. This is the motivation for the value-based screen, which weights the spectrum holdings across bands by relative price.

23. Weighting the spectrum according to relative values, as is done in other industries, greatly improves the screen's effectiveness as a diagnostic tool to prevent an excessive concentration of spectrum and therefore safeguard the public interest.

[signature on next page]

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 26th day of March, 2012.

Peter Cramton

Peter Cramton

CERTIFICATE OF SERVICE

I, M. Renee Britt, hereby certify that on this 26th day of March 2012, I have caused a copy of the foregoing *Reply of T-Mobile USA, Inc. to Opposition to Petition to Deny* to be served, in the delivery manner specified, upon the parties listed below:

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