P E R S P E C T I V E S

PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES

OTI's *Cost of Connectivity 2020 Report*: A Critical Review

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Introduction

With Congress poised to spend as much as $100 billion on broadband deployment and adoption as part of the next COVID relief package,[1] a renewed effort to push municipal broadband to the forefront of the broadband policy debate is afoot. A common narrative in this effort is that government-run networks charge lower prices for broadband than do their private counterparts. In recent years, several reports claim to offer evidence of such discounts.[2] Yet, all these reports suffer from poor design and unskilled analysis. Once corrected for errors, the data used by these reports reveal no price disparity.[3]

Advocates for municipal broadband are, if anything, persistent. For example, the Open Technology Institute ("OTI") at the New America Foundation recently released a report entitled *Cost of Connectivity 2020* which purports to show that municipal broadband networks "offer the fastest, most affordable" broadband services and that "locally-owned networks yield significant cost savings for consumers."[4] Supporters of municipal broadband praised OTI's analysis.[5] A close look at the *OTI Report* and its data, however, reveals severe problems.

As shown in this PERSPECTIVE, the *OTI Report*'s data, once corrected for errors, do not support the hypothesis that government-run networks charge lower prices. Nor should they. The law of one price from economic theory states that within a single market the quality-adjusted prices for rivals should be equal. Using the *OTI Report* data, my analysis finds support for the law of one price. The proper question is not whether prices among firms in a single market differ, but rather whether average prices differ between markets that do or do not have a municipal provider.[6] Using OTI's data, I find that average prices are about 13% higher in cities with a municipal provider than in cities without a government-run network.

[T]he OTI Report's data, once corrected for errors, do not support the hypothesis that government-run networks charge lower prices. Nor should they. The law of one price from economic theory states that within a single market the quality-adjusted prices for rivals should be equal.

My analysis is organized as follows: First, I describe the law of one price and what it says about expected price differences within a market. Second, I discuss the data problems with the *OTI Report*. Third, excluding the bad data, I estimate the difference in average prices between municipal and private broadband providers; no difference is found. Comparing average prices between markets with and without a municipal system shows higher prices in markets with government-run networks. Fourth, I offer a brief discussion of the problems with the price-per-megabit index used in the *OTI Report*, and fifth I

discuss the anticompetitive and predatory nature of municipal broadband.

The Law of One Price

The purpose of the *OTI Report* is to compare prices between government-owned and private networks within markets (or cities). While the *OTI Report* also compares prices across nations, I ignore these international comparisons for now as that is an entirely different and more complex problem (and largely meaningless).[7]

When comparing prices among sellers in a market, it is essential to begin with an expectation about how prices are determined—no such analysis is offered in the *OTI Report*. Economic theory provides a straightforward explanation. Put simply, within a single market, sellers compete for the patronage by offering attractive price-quality combinations to consumers. If one firm offers a highly favorable price-quality combination relative to its rivals, then all consumers will choose that firm's offering, leaving the higher-priced firms without revenue. Rational, efficient sellers will keep their price-quality offerings in line with rivals so as remain profitable. Therefore, prices within a market will converge to equal (quality adjusted) prices.

Presumably, the authors of the *OTI Report* believe that private and municipal broadband providers are competing for customers. To my knowledge, none of the municipal networks in the *OTI Report*'s sample have a 100% market share. Thus, the price-quality offerings of private providers must be comparable to those of municipal providers, assuming consumers act rationally. This similarity of quality-adjusted prices within a single market is known as the "law of one price."[8] 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.[9]

Within a single market, *like* things will sell for *like* prices. If large prices differences are found, then such differences are good evidence that the analyst has failed to properly measure price, is comparing prices of unlike services, or comparing prices *across* rather than *within* markets. For the most part, a search for meaningful price differences among firms in the same market with the same quality of services is pointless, though that is exactly what the *OTI Report* aims to do.

The proper question is not whether prices among firms in a single market differ, but rather whether average prices differ between markets that do or do not have a municipal provider. Using OTI's data, I find that average prices are about 13% higher in cities with a municipal provider than in cities without a government-run network.

Economic theory suggests that we should expect seller prices for a similar broadband service in the same market should be approximately equal.[10] That said, when some or all sellers offer bundles of services, then such price comparisons become very complex. While the *OTI Report* seeks to compare prices for a standalone broadband product, which is popular among some consumers, is not the most common way broadband services are purchased. Even today, many households obtain broadband service combined with multichannel video services, telephone services, and possibly other services.

Given the law of one price, a more appropriate price comparison is between markets that have a

municipal provider and markets that do not. If municipal providers charge lower prices, then those prices will be matched by their private-sector rivals. Markets without a municipal provider are not exposed to this pricing pressure, to the extent it exists. Comparing prices between markets with different market structures is common in the economic literature. For instance, in the literature on competitive cable video markets, prices are compared across monopoly and competitive markets; prices are not compared between providers in a single market. In making such comparisons across markets, differences in the demand- and supply-side conditions among markets are normally accounted for by statistical methods (normally, regression analysis).

The *OTI Report*'s Data Errors

Included in the *OTI Report* is a link to the survey data used to make price comparisons (which is commendable). Here, I will use this data to conduct statistical tests of price differences among ownership types and across market types. But first, errors in the data must be addressed.

First, the *OTI Report* surveys fourteen cities and finds that "the lowest average price is in Ammon, Idaho, a city with a municipally-owned open access network,"[11] thus earning Ammon the title of "most affordable" city in America.[12] Unfortunately for OTI, the prices reported in their *Report* for providers in Ammon are incorrect, and the error should have been obvious to the authors. The *OTI Report*'s data shows that two retail operations using the municipalities open-access network charge $9.88 or $14.88 for a 1 Gbps connection. There is no plausible long-term business case for prices this low, absent substantial subsidization, as these prices cannot possibly cover the full economic cost of providing broadband services.

Nor do they.

Indeed, these prices represent only a small share of the total cost of obtaining this service. In Ammon, a customer of a retailer using the municipal network pays both the retailer and the city for broadband service. These charges appear on the customer's utility bill, including a payment on what is effectively a 20-year loan of $3,000-$3,500 to connect the home to the network.[13] This loan payment and other costs amount to a fee of about $40 per month in additional to the retailer's fee. However, it does not make sense simply to add the $40 to the retailer price, as the customer is required to take out a 20-year loan (or else pay the entire connection cost upfront), which is not a trivial financial transaction.

Within a single market, like things will sell for like prices. If large prices differences are found, then such differences are good evidence that the analyst has failed to properly measure price, is comparing prices of unlike services, or comparing prices across rather than within markets.

Also, the open-access model is prone to aggressive and ruinous price competition. In Ammon, customers can easily switch among retailers, all offering essentially a homogenous service. Consequently, the retailers must resort to aggressive price competition, as there is little room for differentiation. The long-term profitability of the retailers in Ammon charging $10 per month to service an account is unknown, but there are good reasons to question the economic viability of this program. Such models have not proved especially resilient in the past.[14]

Moreover, the service providers in Ammon are not municipalities, but profit-maximizing entities. To describe this scenario as a municipal broadband network is questionable and is more akin to the public-private partnership, especially

given the financial arrangements between the city and the networks subscribers. To what extent the city subsidizes the network with tax or utility revenue is unknown (to me) at this time, but it seems likely that cross-subsidies do exist (as discussed later).

Also, the *OTI Report*'s data include a third retailer (Directcom) in Ammon that charges $109.95 per month for a 1 Gbps connection. A visit to the provider's website, however, confirms that this provider does not offer service in Ammon, so this is a data error. The Ammon data is a mess, so my statistical analysis excludes all data from this city.

[T]he OTI Report surveys fourteen cities and finds that "the lowest average price is in Ammon, Idaho, a city with a municipally-owned open access network," thus earning Ammon the title of "most affordable" city in America. Unfortunately for OTI, the prices reported in their Report for providers in Ammon are incorrect, and the error should have been obvious to the authors.

Statistical Analysis

Given the peculiarities in the business model in and errors in the data for Ammon, Idaho, I exclude all prices from the city for statistical analysis. For the remainder of the sample, I compute a price for broadband service equal to the lowest price available (including promotions) for each service plan including the cost (if any) of a broadband modem. I assume all homes pay the modem fee for a given provider, though this is probably an overstatement of price.

To ensure comparable services, broadband is defined as a connection capable of a download speed of 100 Mbps or better, since the vast majority of consumers could not tell the difference between broadband speeds of 100 Mbps or 1 Gbps. In a separate analysis, I use a threshold of 25 Mbps. Plans with speeds greater than 1 Gbps are excluded since such services do not represent a consumer service and the prices are very high.[15]

Prices Comparison by Firm Type

To test whether municipal providers offer lower prices than private providers, I perform the means difference test using the least-squares regression model,

$$p_{im} = \Delta muni_i + \mu_m + \chi_{im} + \varepsilon_{im} \qquad (1)$$

where p_{im} is the price of provider i in market m, $muni_i$ is a dummy variable indicating whether the provider i is a municipal system (or retailer using the municipal system), μ_m is a market fixed effect, χ_{im} is a download speed fixed effect, and ε_{im} is the econometric disturbance term.[16]

The coefficient Δ measures the difference in average price charged by municipal systems relative to private providers and the t-statistic on this coefficient is used for hypothesis testing. As noted above, the expectation is that the prices among providers in each market is zero. I also apply the natural log transformation to the price, where $\exp(\Delta) - 1$ measures the percentage difference in prices.

Before summarizing the regression results, note that for broadband services with download speeds of at least 100 Mbps the unconditional mean price is $74.66 private providers and is $76.46 for municipal providers, so the average municipal price is slightly higher. Because the regression analysis includes fixed effects for city and speed, the estimated means may differ from these simple averages.

Regression results are summarized in Table 1, based on a sample of 165 plans across 13 cities for

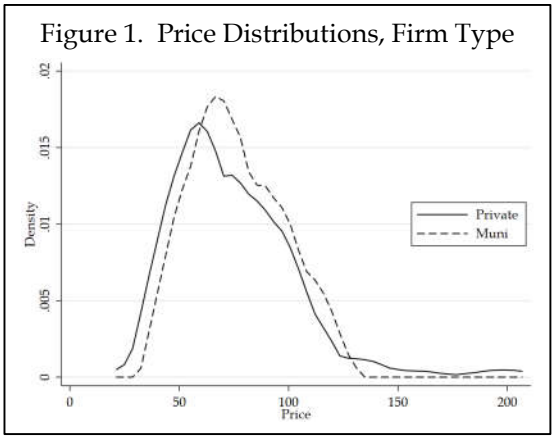
26 providers. Standard errors are robust to heteroskedasticity.

Table 1. Price Comparisons
(Comparing Firm Types, ≥ 100 Mbps)

	p_{im}	$\ln(p_{im})$
Δ	-0.655	0.0237
	(-0.05)	(0.16)
Mean Private	74.78***	4.255***
	(40.94)	(196.1)
City FE	Yes	Yes
Speed FE	Yes	Yes
Observations	165	165
Stat. Sig. * 10%, ** 5% , *** 1%		

From Table 1 we see that the average price for broadband for private sellers is $74.78 per month. The average price for municipal providers is $74.13 (adding the Δ coefficient to the private mean).[17] The difference is trivially small and not statistically different from zero; the t-statistic on the Δ coefficient is only -0.05. With price expressed in log form, the Δ coefficient is positive but again small and not statistically different from zero (t = 0.16). It is not possible to reject the null hypothesis that the prices charged by municipal providers and private providers are equal. The law of one price holds.

Figure 1. Price Distributions, Firm Type



It may be easier to grasp the results by looking at the distributions of prices. Figure 1 illustrates the price distribution of private and municipal providers (using a kernel-density function, which is smoothed histogram) for plans with speeds of at least 100 Mbps. There are two distributions shown: (1) the solid line for private providers and (2) the dashed line for municipal providers. The distributions of prices across the ownership types are nearly identical, as the regression confirms. Across plans and markets, municipal and private providers are charging prices drawn from essentially the same distribution.

This analysis confirms that any statistically meaningful differences in prices between municipal and private providers from the OTI Report's survey is the consequence of careless data collection.

Setting the broadband threshold at 25 Mbps, Equation (1) is re-estimated. The results are summarized in Table 2. Now there are 210 observations across 13 cities and 30 providers. The Δ coefficient is now positive, but very small. The null hypothesis of equal prices cannot be rejected at standard levels for either specification of the dependent variable (the t-statistics are 0.03 or 0.07).

Table 2. Price Comparisons
(Comparing Firm Types, ≥ 25 Mbps)

	p_{im}	$\ln(p_{im})$
Δ	0.264	0.009
	(0.03)	(0.07)
Mean Private	69.47***	4.160***
	(38.14)	(188.5)
City FE	Yes	Yes
Speed FE	Yes	Yes
Observations	210	210
Stat. Sig. * 10%, ** 5% , *** 1%		

As should be expected, the law of one price holds—there are no price differences by ownership type within a market. The Open Technology Institute's claim that municipal systems charge lower prices is unsupported by the data used in its *Report* once the data anomalies are eliminated.

We can see the effect of the data problems in the *OTI Report*'s survey by including the data from the city of Ammon in the sample. The results are summarized in Table 3 and the sample includes 14 additional observations (which includes additional private providers as well).

Table 3. Price Comparisons
(Including bad data, ≥ 100 Mbps)

	p_{im}	$\ln(p_{im})$
Δ	-20.18*	-0.487**
	(-1.95)	(-2.55)
Mean Private	74.53***	4.241***
	(37.84)	(146.5)
City FE	Yes	Yes
Speed FE	Yes	Yes
Observations	179	179
Stat. Sig. * 10%, ** 5% , *** 1%		

The Δ coefficient is has changed from -0.655 to -20.18, a huge difference. The bad data are very influential, but with relatively few perverse datapoints the coefficient (despite being large) is statistically different from zero only at the 10% level. With log price, the percentage difference is 39%, and the coefficient is statistically different from zero at the 5% level. This analysis confirms that any statistically meaningful differences in prices between municipal and private providers from the *OTI Report*'s survey is the consequence of careless data collection.

Price Comparisons by Market Type

The more interesting question is whether prices in markets with a municipal provider are, on average, lower than in markets without a government-run network. To test for such a difference, the regression model is,

$$p_{im} = \beta_0 + \delta munimkt_m + \chi_{im} + \varepsilon_{im} \qquad (2)$$

where $munimkt_m$ is a dummy variable indicating the presence of municipal network in market m.[18]

The β_0 measures the average price in markets without a municipal network and $\beta_0+\delta$ measures the price in markets with a municipal network (so δ measures the difference in prices). Results are summarized in Table 4. Note that the unconditional mean prices are $71.77 in cities without a municipal provider and $84.72 in cities with a government-run network.

Table 4. Price Comparisons
(Comparing Market Types, ≥ 100 Mbps)

	p_{im}	$\ln(p_{im})$
δ	16.96**	0.206***
	(2.88)	(3.50)
β_0	70.85***	4.208***
	(36.64)	(167.9)
City FE	No	No
Speed FE	Yes	Yes
Observations	165	165
Stat. Sig. * 10%, ** 5% , *** 1%		

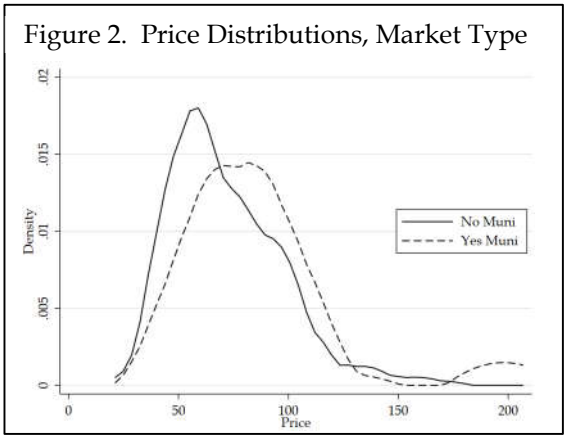
In Table 4, we see that average prices in markets with a municipal network are much higher than markets without government-run networks. The average price in non-muni cities is $70.85, but $87.80 in cities with municipal networks. The difference (δ = $16.96) is statistically different from zero at the 5% level. When price is expressed in natural log form, prices are 23% higher in cities with municipal networks, and this difference is also statistically different from zero at the 1% level. Similar results are found at the broadband threshold of 25 Mbps (a 20% difference, also significant at the 1% level).

Much of the analysis in the OTI Report is based on price-per-megabit, an index created by dividing price by the download speed of the connection. Serious analysts know that for several reasons "price-per-megabit" is largely a meaningless statistic, at least for price comparisons.

Figure 2 illustrates the price distributions by market type, with the solid line showing the price

distribution in markets without municipal providers and the dashed line for markets with government-run networks. The figure shows that the price distribution in markets with municipal providers is shifted to the right (toward higher prices), as the regression confirms.

Figure 2. Price Distributions, Market Type



When comparing prices across cities, it probably makes sense to include other factors that may affect prices. Prices may be higher, for instance, in cities where incomes are higher. The augmented regression model may be written as,

$$p_{im} = \beta_0 + \delta munimkt_m + \chi_{im} + \theta X_m + \varepsilon_{im} \quad (3)$$

where X_m is a matrix of market factors that may influence price (and θ a vector of coefficients). Regressors include median income, average age, and average gross rent for the city.[19] For this model, all variables are expressed in natural log form (so $\exp(\delta) - 1$ measures the percent difference); the coefficients on the additional regressors measure elasticities. Results are summarized in Table 5 for the two broadband threshold levels.

Table 5. Price Comparisons
(Comparing Market Types)

	≥ 25 Mbps	≥ 100 Mbps
δ	0.113**	0.139**
	(2.24)	(2.53)
Med. Income	0.116	0.266
	(0.46)	(1.17)
Avg. Age	-1.159***	-1.528***
	(-3.45)	(-4.01)
Avg. Rent	0.191	-0.346
	(-0.60)	(-1.18)
β_0	8.324***	9.174***
	(6.67)	(6.24)
City FE	No	No
Speed FE	Yes	Yes
Observations	210	165
Stat. Sig. * 10%, ** 5% , *** 1%		

We see from the table that the prices are not much affected by the demographics. A 10% increase in income changes prices by about 2%, though the change is not statistically different from zero. Only age is statistically different from zero; prices are lower in cities with younger populations.

Even with additional regressors, the δ coefficients remain statistically different from zero at the 5% level. Prices in cities with a municipal provider are about 13% higher (on average) than prices in cities without a municipal provider. Based on the *OTI Report*'s survey data, in cities with a government-run network, prices are higher for broadband.

Price-Per-Megabit is a Misleading Statistic

Much of the analysis in the *OTI Report* is based on price-per-megabit, an index created by dividing price by the download speed of the connection. Serious analysts know that for several reasons "price-per-megabit" is largely a meaningless statistic, at least for price comparisons.

First, consumers do not pay a price-per-megabit, so the price does not reflect the prices faced by consumers. Second, broadband speeds are routinely increased by providers without changes in price, though most consumers do not

view this as a price reduction. Third, price and quality cannot be condensed to single index.

Perhaps more importantly, price-per-megabit comparisons can lead to very perverse conclusions. 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.

We can see this problem in OTI's data. The average price for a 1 Gbps connection is about $80, so the price-per-megabit is about $0.08. For a 10 Gbps connection, the average monthly price is about $475 for a price-per-megabit of $0.0475. In terms of price-per-megabit, the 10 Gbps services is 40% cheaper, when the monthly price is nearly five-times as expensive. In making a choice, the consumer will compare $80 to $475 not $0.08 to $0.0475.

Unless theoretically justified, price-per-megabit should be cautiously and sparingly used, and its limitations explicitly recognized.

Subsidies and Predation

As I have detailed elsewhere, municipal broadband is not pro-competitive but predatory.[20] Municipal networks are typically highly subsidized, with expenses covered by taxation and, in some cases, higher utility bills.[21] Private providers in the market do not obtain such government support, causing an asymmetry in the costs of providing service. Even so, the expectation is that municipal networks will fail financially, so the government-run networks must be highly inefficient relative to private providers.

In the case of Ammon, Idaho, reports on the network demonstrate the problem. As noted by Patterson (2018), Ammon's city network "does not rely on achieving a specific take rate to break even, and it will never generate a profit."[22] If the municipal network "will never generate a profit," then low relative prices, to the extent they exist, reflect prices below cost. Financial support from the city, which is withheld from private companies operating in the city, distort competition rather than support it. Such practices should receive antitrust scrutiny, and one day may do so when private providers grow sufficiently weary of such unfair practices.

If the municipal network "will never generate a profit," then low relative prices, to the extent they exist, reflect prices below cost.

Conclusion

By the law of one price, price differences for like products and services are unsustainable. Thus, the Open Technology Institute's attempt to show that municipal systems charge lower prices than their private counterparts, which is one goal of the *OTI Report*, is largely a meaningless exercise. In fact, using the data from the *OTI Report*, but excluding survey errors, I show in this PERSPECTIVE that the law of one price holds: prices charged by municipal providers are no different than those charged by private providers in the same market.

Empirical evidence suggests, however, that prices in markets with a municipal provider are higher than those in markets without a government-run network. Higher prices in cities with municipal networks do not support an expansion of municipal broadband, though government-run networks may be rejected as sensible on antitrust grounds and the financial burden imposed on residents.

NOTES:

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1 *House Democrats Release Text of H.R. 2, A Transformational Infrastructure Bill to Create Jobs and Rebuild America*, Press Release (Jun 22, 2020) (available at: https://energycommerce.house.gov/newsroom/press-releases/house-democrats-release-text-ofhr-2-a-transformational-infrastructure-bill) ("Delivers affordable high-speed broadband Internet access to all parts of the country by investing $100 billion to promote competition for broadband internet infrastructure in unserved and underserved communities, prioritizing those with persistent poverty.").

2 G.S. Ford, *A Review of the Berkman Center's Price Survey of Municipal Broadband Markets*, PHOENIX CENTER POLICY PERSPECTIVE No. 18-01 (January 24, 2018) (available at: https://www.phoenix-center.org/perspectives/Perspective18-01Final.pdf); G.S. Ford, *Why Chattanooga is not the "Poster Child" for Municipal Broadband*, PHOENIX CENTER POLICY PERSPECTIVE No. 15-01 (January 20, 2015) (available at: https://www.phoenix-center.org/perspectives/Perspective15-01Final.pdf); 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: https://www.phoenix-center.org/perspectives/Perspective14-01Final.pdf).

3 *Id*.

4 B. Chao and C. Park, *The Cost of Connectivity 2020*, Open Technology Institute (July 15, 2020) (available at: https://www.newamerica.org/oti/reports/cost-connectivity-2020) (hereinafter "*OTI Report*") at p. 7.

5 *See, e.g.,* Tweet by Representative James Clyburn (July 15, 2020 · 12:08 PM) ("Affordability must no longer be a barrier to internet adoption. The #HousePassed Accessible, Affordable Internet for All Act addresses this by promoting price transparency, protecting local public options, and ensuring affordable plans are offered on newly-funded networks."); Tweet by FCC Commissioner Geoffrey Starks (July 15, 2020 · 12:42 PM) ("Kudos to @OTI for investing in this deep analysis and supporting efforts to make affordable broadband universal.").

6 There is a rich literature comparing market outcomes across varying market structures, regulatory paradigms, and ownership types. *See, e.g.*, S. Martin, ADVANCED INDUSTRIAL ECONOMICS (2002), at Ch. 5; S.M. Besen and J.R. Woodbury, *Rate Regulation, Effective Competition, and the 1992 Cable Act*, 17 HASTINGS COMMUNICATIONS & ENTERTAINMENT Law Journal 203-224 (1994) (available at: https://repository.uchastings.edu/hastings_comm_ent_law_journal/vol17/iss1/9); T.R. Beard, R.P. Saba, G.S. Ford, and R.C. Hill, *Fragmented Duopoly: A Conceptual and Empirical Investigation*, 78 JOURNAL OF BUSINESS 2377-2396; S. Basu, J. Andrews, S. Kishore, R. Panjabi, and D. Stuckler, *Comparative Performance of Private and Public Healthcare Systems in Low- and Middle-Income Countries: A Systematic Review*, 9 PLoS MED 1-14 (2012) (available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3378609/pdf/pmed.1001244.pdf); A.F. Alkhuzam J. Arlet, S.L. Rocha, *Private Versus Public Electricity Distribution Utilities: Are Outcomes Different for End-Users?*, WORLD BANK BLOGS (May 03, 2018) (available at: https://blogs.worldbank.org/developmenttalk/private-versus-public-electricity-distribution-utilities-are-outcomes-different-end-users).

7 *C.f.,* G.S. Ford *Is France a Broadband Nirvana? A Look at the Data,* PHOENIX CENTER POLICY PERSPECTIVE NO. 20-03 (June 18, 2020) (available at: https://www.phoenix-center.org/perspectives/Perspective20-03Final.pdf); G.S. Ford, *Be Careful What You Ask For (Redux): A Comment on the New America Foundation's Mobile Price Metrics,* PHOENIX CENTER PERSPECTIVE NO. 10-06 (November 11, 2010) (available at: https://www.phoenix-center.org/perspectives/Perspective10-06Final.pdf).

8 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).

9 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.").

NOTES CONTINUED:

[10] 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 *OTI Report*.

[11] *OTI Report*, *supra* n. 4 at p. 7.

[12] *Id.* at p. 6.

[13] *See, e.g.,* R. Suppe, *Ammon Fiber Explained: Utility Leaders Host Information Meeting to Deter Misinformation*, POST REGISTER (June 6, 2019) (available at: https://www.postregister.com/news/local/ammon-%c3%95ber-explained-utility-leaders-host-information-meeting-to-deter-misinformation/article_159dde53-c15f-541c-8891-cfc18f1927c5.html).

[14] *See, e.g.,* W. Lehr, M. Sirbu, and S. Gillett, *Broadband Open Access: Lessons from Municipal Network Case Studies*, Working Paper (2003) (available at: https://www.researchgate.net/publication/228528290_Broadband_open_access_Lessons_from_municipal_network_case_studies).

[15] Including these service tiers leads to much higher prices for municipal systems. There are only 9 plans and 5 providers in the sample offering such speeds. The average price of these high speed connections is about $380 per month.

[16] The fixed effects limit (to a large extent) the price comparison to price differences by firm type rather than by market or speed. Some recoding of speed was done so that at least two observations were in each speed group (e.g., 155 Mbps was recoded to 150 Mbps; 80 Mpbs was recoded to 75 Mbps; and so forth). Price-per-megabit was calculated with the raw speed data.

[17] Excluding the fixed effects, the Δ coefficient is 1.80 with a t-statistic of 0.26.

[18] The market fixed effect is eliminated due to collinearity.

[19] All demographics are obtained from www.city-data.com.

[20] G.S. Ford, *The Impact of Government-Owned Broadband Networks on Private Investment and Consumer Welfare*, State Government Leadership Foundation (April 6, 2016) (available at: http://sglf.org/wp-content/uploads/sites/2/2016/04/SGLF-Muni-Broadband-Paper.pdf).

[21] *Id.*; *see also* citations *supra* n. 2.

[22] B. Patterson, *What is the "Ammon Model"?*, BROADBAND PROPERTIES (May/June 2018) (available at: https://www.bbcmag.com/community-broadband/what-is-the-ammon-model).