PERSPECTIVES

PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES

# A Review of the Berkman Center's Price Survey of Municipal Broadband Markets

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A few hundred cities across America have constructed and operate high-speed Internet networks, often in markets already served by private firms.[1] These municipal broadband networks are highly controversial, with policy positions ranging from their outright prohibition to the nationalization of Internet services.[2] Every debate has its extremes, but it is safe to say that the policy debate regarding the municipal provision of broadband services continues with vigor.

A recent contribution to the debate receiving some attention is a pricing analysis conducted by the Berkman Klein Center for Internet and Society at Harvard University. The report, entitled *Community-Owned Fiber Networks: Value Leaders in America*, summarizes a survey of prices conduced in late 2015 for standalone broadband service in twenty-seven cities where a municipal broadband network is in operation (hereinafter, the "*Berkman Report*").[3] Using data now two-years old, the *Berkman Report* concludes that municipal systems typically charge lower prices—often substantially lower—for broadband services than do the private providers operating in the *same market*.[4] This within-market comparison is a peculiar analysis; the municipal "treatment" is not different within the municipality's market. The more interesting and policy-relevant question of whether prices are lower in cities with a municipal provider than without one is not addressed.

The *Berkman Report* has been ravaged by Bennett (2018) and Santorelli and Davidson (2018) for its numerous errors and inconsistencies.[5] Even the authors of the *Berkman Report* concede that the price comparisons they seek to make are "extraordinary difficult" and that the work is "inherently incomplete."[6]

Perhaps I am guilty of kicking a dead horse, but in this PERSPECTIVE I delve into some interesting conceptual and practical problems with the *Berkman Report's* analysis. These problems manifest as *within-market* price differences as large as 100%, presumably for the same service. The *Berkman Report* offers no competitive theory that would permit such large price differences. Competition among providers ensures that prices for similar services in the same market must be very similar (known as the "law of one price" in antitrust analysis).[7]

In fact, the *Berkman Report* makes no effort to compare prices for the same services. In fact, the survey is based on "prices for the lowest-cost program."[8] Not only does this approach lead to price comparisons of unlike things, but using price as a determining part of the sample selection leads to sample selection bias.[9] Nor are the prices for the most widely-consumed services compared. Broadband providers are primarily in the business of selling bundles of communications services. For more popular triple-play services, earlier research has demonstrated that municipal systems do not

charge lower prices for comparable services of the type most frequently purchased (the triple play).[10] The *Berkman Report*'s analysis is flimsy, for sure.

***Oddly, no attempt is made to ensure that the service offerings are similar. Since the prices of unlike things are often unalike, it is unclear exactly what the Berkman Report is attempting to demonstrate. No hypothesis is offered, and aside from some rudimentary computations, no statistical analysis is conducted.***

Also, to update and maybe improve the *Berkman Report*'s analysis, I compare the current prices for similar service levels and find that, if anything, private providers offer lower prices than do municipal systems. Statistical analysis indicates, however, that over a three-year window, the prices of municipal and private providers are (statistically) equal. In fact, adjusting for sizable differences in service levels reported in the *Berkman Report* (albeit crudely), statistical tests indicate that the hypothesis of equal prices between municipal and private providers listed in the *Berkman Report* cannot be rejected.

### *Berkman Report* on Prices

At the core of the *Berkman Report* is a survey of standalone broadband prices in markets where cities operate broadband networks. The pricing data reported in this 2018 study is from November 2015 through January 2016, so the pricing data is now two-years old.[11] The prices in the survey represent the lowest-priced service satisfying the Federal Communications Commission's (largely arbitrary) definition of broadband service (that is, a downstream/upstream threshold of 25/3 Mbps). Oddly, no attempt is made to ensure that the service offerings are similar. Since the prices of unlike things are often unalike, it is unclear exactly what the *Berkman Report* is attempting to demonstrate. No hypothesis is offered, and aside from some rudimentary computations, no statistical analysis is conducted.

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The *Berkman Report's* research strategy suffers from a number of serious conceptual problems, nearly all of which arise from the authors' failure to specify what hypothesis is being evaluated or tested. Sadly, the Scientific Method is rarely applied in policy debates, permitting confirmation bias to run wild.[12] Certainly, no discussion is provided in the *Berkman Report* that gives the reader any confidence that the authors' approach has identified a "treatment effect" of interest.

*Different Services, Different Prices*

What we do know is that the *Berkman Report* gathers some price data from late 2015 (and January 2016) from markets where a municipality offers broadband service (save one case, where the city does not yet offer service). The prices are chosen by looking for the lowest

price service of at least 25 Mbps download speed.

While seemingly innocuous, this method of choosing services to compare based on "lowest price" is a considerable error. The purpose of the *Berkman Report* is to compare prices, but their data collection procedure uses price as a criteria for selection. Thus, the outcome of interest is driving the sample selection process, an approach that nearly ensures selection bias and a distorted analysis of relative prices.

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The service selection criteria presents another problem. In the choice of service for which to compare prices, the *Berkman Report* makes no attempt to ensure that the comparisons are for similar services. In a number of cases, the services compared have speed differences (measured in Mbps) of 400% (100 Mbps versus 25 Mbps). It is little surprise that prices differ for different things, and confirming that is entirely uninteresting. This empirical strategy—comparing prices of unlike things in a sample collected based on price—is plainly not a good one. Yet, price comparisons are made in the *Berkman Report*, and without any explanation as to what such comparisons are intended to tell us.

In the absence of clearly defined hypothesis or identification strategy, we are forced to construct a framework for the *Berkman Study* (or try to do so).

Here it goes.

Presumably, the authors of the *Berkman Report* believe that private and municipal providers of broadband are competing for customers in these cities. The providers are, after all, matched to cities. Comparing the prices of unlike things is silly, so in comparing prices, the authors must believe they are comparing the prices for similar services.

What, then, is the expectation about the relationship of prices among firms selling identical (or similar) services in a single market? The answer is—the prices will be similar. If the prices were not similar, then customers will migrate to the low-price seller, either forcing its rivals to lower price or surrender the market. The *Berkman Report's* focus on price differences suggest that similar prices were, in fact, the expectation, if there was an expectation at all.

There is the concept from (antitrust) economics called the "law of one price."[13] Davis and Garcés (2010) define the "law of one price" as follows:

> The "law of one price" states that active sellers of identical goods must sell them at identical prices. If one seller lowers price, it will get all the demand and the others will sell nothing. If a seller increases price above a rival, she will sell nothing. Since only the firm with the lowest price sells, the equilibrium result is that all active firms sell at the same price and share the customers.[14]

Within a single market, *like* things will sell for *like* prices. If one observes big price differences between two providers' services, then the services are either different in some way or they are sold in different markets. For the most part, price data is meaningless without quantity data. If a higher price for one seller is observed in a market, but that seller maintains a high market share, then there is some feature of the services

or the sellers that is unaccounted for in the analysis. A Five Guys hamburger in Birmingham, Alabama, is $6.29. At the nearby McDonalds, a hamburger can be had for $1. Does Five Guys have market power, or is it out to do harm to consumers? Of course not. There are quality differences in the item being sold.

Seller prices for similar broadband service in the same market should, therefore, be approximately equal.[15] If large prices differences are found, certainly like those reported in the *Berkman Report*, then such differences are good evidence that the analysis has failed to compare the prices of comparable services sold in the same market. Or, there may be more to the rivalry among sellers than just price, including contract issues and so forth. Price comparisons in such situations may prove quite difficult, since theory may not provide unambiguous guidance.

Consider some examples from the *Berkman Report*, including some updates to the data. In the first of the *Berkman Report's* price comparisons (Lafayette-Louisiana), the authors contrast an offering of $600 per year to another at $1200 per year.[16] Obviously, the higher-priced firm would not survive long charging twice the price of its rival. We must conclude, therefore, that these two service offerings are not in the same market, differ in some material way, or that the high price firm is doomed. To verify the facts, I contacted the higher-price firm: it is still in operation and I was told that the company does not offer terrestrial broadband service in Lafayette.[17]

The second comparison in Lafayette is between LUS Fiber (the municipal system) and Cox Communications, with the authors claiming a price differential of $311.36 annually. Again, we must ask—what type of customer would pay that large of a difference for the same service? If the answer is "none," then there is obviously a quality difference and thus no consumer impact of the price difference. In any case, the authors offer no explanation. In fact, the *Berkman Report*'s conclusion that municipal systems charge less could be interpreted as a result of the municipalities offering lower quality service.

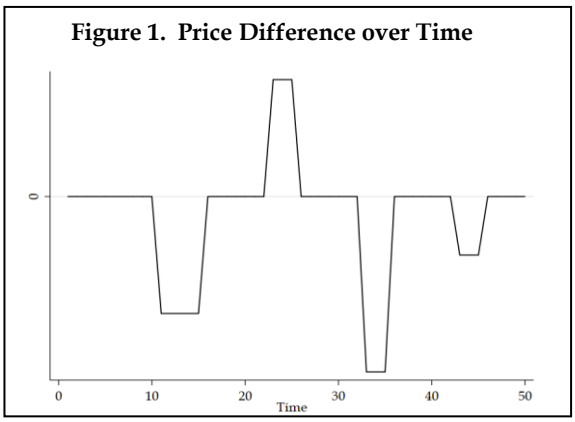
Today, LUS Fiber's lowest, FCC-compliant broadband service (at 60 Mbps) is priced at $52.95 per month.[18] Cox's compliant offering (at 30 Mbps) has an introductory rate of $29.99 for a year increasing to $63.99 thereon.[19] Assuming the customer does not renegotiate the promotional rate at year end, over a three-year period the monthly costs for standalone broadband averages $52.95 for LUS Fiber and $52.66 for Cox.[20] The prices are nearly identical.

Looking at Opelika-Alabama, the *Berkman Report* reports an annual price differential of $139.23 between Opelika's system and Charter Communications (with the former having a lower price).[21] The current lowest-priced standalone broadband service for Opelika's system is $64.99 per month for 100 Mbps.[22] Charter offers a 100 Mbps service at a one-year promotional price of $44.99, increasing to $64.99 at expiration.[23] The service levels are identical. Charter's average price is lower than that of Opelika's system (see Table 1 below), but the prices are very similar.

*Comparing "Instant" Prices*

Significantly, the "law of one price" does not demand that prices are equal at every instant in time. Price competition normally manifests as one firm cutting price in the hopes of obtaining a market advantage over rivals to increase market share and profits. So, prices on any given day need not be equal. Surveys like that in the *Berkman Report* (and my own analysis here) pick prices at a certain time to compare. At that particular time, firms may be searching for a new equilibrium. Price and speed level changes are frequent in broadband markets, but they are also costly to implement due to advertising, billing systems, and so forth. Municipal prices often require government approval, which could take a long time to obtain.

**Figure 1. Price Difference over Time**




Say, for instance, there are two firms in a market engage in non-cooperative competition. Figure 1 shows a hypothetical series of price differences between the two rivals over time. The average price difference over the interval is zero (by design), but the competitive process permits prices to differ during short intervals as one firm uses price cuts either because of cost changes or to gain market share.[24] A survey at prices at specific time period (say, $t = 12$ or 34) may show price differences, though over time the difference is zero.

Any price comparison based on a single instant in time within a market may present a highly distorted view of the actual market prices faced by consumers. By the "law of one price," when measured and averaged over time, the prices charged by different sellers for the same items will tend to converge. When price comparisons are made within markets, they should be made over longer periods of time and, of course, for identical services.

*What's the Market?*

The *Berkman Report* collects data and report prices for a standalone broadband service. This strategy presumes that this is a product in high demand. In 2015, however, broadband providers were not really in the business of selling the standalone product being analyzed. Even today, most consumers buy multiple products from both private and municipal providers.

A look at Comcast's financials illustrates the point. The *Berkman Report* lists Comcast's average price for a standalone broadband service at about $60 per month. In 2015 and 2016, about 70% of Comcast's customers purchased more than a single service (which could be multichannel video and not broadband).[25] Across all its offerings, the company's average revenue per customer was about $135 per month, more than twice the standalone broadband price.[26] The *Berkman Report* focuses on a fairly narrow aspect of the broadband business—standalone broadband. Even today, broadband customers most commonly buy bundles of data, voice, and video services. In the future, standalone broadband may become a more commonly consumed service, but it was not a popular service at the time of the *Berkman Report's* survey.[27]

*Cross-Subsidies?*

In making price comparisons between private and government broadband sellers and drawing conclusions therefrom, the researcher must consider the cross-subsidy problem and the idiosyncratic and sometimes peculiar motivations of local governments.[28] As is well-documented, municipal broadband systems are heavily cross-subsidized. Market prices arise when rational, profit-seeking firms compete. What motivates private actors is largely known. Local governments, however, do not have the same incentives as private actors and thus their choices may bear no nexus to the profit calculation. In fact, some advocates and municipal officials claim decisions unhinged from the consideration of revenue and costs is desirable.[29]

Cross-subsidization is a rampant and sizable problem for municipal broadband networks. Recent analysis of Opelika-Alabama's financial statements and city council meetings reveal that Opelika's captive electric ratepayers were hit with a $200 annual increase in their electric bills to cover the losses of the broadband network.[30] Adding in the system's losses, each of Opelika's

broadband customers receives a subsidy of about $900 per year from electric customers.

Next, consider the corruption-plagued municipal broadband system in Bristol-Virginia. A recent audit of that system by the state's Auditor of Public Accounts concluded that the system does "not have the resources to continue operating without cross-subsidization."[31] The audit also concludes that the "BVU Authority has cross-subsidized services within OptiNet over the years [including] improperly writing off $13.7 million of interfund debt between OptiNet and the Electric Division."[32] This one instance of cross-subsidy from the electric division amounts to over $1,000 per customer. That same system spent $185 million to build the network ($23 million from the federal government), but was sold last year for $50 million.[33]

***A recent paper by Professor Robert Seamans (2012) makes a strong case for the cross-subsidy problem *** [and] *** is consistent with my economic analysis of municipal broadband published in 2015 and a potent indictment against municipal broadband.***

The cross-subsidies for these financially failing networks is hardly hidden. In Provo-Utah, the broadband system's request for transfers from the electric utility were explicit.[34] The city eventually levied a $5.35 month fee on residents' electric bills to pay the broadband network's bond payments and sold the network to Google for $1.[35] In Tacoma-Washington, the municipal broadband network lost millions, adding about $3.50 to captive electric ratepayers' monthly bills.[36] A poll of residents found that seven of ten ratepayers preferred to have the network shut down rather than continue to fund the cross-subsidy. Electric ratepayers in Groton-Connecticut were left paying off the nearly $40 million in debts for a system that was sold "at auction" for a paltry $500,000.[37] In Burlington-Vermont, once the poster child for municipal broadband, the state's Public Service Board found the broadband network dipping directly into the city's bank account.[38]

Almost universally, municipal broadband systems are financially unsustainable on their own.[39] Losses are covered by cross-subsidy or by federal and state subsidies in the form of grants.[40] Chattanooga's system, for instance, received $111 million in federal grants, in addition to placing much of the debt for the broadband network on electric customers.[41] BVU in Bristol-Virginia received millions in grants from the tobacco fund.[42] It is little surprise that most of these municipal broadband systems are attached to a municipal electric utility. The municipal utility's profits serve a bountiful source for cross-subsidy dollars, exploiting market power over captive electric ratepayers to fund losses.

A recent paper by Professor Robert Seamans (2012) makes a strong case for the cross-subsidy problem.[43] His econometric analysis of municipal broadband systems shows that the threat of municipal entry into broadband markets is eliminated in states where cross-subsidies are prohibited, providing empirical evidence that cross-subsidization is a requirement for municipal entry into broadband markets. This result is consistent with my economic analysis of municipal broadband published in 2015 and a potent indictment against municipal broadband.[44]

How cross-subsidies are expected to affect price comparisons in unclear, though it should be considered. Are the cross-subsidies required because price is too high, or too low? Are the subsidies affecting pricing decisions? Do the subsidies cover fixed costs or do they create the

illusion of a lower marginal cost? These questions are worth asking.

**An Updated Price Comparison**

Given the old data used in the *Berkman Report*, it seemed sensible to obtain more recent data for comparison purposes, even if for a more limited sample. As explained above, I do not believe the *within-market* price comparisons offered in the *Berkman Report* are terribly meaningful, but in light of their conclusions I have conducted a similar analysis and, as shown here, come to very different conclusions.

I limit my attention to a few markets. Charter is the easiest private provider for which to obtain prices. The company charges a uniform price across markets—whether with or without a muni system—and also is a listed provider in about half the markets surveyed in the *Berkman Report*. The company imposes no cap on usage and imposes no charge on the modem. So, my survey a prices is limited to markets listed in the *Berkman Report* where Charter offers services, giving a sample of thirteen cities.

For its 100 Mbps residential service (its current baseline service), Charter now charges $64.99 with a first-year promotion of $44.99. Customers may be able to obtain the same or other promotions upon expiration (I know I do), but for now I assume over a three-year window the promotion applies only in the first year. The average monthly price over three years if no further promotions apply is $58.32.

To maximize the comparability of the services, for the municipal systems I use its price for a standalone Internet service closest to a 100 Mbps service level, which many offer. Prices are obtained from the providers' websites with two exceptions.[45] Two pricing options are included in the sample for Bristol-Virginia (75 Mbps and 150 Mbps), since the system does not offer a plan very close to the 100 Mbps benchmark. Only one of the municipal systems in the group offered a promotional rate (Churchill-Nevada). In all, there are fourteen cities and fifteen prices to compare.

Let $P_M$ be the price for the municipal system and $P_C$ the price for Charter's service. For comparison purposes, I compute the average monthly difference in prices between the municipality and Charter, or $\Delta = P_M - P_C$. A negative number indicates the municipality charges a lower price than does Charter. The differences are summarized in Table 1 for both the first year and the three-year average.

**Table 1. Price Comparisons (Jan 17, 2018)**
(Δ = Muni Price - Charter Price)

| City | Mbps | Δ: Year 1 | Δ: 3 Year |
|---|---|---|---|
| Morristown, TN | 100 | -5.04 | -18.37 |
| Highland, IL | 100 | 19.96 | 6.63 |
| Pulaski, TN | 100 | 38.56 | 25.23 |
| Dalton, GA | 100 | 19.96 | 6.63 |
| Bristol, VA (1) | 75 | 4.96 | -8.37 |
| Bristol, VA (2) | 150 | 14.96 | 1.63 |
| Opelika, AL | 100 | 20.00 | 6.67 |
| Clarksville, TN | 250 | -0.04 | -13.37 |
| Monticello, MN | 100 | 0.96 | -12.37 |
| Bristol, TN | 80 | 24.96 | 11.63 |
| Reedsburg, WI | 100 | 4.96 | -8.37 |
| Crosslake, MN | 90 | 54.96 | 41.63 |
| Tullahoma, TN | 100 | 14.96 | 1.63 |
| Jackson, TN | 100 | 80.01 | 66.68 |
| Churchill, NV | 100 | 5.00 | 2.79 |
| Average | | 19.94 | 6.61 |
| Conf. Interval (95%) | | (10.0, 32.1) | (-3.3, 18.7) |

For the first year comparison we see that Charter's prices are lower than the municipal's prices for thirteen of the fifteen comparisons in the sample. For the two municipalities charging lower prices, the monthly difference is only $5.04 in one case and $0.04 the other. On average, Charter's prices are lower by $19.94 per month.

Table 1 shows some very large price differences. In Jackson-Tennessee, for example, a residential 100 Mbps service is priced at $125 per month, well-above the prices charged by Charter for the same service level. Jackson alone adds $5.72 to the mean. Large differences are also found in Bristol-Tennessee, Pulaski-Tennessee, Opelika-Alabama, and Crosslake-Minnesota.

Clarksville's minimum service level of 250 Mbps is also much higher than 100 Mbps benchmark. For the reasons discussed above, these large price differences suggest that there is likely more to rivalry in these cities then mere pricing competition over a single service level. Municipal systems may not, for instance, give much attention to costs or subscriptions in light of cross-subsidies, or may move slow to adjust price. Availability may be a key difference in service prices. Also, municipal systems often advertise to their citizens that buying broadband from the city is akin to a civic duty, which may allow for higher prices.[46]

Assuming that the price differences in Table 1 reflect the typical pricing differentials in markets where both a public and a private broadband firms (at least a major private provider) operate, I can employ the bootstrap method to obtain the confidence intervals from the empirical distribution of price differences ($\Delta_b$). The bootstrap is a relatively low power technique, so the confidence intervals could be relatively wide, and this favors a finding of "no difference."

A basic cross-check on a few other cities confirms the representativeness of the prices comparisons in Table 1 for municipal broadband markets. In Chattanooga-Tennessee, a 100 Mbps service has a price of $57.99 for the city's service and $59.99 for Comcast (without any promotional discounts).[47] In Issaquah Highlands-Washington, the city's utility charges $60 per month for 100 Mbps service and Comcast charges $59.99 per month for a 150 Mbps service (without any promotional discounts).[48] In Sebewaing-Michigan, the city's utility charges $105 per month and Comcast $59.99 per month (no promotional discounts, but with a few television channels at no charge), so this large price difference looks a bit like the Jackson-Tennessee case in the table.[49] I do not add Comcast to the sample because its offerings (both price and speeds) vary across its cities and in some cases a 100 Mbps service is not offered (as is the case with some of the markets excluded from my analysis). The large positive disparity, like that in Sebewaing, would shift the empirical distribution to the right (and vice versa for a negative Δ).

**Figure 2. Distribution of $\Delta_b$**

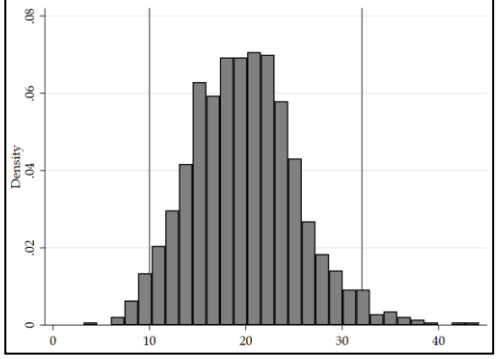
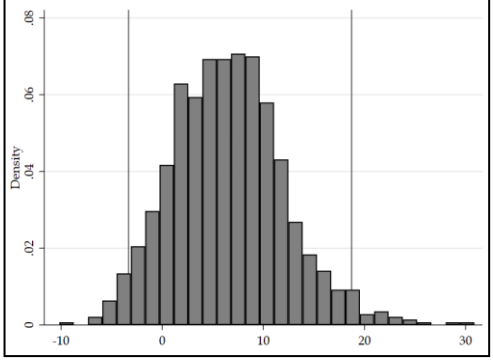



Figure 2 illustrates the empirical distribution of Δ for the first-year price. The 95% confidence interval is bounded by $10.0 to $32.1, as marked in the figure.[50] This confidence interval does not include zero (marked by the vertical lines in the figure), indicating that the municipal systems' prices are systematically higher for customers in the first year where promotional discounts are available from private providers.

Over the three-year window, Charter's prices are lower in ten of the fifteen comparisons. The average savings offered by the private provider is $6.61 per month. The empirical distribution is illustrated in Figure 3, and the 95% confidence interval of -$3.3 to $18.7 is marked in the figure. This interval includes zero, so it is not possible to reject the hypothesis that private and municipal systems charge equal prices for something very close to a 100 Mbps standalone broadband service over a three-year period that includes promotional discounts.

**Figure 3. Distribution of $\Delta_b$ (3 year)**




A review of Table 1 indicates that the services are not always identical by the only technical measure included (Mbps), but they are typically the same. The reported results are not much affected if the sample is limited to cities with exactly 100 Mbps service offerings. Excluding Jackson-Tennessee as a severe outlier lowers the average difference, but the first-year confidence interval still does not include zero.

The sometimes large differences in this sample for broadband service of the same speed suggests that competition in broadband markets is more complex than this sort of simplistic analysis in the *Berkman Report* can convey. That said, if one wishes to believe such comparisons are valid, then the evidence clearly shows that municipal systems do not today systematically charge lower prices for similar services.

**A Statistical Look at the Berkman Data**

The authors of the *Berkman Report* make no effort to find comparable services for their price comparisons. Instead, they look for the lowest-priced service that satisfies the FCC's definition of broadband, injecting selection bias into the survey.

The failure to gather data on nearly identical services makes statistical comparison of prices difficult. By not choosing similar services, the service levels for which prices are compared are dissimilar, often by large amounts. For instance, in Chattanooga, the authors compare the price of a 100 Mbps service to a 25 Mbps service. In Marshall-Missouri, a 100 Mbps service is compared to a 40 Mbps service. What price comparisons mean across such disparate service levels is unclear, but there is certainly reason to be skeptical of the results.

One possible solution is to adjust prices to account for service level disparities. A common approach is to use price-per-megabit.[51] I am not a fan of this statistic (observing before that "price-per-megabit is a meaningless statistic"), since it is highly non-linear and can render perverse results.[52] For instance, a price-per-megabit of $1 is not necessarily better for consumers than a price-per-megabit of $2. Say, the price-per-megabit of $1 is based on a gigabit service level, having a monthly price of $1,000—more than nearly any consumer could afford. The price of $2 per-megabit might be for a 25 Mbps service, for a monthly price of $50. Nearly every consumer would prefer the lower priced service despite its lower speed.

Despite the flaws, I use (with trepidation) price-per-megabit (*PMB*) in an attempt to make comparisons across the widely disparate service levels listed in the *Berkman Report*. Note that I divide the annual price data by 12 to produce a monthly price index to coincide with my approach above.

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Across the Berkman sample, there are 61 such prices, with 27 belonging to municipal systems and 34 to private providers. Using this data,

whether or not the prices charged by municipal providers are different than those charged by private providers can be tested using the basic t-test:

$$t = \frac{PMB_P - PMB_M}{\sqrt{s_P^2 / N_P + s_M^2 / N_M}} \quad , \qquad (2)$$

where $s$ is the standard deviation, $N$ is the sample size, and the subscripts are as before. For the municipal sample, the average price-per-megabit is $1.464, and the private providers is $1.482, for a difference of 0.018 (the numerator of Eq. 2).

The t-statistic computed using Equation (2) is 0.11 with a probably level of 0.91. For the *Berkman Report* sample, the null hypothesis of equal prices cannot be rejected at anywhere near standard significance levels. Thus, by this measure of price, the prices of the two sorts of providers are the same.

**Figure 4. Density of *PMB***

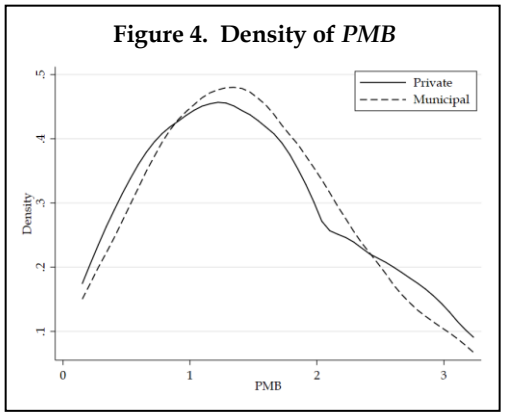


Figure 4 illustrates the kernel density of the *PMB* data for the private and municipal systems. The distributions are comparable, consistent with the results of the means difference test.

Testing for a difference of medians rather than means using the non-parametric Wilcoxon rank-sum test.[53] The z-statistic is -0.20 with probability 0.83. The non-parametric Hodges-Lehmann test renders a Δ of -0.069 with a confidence interval bounded by -0.31 and 0.33.[54] Thus, it is not possible to reject the null hypothesis that the medians are the same.

For all the reasons stated above, such comparisons are of little policy relevance absent some theoretical framework that explains why prices would be different. In addition to the problems of using price-per-megabit (though it is a popular index of price), the task of *within* market price comparisons between dissimilar services is conceptually problematic. A poorly designed empirical inquiry cannot be fixed by the mere division of two numbers in a crude attempt to create a single index of both price and quality. In any case, a comparison of current prices of similar services (see Table 1) does not indicate any material disparities of prices between municipal and private providers of broadband, at least on average.

## Conclusions

In this PERSPECTIVE, I review a recent report by the Berkman Klein Center at Harvard comparing broadband prices among rivals in a single market where a municipality offers service. I demonstrate that the *Berkman Report* is a poorly conceptualized experiment in price comparisons, ignoring the "law of one price" among other conceptual and practical problems.

While the *Berkman Study* claims municipal broadband systems charge lower prices than their private counterparts based on data now two-years old, statistical analysis and more recent data does not support the conclusion. My analysis of current data indicates that municipal prices are, if anything, higher than their private sector counterparts. Crudely adjusting the *Berkman Report's* old data for service level differences, I present statistical evidence that the prices charges by municipal and private providers are not different.

## NOTES:

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1 For a detailed analysis of the economics of municipal broadband, *see* G.S. Ford, *The Impact of Government-Owned Broadband Networks on Private Investment and Consumer Welfare*, STATE GOVERNMENT LEADERSHIP FOUNDATION (2016) (available at: http://sglf.org/wp-content/uploads/sites/2/2016/04/SGLF-Muni-Broadband-Study-1.pdf). A listing of current networks is available here: https://muninetworks.org/communitymap.

2 *See*, *e.g.*, D. Morris, *To Save the Internet We Must Own the Networks*, INSTITUTE FOR SELF RELIANCE (December 18, 2017) (available at: https://ilsr.org/to-save-the-internet-we-must-own-the-networks); CS. Crawford, CAPTIVE AUDIENCE: THE TELECOM INDUSTRY AND MONOPOLY POWER IN THE NEW GILDED AGE (2013); G.S. Ford, *Sloppy Research Sinks Susan Crawford's Book*, Law & Economics Blog (January 18, 2013) (available at: http://www.phoenix-center.org/blog/archives/1075). R.D. Atkinson and D. Brake, *How Broadband Populists Are Pushing for Government-Run Internet One Step at a Time*, INFORMATION TECHNOLOGY & INNOVATION FOUNDATION (January 2017) (available at: http://www2.itif.org/2017-broadband-populism.pdf); S. Lichtenberg, *Municipal Broadband: A Review of Rules, Requirements, and Options*, NRRI REPORT NO. 14-11, NATIONAL REGULATORY RESEARCH INSTITUTE (November 2014) (available at: https://pensacolabroadband.files.wordpress.com/2015/08/11-2014-municipal-broadband-a-review-ofrules-requirements-and-options.pdf).

3 David Talbot, K. Hessekiel, and D. Kehl, *Community-Owned Fiber Networks: Value Leaders in America*, BERKMAN KLEIN CENTER FOR INTERNET & SOCIETY AT HARVARD UNIVERSITY (January 2018) (available at: https://cyber.harvard.edu/publications/2018/01/communityfiber).

4 The Berkman survey of prices took place between November-2015 and January-2016. *Id.*, at p. 15.

5 R. Bennet, *Community Broadband is Cheaper – and Slower*, HIGH TECH FORUM (January 16, 2018) (available at: http://hightechforum.org/community-broadband-cheaper-slower) and M.J. Santorelli & C.M. Davidson, *A Closer Look: Berkman's Municipal Fiber Pricing Study,* Advanced Communications Law and Policy Institute (ACLP) at New York Law School (January 2018) (available http://www.nyls.edu/advanced-communications-law-and-policy-institute/wp-content/uploads/sites/169/2018/01/Closer-Look-Berkman-GON-Pricing-Study-January-2018.pdf).

6 *Berkman Report*, *supra* n. 3 at p. 3.

7 *See*, *e.g.*, MARKET POWER HANDBOOK: COMPETITION LAW AND ECONOMIC FOUNDATIONS, American Bar Association (2005) at pp. 62-3; P. Davis and B. Garces, QUANTITATIVE TECHNIQUES FOR COMPETITION AND ANTITRUST ANALYSIS (2010) at pp. 170-1 ("The 'law of one price' states that active sellers of identical goods must sell them at identical prices. If one seller lowers price, it will get all the demand and the others will sell nothing. If a seller increases price above a rival, she will sell nothing. Since only the firm with the lowest price sells, the equilibrium result is that all active firms sell at the same price and share the customers."). This "law of one price" is why price effects of treatments are measured *between* and not *within* markets. Finding large prices differences within a market indicates that the *Berkman Report* is: (a) comparing the prices of different services (which it admittedly is); (b) comparing the prices of services sold in the different markets (which it may be); or (c) that the nature of rivalry is more complex than mere price competition, which means that looking at price differences presents a distorted picture of market activity.

8 *Berkman Report, supra* n. 3 at p. 3.

9 A basic definition of sample selection is: "A bias that occurs as a result of using samples from a non-randomly selected data, distorting the result of the experiment" (*see* http://www.businessdictionary.com/definition/sample-selection-bias.html). More formally, *see* G.W. Imbens and J.M. Wooldridge, *Recent Developments in the Econometrics of Program Evaluation*, 47 JOURNAL OF ECONOMIC LITERATURE 5-86 (2009).

10 G.S. Ford, *Do Municipal Networks Offer More Attractive Service Offerings than Private Sector Providers? A Review and Expansion of the Evidence*, PHOENIX CENTER POLICY PERSPECTIVE No. 14-01 (January 27, 2014) (available at: http://phoenix-center.org/perspectives/Perspective14-01Final.pdf).

11 *Berkman Report, supra* n. 3 at p. 15. While collecting such data can be yeoman's work, more recent data would certainly offer a more interesting and accurate assessment of broadband service today. Also, collecting pricing data over time may

## NOTES CONTINUED:

avoid pricing transitions across competitors in a single market. I cannot help but think the strange results of the survey led to it being shelved in 2016, only now to arise in an effort to influence President Trump's infrastructure agenda.

[12] On the Scientific Method, *see* https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method. On Confirmation Bias, *see* https://www.britannica.com/topic/confirmation-bias.

[13] There's also a "law of one price" regarding commodity pricing; it is a related but different concept (https://www.investopedia.com/terms/l/law-one-price.asp).

[14] P. Davis and B. Garcés, QUANTITATIVE TECHNIQUES FOR COMPETITION AND ANTITRUST ANALYSIS (2010), at pp. 170-1. This idea is normally attributed to George Stigler. G.J. Stigler, *Imperfections in the Capital Market*, 75 JOURNAL OF POLITICAL ECONOMY 287-292 (1967) (available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.541.5796&rep=rep1&type=pdf) ("The function of a market is to permit the exchange of goods, so an efficient market (clearly a normative concept) permits all exchange which the traders prefer to nonexchange. If we assume away all costs of trading, the efficient market will achieve every desired exchange for homogeneous goods when there is only one price. This condition is clearly necessary: with two (or more) prices, one seller is receiving less than some other buyer is paying, and both would prefer to trade with one another than with whomever they are trading.").

[15] This assumes, however, that the sellers are really interested in serving the market in question. Here, the "market" is standalone broadband market, which in 2015 was not a service in high demand. Even today, very few consumers buy broadband alone. How seller prices compare in small sub-markets is unaddressed by the *Berkman Report*.

[16] *Berkman Report, supra* n. 3 at p. 8.

[17] Telephone interview on January 16, 2018.

[18] http://www.lusfiber.com.

[19] http://www.cox.com.

[20] Over the arbitrarily chosen four-year window of the *Berkman Report,* Cox's average monthly price is $55.49, a difference of only $30.48 per year.

[21] *Berkman Report, supra* n. 3 at p. 8.

[22] http://www.opelikapower.com.

[23] http://www.charter.com.

[24] For an excellent, policy-relevant discussion of the competitive process, *see* L. Phlips, COMPETITION POLICY: A GAME-THEORETIC PERSPECTIVE (1995).

[25] Comcast 2016 Annual Report, at p. 2 (available at: https://www.cmcsa.com/financials/annual-reports).

[26] *Id*. at pp. 2, 49.

[27] But, see A. Maclean, *Wither Goes the Video Bundle?* CABLEFAX (January 23, 2018) (available at: http://www.cablefax.com/programming/whither-goes-the-video-bundle).

[28] *See, e.g., Impact of Government-Owned Broadband Networks*, *supra* n. 1; S. Wallsten and L. Gamboa, *Public Investment in Broadband Infrastructure: Lessons from the U.S. and Abroad*, TECHNOLOGY POLICY INSTITUTE (June 2017) (available at: https://techpolicyinstitute.org/wp-content/uploads/2017/06/Public-Investment-in-Broadband-Infrastructure.pdf).

[29] H. Rosoff, *Tacoma Could be First Major Washington City with Publicly-Owned Broadband Network*, KIRO7.COM (November 30, 2015) (quoting Tacoma Public Utility Board Chairman Bryan Flint: "Publicly-run means we don't have a profit motive") (available at: http://www.kirotv.com/news/news/utilityboard-tacoma-council-decide-click-cable-tv/npY6z); D. St. John, *Municipal Fiber to the Home Deployments: Next Generation Broadband as a Municipal Utility*, Fiber to the Home Council (April 2008) at p. 3 (available at: http://community-wealth.org/sites/clone.community-wealth.org/files/downloads/article-st-john.pdf) ("In the case of muni systems, which are not-for-profit enterprises, one measure of "success" is defined as the level

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of their "take rate"—that is, the percentage of potential subscribers who are offered the service that actually do subscribe"); J. Engebretson, *Broadband Payback Not Just About Subscriber Revenues*, CONNECTED PLANET (January 6, 2011) (available at: http://muninetworks.org/content/broadband-payback-not-justabout-subscriber-revenues) ("[I]n doing a cost/benefit analysis on telecom infrastructure investment, it's important to take into account not only the direct revenues that the infrastructure generates but also the dollars that flow into a community as a result of the investment."); M. Halverson, *Disbanded: No Broadband Utility for Seattle*, SEATTLE MET (June 20, 2012) (available at: http://www.seattlemet.com/articles/2012/6/20/disbanded-no-broadband-utility-for-seattle-july-2012) ("A municipal network should be evaluated on the same basis of how we evaluate roads and other infrastructure," says Christopher Mitchell, founder of muninetworks.org, which tracks community broadband issues. "Which is to say that the point of the road is not to produce revenue for the general fund. It's to produce economic development and other benefits."); B. Levin, *New Report Swings and Misses on Communities and Next Generation Broadband*, THE AVENUE: BROOKINGS INSTITUTION (June 29, 2017) (available at: https://www.brookings.edu/blog/the-avenue/2017/06/29/new-report-swings-and-misses-on-communities-and-next-generation-broadband); C. Mitchell, *Correcting Community Fiber Fallacies: Yoo Discredits UPenn, Not Municipal* Networks, COMMUNITY NETWORK INITIATIVE AT THE INSTITUTE FOR LOCAL SELF-RELIANCE (June 2017) at p. 1 ("The Net Present Value calculation is inappropriate in this context for many reasons and does not offer an accurate view of the financial performance of these networks or the larger context of the investment impact on the community") (available at: https://muninetworks.org/sites/www.muninetworks.org/files/fiber-fallacies-upenn-yoo-1.pdf).

30 G.S. Ford, *Financial Implications of Opelika's Municipal Broadband Network*, PHOENIX CENTER POLICY PERSPECTIVE NO. 17-11 (August 24, 2017) (available at: http://www.phoenix-center.org/perspectives/Perspective17-11Final.pdf).

31 M.S. Mavredes, *Review of Bristol Virginia Utilities Authority*, Virginia Auditor of Public Accounts (October 2016) (available at: http://www.apa.virginia.gov/reports/BVUA2016-web.pdf).

32 *Id.* at Executive Summary.

33 T. Bohner, *Bristol, Va. Approves Sale of BVU's Optinet to Sunset Digital*, WCYB NEWS (March 15, 2016) (available at: http://www.wcyb.com/news/bristol-va-approves-sale-of-bvus-optinet-to-sunset-digital/14609711); N. Shepherd, *Sunset Digital Clears Hurdle in Bid to Purchase BVU OptiNet*, KINGSPORT TENNESSEE TIMES NEWS (August 3, 2017) (available at: http://www.timesnews.net/Business/2017/08/03/Sunset-Digital-clears-hurdle-in-bid-to-purchase-BVU-OptiNet); J. Bacon, *Broadband Boondoggles in Southwest Virginia*, BEARINGDRIFT (November 30, 2017) (available at: https://bearingdrift.com/2017/11/30/broadband-boondoggles-southwest-virginia).

34 S. Titch, *Spinning its Wheels: An Analysis of Lessons Learned from iProvo's First 18 Months of Municipal Broadband*, REASON FOUNDATION (December 2006) (available at: http://reason.org/files/33224c9b01e12f3b969f4257037c057e.pdf) ("request $1 million in additional funds from the Provo's electric utility to meet its costs").

35 V. Horiuchi, *Provo Googled its Way Out of Fiber-Optic Network But Costs Live On*, SALT LAKE TRIBUNE (June 3, 2013) (available at: http://archive.sltrib.com/article.php?id=56288307&itype=CMSID).

36 K. Martin, *Poll Results Differ from Public Feedback on Potential Click Lease*, THE NEWS TRIBUNE (June 18, 2015) (available at: http://www.thenewstribune.com/news/local/politicsgovernment/article26337643.html).

37 G. Smith, *Groton's Deal to Shed TVC Finalized as New Owners Take the Reins*, THEDAY.COM CONNECTICUT (February 1, 2013) (available at: http://www.theday.com/article/20130201/NWS01/130209982); D. Straszheim, *How a Promising Idea Went Terribly Wrong in Groton*, GROTON PATCH (January 6, 2013) (available at: http://groton.patch.com/groups/politics-and-elections/p/how-a-promising-idea-went-horribly-wrong-ingroton).

38 State Of Vermont Public Service Board, Docket No. 7044, *Petition of City of Burlington, d/b/a Burlington Telecom, for a certificate of public good to operate a cable television system in the City of Burlington, Vermont (In Re: Amended Petition to amend Condition No. 17 of CPG related to completion of system build-out and to grant temporary relief from limitation in Condition No. 60 of CPG on financing operations*, ORDER ON MOTIONS AND CROSS-MOTION FOR PARTIAL SUMMARY JUDGMENT (Order entered: 10/8/2010) (emphasis supplied).

39 Case studies are provided in *Financial Implications of Opelika's Municipal Broadband Network*, *supra* n. 30.

## NOTES CONTINUED:

[40] *Id.*; C. Davidson and M. Santorelli, *Understanding the Debate over Government-Owned Broadband Networks: Context, Lessons Learned, and a Way Forward for Policy Makers*, NEW YORK LAW SCHOOL (June 2014) (available at: http://www.nyls.edu/advanced-communications-law-and-policy-institute/wp-content/uploads/sites/169/2013/08/ACLP-Government-Owned-Broadband-Networks-FINAL-June-2014.pdf).

[41] http://www.cga.ct.gov/2012/rpt/2012-R-0515.htm.

[42] J. Shea, *Tobacco Dollars Extend Broadband for Southwest Virginia*, BRISTOL HERALD COURIER (December 8, 2013) (available at: http://www.heraldcourier.com/news/local/tobacco-dollars-extend-broadband-for-southwest-virginia/article_ea52b42c-6083-11e3-8d56-0019bb30f31a.html).

[43] R. Seamans, *Fighting City Hall: Entry Deterrence and New Technology Deployment in Local Cable TV Markets*, 58 MANAGEMENT SCIENCE 461-475 (2012) (available at: http://www.jstor.org/stable/41431664; Draft available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1289454).

[44] *Financial Implications of Opelika's Municipal Broadband Network*, *supra* n. 30.

[45] Pricing data was not available online for the systems in Reedsburg-Wisconsin and Jackson-Tennessee. Prices were obtained by telephone.

[46] http://www.greenlightnc.com.

[47] http://www.comcast.com; http://www.epb.com. I apply a discount for AutoPay for Comcast.

[48] http://www.highlandsfibernetwork.com/internet; http://www.comcast.com.

[49] http://www.slandw.com/index.php/services/wireless-internet; http://www.comcast.com.

[50] The bootstrap employs 1,000 replications.

[51] C. Li and J. Losey, *Price of the Pipe*, NEW AMERICA (April 15, 2010) (available at: https://www.newamerica.org/oti/policy-papers/price-of-the-pipe); C. Farivar, *DC Think Tank Tells Americans that Their Broadband is Really Great,* ARS TECHNICA (February 13, 2013) (available at: https://arstechnica.com/information-technology/2013/02/dc-think-tank-says-state-of-us-broadband-is-good-and-getting-better); *Further Reply Comments of Consumers Union, Consumer Federation of America, Free Press and Public Knowledge*, WC DOCKET NO. 07-38 (September 2, 2008), at p. 8 (available at: https://ecfsapi.fcc.gov/file/6520064157.pdf); M. Cooper, *The Central Role of Wireless in the 21st Century Communications Ecology: Adapting Spectrum and Universal Service Policy to the New Reality*, Unpublished Manuscript presented at the 2011 Telecommunications Policy Research Conference (2011) (available at: https://ssrn.com/abstract=1979789); R.D. Atkinson, *The Role of Competition in a National Broadband Policy*, 7 JOURNAL ON TELECOMMUNICATIONS & HIGH TECHNOLOGY LAW 1-18 (2009) (available at: http://www.jthtl.org/content/articles/V7I1/JTHTLv7i1.pdf); R.D. Atkinson, D.K. Correa and J.A. Hedlund, *Explaining International Broadband Leadership*, INFORMATION TECHNOLOGY & INNOVATION FOUNDATION (February 2013) (available at: https://www.itif.org/files/ExplainingBBLeadership.pdfOpelika); *Current Broadband Measures Have Limitations, and New Measures Are Promising but Need Improvement*, Government Accounting Office, GAO-10-49 (October 2009) at p. 3 (available at: https://www.gao.gov/new.items/d1049.pdf) ("While some stakeholders suggested additional measures, such as price per megabit per second, opinions were mixed on these alternatives, with consumer advocacy groups, academicians, and representatives from think tanks generally in favor of and broadband providers and related trade and industry groups generally against them."). Others reject it. *See*, *e.g.*, R. Bennett, L.A. Stewart, and R.D. Atkinson, *The Whole Picture: Where America's Broadband Networks Really Stand*, INFORMATION TECHNOLOGY & INNOVATION FOUNDATION (February 2013) at p. 14 (available at: https://www.unh.edu/broadband/sites/www.unh.edu.broadband/files/media/kb-reports/2013-whole-picture-america-broadband-networks.pdf); *Next Generation Connectivity: A Review of Broadband Internet Transitions and Policy from Around the World*, BERKMAN CENTER FOR INTERNET & SOCIETY (February 2010) (available at: http://cyber.harvard.edu/sites/cyber.harvard.edu/files/Berkman_Center_Broadband_Final_Report_15Feb2010.pdf).

[52] G.S. Ford, *The Misuse of International Broadband Rankings Continues*, @LAWANDECONOMICS BLOG (February 19, 2013) (available at: http://www.phoenix-center.org/blog/archives/1156).

[53] H. B. Mann and D. R. Whitney, *On a Test Whether One of Two Random Variables is Stochastically Larger than the Other*, 18 ANNALS OF MATHEMATICAL STATISTICS 18: 50-60 (1947).

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[54] R. Newson, *Parameters Behind "Nonparametric" Statistics: Kendall's Tau, Somers' D and Median Differences*, 2 STATA JOURNAL 45-64 (2002).