MEASURING BROADBAND INTERNET PRICES

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1. INTRODUCTION

How much? – asks the boss of the expert.
30! – the expert answers.
What do you mean when you say 30? – asks the boss.
What do you mean when you ask how much? – replies the expert.[1]

We may experience similar situations to the joke above when trying to collect economic data for broadband Internet access. Some data is available,[2] but when we make an attempt to understand how broadband markets and their players behave, we soon realize that there is no data in

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1. This is a classic joke in central Europe.

2. For example, the number of subscribers of the largest Internet Service Providers is available. *See* LEICTMAN RESEARCH GROUP, 2.6 MILLION ADDED BROADBAND FROM TOP CABLE AND TELEPHONE COMPANIES IN 2013 (2014), *available at* http://www.leichtmanresearch.com/press/031714release.html.

the public domain that could be used to track national or regional broadband service price development.

Consider the all-item Consumer Price Index ("CPI"), one of the most closely watched national economic statistics in the United States.[3] This general price index tracks the average change in prices over time, and it is commonly used to adjust the real values of salaries and pensions and to regulate prices. The Internet services CPI is part of the all-item CPI, but it cannot be used to monitor broadband price movements. The U.S. Bureau of Labor Statistics ("BLS") has been publishing an Internet price index since 1997, but this index does not consider the appreciable improvements in broadband end user experience and overestimates the results of inflation.[4] If we have an improperly calculated broadband CPI and we include this broadband CPI in the overall CPI, the overall CPI will also be incorrect.[5]

A more accurate broadband price index and a better understanding about aggregate prices are beneficial for many reasons. First, better pricing information means better inferences about market power and better policy decisions. Second, better pricing information is useful for estimating supply-demand models for broadband markets and calculating demand elasticity for high-speed Internet services. Third, price indices are useful for tracking conduct over time. Finally, a well-constructed Internet price index would mean a better general price index for the whole economy.

Despite these benefits and resultant academic criticism regarding the status quo, there is still no data available in the public domain to show how the quality-adjusted prices of Internet service in the United States change over time. This is a serious drawback. We must find a way to construct a relevant Internet price index that can be used by industry stakeholders as a benchmark for monitoring nationwide broadband price movements. If we accept that "broadband [Internet] is a foundation for economic growth, job creation, global competitiveness and a better way of life," and that "every American should have affordable access to robust broadband service,"[6] we should also seek to collect more reliable national and regional pricing data related to Internet access.

One of the recommendations of the National Broadband Plan is to

3. *See* CONSUMER PRICE INDEX, http://www.bls.gov/cpi/ (last visited Mar. 26, 2014).

4. Shane Greenstein, *Is the Price Right? The CPI for Internet Access: A Report for the Bureau of Economic Analysis* (Dec. 20, 2002), *available at* http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/WP/Is_the_price_right.pdf.

5. The weight of the Internet services CPI in the overall CPI is not large today, but with convergence and cord cutting, the former's importance will likely grow.

6. FED. COMMC'NS COMM'N, CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN XI, XIV (2010), *available at* http://download.broadband.gov/plan/national-broadband-plan.pdf.

improve the availability of information about broadband services.[7] The Federal Communications Commission's ("FCC") Measuring Broadband America program built an ongoing, rigorous, nationwide study of residential broadband technical service parameters in the United States.[8] As a result, researchers now have open access to the data of the program and can also access open platforms to deploy additional engineering measurements tools. We argue that there is also a need to create an ongoing, rigorous, nationwide study of *residential broadband price movements* in the United States.

In Section 2 of this paper, we provide an overview of the history of the CPI and review the shortcomings of the Internet access CPI. Section 3 adds relevant literature and reviews the most important challenges pertaining to the construction of a broadband price index. In Section 4, we show a simple example to illustrate why it is not possible to construct a price index with the public data currently available. Section 5 includes our recommendation on how data transparency could be improved by using a trusted repository and setting up an ongoing broadband pricing trends study. Section 6 concludes and outlines future efforts.

2. OVERVIEW

The CPI shows how the prices of certain products and services change over time. The Index is probably the most commonly used tool to monitor change in consumer prices around the world. In addition to its primary monitoring function, it has two other important applications. First, it is used as a deflator when time series data need to be adjusted to ensure that data is reported in monetary units that are comparable over time. Second, it is used as a benchmark measure in various types of contracts that include terms or conditions indexed to inflation.

A price index operates as a measure that examines the weighted average of prices of a predefined "basket" of consumer goods in time period t_o and compares this calculated average price with the weighted average of prices of the basket in time period t_1. As a simple example to illustrate the calculation of a broadband service price index, consider a single market with two Internet Service Providers ("ISPs"). One is a

7. *Id.* at 18-26.

8. The FCC's Measuring Broadband America program employs a comprehensive suite of software-based tools that periodically measure technical parameters, including upstream and downstream data rates, packet loss, latency, and jitter, while excluding the effects of consumers' equipment and their Internet activity. *See* OFFICE OF ENG'G & TECH. & CONSUMER & GOVERNMENTAL AFFAIRS BUREAU, FED. COMMC'NS COMM'N, MEASURING BROADBAND AMERICA: A REPORT ON CONSUMER WIRELINE BROADBAND PERFORMANCE IN THE U.S., 1-7 (2011), *available at* http://transition.fcc.gov/cgb/measuringbroadbandreport/Measuring_U.S._-_Main_Report_Full.pdf.

cable ISP and the other is a DSL ISP, each offering only one tier of service with an advertised downstream rate of 4Mbps. If the ISP of the 4Mbps DSL service, priced at $20 in year 0, increases the monthly price of the service to $22 in year 1, while holding other characteristics of the service (e.g. data rate) constant, the DSL Internet price index would record a 10 percent year-to-year increase. If the ISP of the 4Mbps cable service, also priced at $20 in year 0, increases the monthly price of the service to $24 in year 1, while holding other characteristics of the service constant, the cable Internet price index would show a 20 percent increase. In this example, assuming a hypothetical market share of 75 percent to cable and 25 percent to DSL, the overall broadband price index would show an annual increase of 17.5 percent.

2.1 Brief historical summary

The CPI is over 100 years old. The BLS first published an index of consumer prices for food in 1903.[9] By 1914, the index basket was expanded to include cloth and clothing.[10] It soon became apparent that the early version of the CPI was not representative of consumer prices in general. As a remedy, the BLS introduced a consumer expenditure survey to develop a broader index basket. Regular publication of a national CPI based on expenditure survey data began in 1921.[11] Since that time, the CPI has been revised six times to implement changes regarding weights, expanded coverage, and methodologies.[12] The improvements introduced over the years have reflected not only BLS's own experience but also the results of academic research.[13]

Although the accuracy of the CPI has long been questioned due to various types of potential biases,[14] the BLS and other statistical agencies around the world employ the same fundamental methodological principle

9. JOSEPH P. GOLDBERG & WILLIAM T. MOYE, FIRST HUNDRED YEARS OF THE BUREAU OF LABOR STATISTICS 36 (1985), *available at* http://www.bls.gov/opub/blsfirsthundredyears/100_years_of_bls.pdf.

10. Marshall Reinsdorf & Jack E. Triplett, *A Review of Reviews: Ninety Years of Professional Thinking About the Consumer Price Index*, *in* PRICE INDEX CONCEPTS AND MEASUREMENT 17 (Erwin W. Diewert et al. eds., 2009), *available at* http://www.nber.org/chapters/c5068.

11. BUREAU LABOR STATISTICS, *The Consumer Price Index,* in BLS HANDBOOK OF METHODS 7 (2007), *available at* http://www.bls.gov/opub/hom/pdf/homch17.pdf.

12. *Id.* at 8-12.

13. *Id.* at 10-12. Changes include, but are not limited to, methodology changes, changes in consumer spending weights, geographic and housing sample updates, and item classification revisions.

14. The Boskin Commission report emphasized four sources of possible CPI bias: substitution bias, outlet bias, quality bias, and new product bias. *See e.g.* ADVISORY COMM'N TO STUDY THE CONSUMER PRICE INDEX ("BOSKIN COMMISSION"), TOWARD A MORE ACCURATE MEASURE OF THE COST OF LIVING; FINAL REPORT TO THE SENATE FINANCE COMMITTEE (1996), *available at* http://www.ssa.gov/history/reports/boskinrpt.html.

today. First, the statistical agency chooses a sample of products and services as well as their sellers. Then the agency assigns a weight to each of these items based on how much a typical consumer spends on each of those items. Next, it gathers the price in the initial period for each of the product and service categories selected. After that, in a second period, the agency collects the price for exactly the same product or service from the same seller that was selected in the initial period. Finally, the agency calculates the CPI for the given time period from the data collected.[15]

The formula for the all-item CPI assumes that products and services have constant quality, and that their characteristics are not changing. There are goods and services, however, which show rapid rates of quality change, including Internet service. Customers may pay the same amount of money during the first and the second time periods, but they may experience a significantly better service in the second period due to data rate improvements offered by the ISP. Not adjusting for quality means that, for example, should an ISP increase its 1Mbps service (priced at $20) to 1.5Mbps, while holding other characteristics of the service constant, the official CPI would not record a price change.

2.2 The BLS Internet CPI methodology and its shortcomings

Simply put, the BLS constructs its price indices in two stages. In the first stage, basic indices are determined for each CPI item-area combination.[16] The weights for the first stage come from the sample data for the category in the area. The weights for the second stage are derived from reported expenditures from consumer expenditure surveys. The BLS then creates the all-items CPI from 8,018 basic indices derived from 38 geographic areas and 211 item categories.[17] Aggregate, higher-level indices are created by averaging across subsets of the 8,018 CPI item-area combinations. For example, the all-items CPI for Denver is the average of all 211 basic indexes in the Denver CPI area.[18] Similarly, the aggregate CPI for Internet services is the average of the basic indices for Internet services in each of the 38 index areas.[19]

The Internet services CPI has two components: one for new broadband customers and another for existing Internet users. These two components are added together to generate the Internet CPI, using price information from the relevant service providers. The appropriate weights

15. Jack Triplett, *Handbook on Hedonic Indexes and Quality Adjustments in Price Indexes: Special Application to Information Technology Products*, (Org. for Econ. Co-Operation & Dev. Directorate for Sci. Tech. & Indus., Working Paper No. 2004/9, 2004), *available at* http://www.oecd.org/science/scienceandtechnologypolicy/33789552.pdf.

16. For example, the Internet services index for the Denver CPI area is a basic index.

17. BUREAU LABOR STATISTICS, *supra* note 11, at 20-21.

18. *Id.*

19. GOLDBERG & MOYE, *supra* note 9, at 12-20.

are determined by the consumer expenditure surveys.[20]

The BLS first calculated and added the Internet access CPI to the all-item CPI in 1997.[21] Despite its relatively long existence, the Internet services CPI still does not reflect the steady changes in broadband end-user experience. In addition, the Internet services CPI does not provide relevant information for rural areas. We address each of these inadequacies in turn.

First, the BLS does not consider service quality when it constructs the Internet service price index. The BLS does not differentiate between distinctive service data rates, and considers a lower-tier Internet access service the same as a higher-tier Internet access service. Using the example from the beginning of this section, if the Internet service provider of the 4Mbps DSL service doubles the data rate of its broadband service in year 1, while keeping its price the same, the DSL CPI would show no change. Similarly, if the Internet service provider of the 4Mbps cable service increases the data rate to 20Mbps in year 1, while keeping its prices the same, the cable Internet price index still would not show any change. Although every customer would be receiving better service, the broadband price index for this sample market would show no change.

Year	All item CPI	Internet CPI	Ave. d/s data rate
2007	100	100	2.05 Mbps
2008	104	101	2.07 Mbps
2009	103	104	3.95 Mbps
2010	105	105	3.82 Mbps
2011	108	104	3.85 Mbps
2012	111	104	4.51 Mbps

TABLE 1. ALL ITEM CPI, INTERNET SERVICES CPI, AND AVERAGE DOWNSTREAM DATA RATES (2007-2012)[22]

At the time of writing, Internet access still is not among the CPI categories that utilize hedonic quality adjustment.[23] As a result, the official Internet CPI remains quite flat, notwithstanding the significant

20. Greenstein, *supra* note 4, at 7-8.

21. GOLDBERG & MOYE, *supra* note 9, at 7-11.

22. This information can be pulled from the BLS's online database under index item SEEE03 for years 2007-2012 and using 2007 as a baseline of 100. *Consumer Price Index-All Urban Consumers: Multi-Screen Data Search*, BUREAU OF LABOR STATISTICS, http://data.bls.gov/cgi-bin/dsrv?cu (last visited Oct. 23, 2013).

23. Hedonic quality adjustment methods remove price differentials due to quality change by adjusting the price with the estimated value of the change. For the full list of CPI items that utilize quality adjustments *see Hedonic Quality Adjustment in the CPI*, BUREAU OF LABOR STATISTICS, http://www.bls.gov/cpi/cpihqaitem.htm (last modified Feb. 23, 2012).

improvement in broadband access speeds. Table 1 shows the all-item CPI and the Internet services CPI of the BLS for the years 2007-2012. The last column presents the growth of the average downstream data rate within the same time period.[24] Table 1 illustrates that Internet prices, on average, have increased by four percent between 2007 and 2012, while the all-item CPI has increased by eleven percent. During the same period, Internet subscriptions increased by 250 percent and the average downstream data rate of broadband subscriptions increased by 120 percent.[25] Contrary to this, the BLS does apply hedonic quality adjustment in certain other item categories that tend to experience a high degree of quality change. For instance, the Bureau adjusts for quality changes in television or video equipment.[26]

Another issue is that the Internet service price indices of the BLS do not reflect the inflation impact across the entire US population. This is not an error in the CPI construct, but it is an attribute by definition. The CPI is defined as a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer products and services.[27] That is, the BLS price indices reflect only the inflation experiences of urban consumers.[28] This is also an issue for economists and policymakers, as ISP service offerings can differ substantially between urban and rural areas. Without realistic data on quality, price, and number of subscriptions from all regions of the U.S., it is difficult to reliably assess the effectiveness of policy programs intended to increase broadband service penetration in underserved areas. Regardless of these shortcomings, we believe that a broadband price index can be constructed that is more relevant and able to address these issues. The next section reviews the most significant challenges pertaining to its creation.

24. Average data rates are based on the connections-by-speed-tier data reported by the FCC. *See* High-Speed Services for Internet Access, INDUS. ANALYSIS & TECH. DIV., WIRELINE COMPETITION BUREAU, FED. COMMC'NS COMM'N. (2007-2012), *available at* http://transition.fcc.gov/wcb/iatd/comp.html.

25. Data from FCC form 477 filings for the years of 2007-2012. Only Internet connections where data rates exceeded 200kbps in both direction were considered. *See Local Telephone Competition and Broadband Deployment*, FED. COMMNC'NS COMM'N, http://transition.fcc.gov/wcb/iatd/comp.html.

26. BUREAU LABOR STATISTICS, *supra* note 11, at 12-20.

27. BUREAU LABOR STATISTICS, *Consumer Price Index Frequently Asked Questions (FAQs*), http://www.bls.gov/cpi/cpifaq.htm (last modified Aug. 15, 2013).

28. The BLS publishes two CPIs: one for all urban consumers (CPI-U) and another one for urban wage earners and clerical workers (CPI-W). They differ in the relative weights that are attached to the basic item-area components. *See* BUREAU LABOR STATISTICS, *supra* note 11, at 20-21.

3. CONSTRUCTING A BROADBAND CPI

Simply put, we need two things to create a broadband price index. First, we need reliable, validated data about service penetration and prices. That is, we need to know—for every relevant time period—the number of broadband customers in each geographical market, their service levels, and the price they pay for their broadband service. Second, we need to build a method that adequately accounts for quality changes between relevant time periods. This section reviews these two areas of consideration.

3.1 Data on service availability, penetration, and prices

There are various entities that collect and offer empirical data about Internet service, but none of the databases allow us to construct a broadband price index and truly monitor broadband price movements. The FCC aggregates information about broadband and voice connections from ISPs twice a year.[29] Based on the current rules of the FCC's Form 477 data program, all broadband service providers must report the numbers of residential subscribers at the census-tract level, broken down by technology and speed tier. The Form 477 program, however, does not collect price information, and makes only the summary statistics of subscribership data available to the public.[30]

The National Broadband Map ("NBM") also offers data on broadband Internet service availability, on the technology used to provide the service, and on the service levels offered by ISPs.[31] Created from a collaboration between the National Telecommunications and Information Administration ("NTIA"), the FCC, and all states and territories of the U.S., the NBM is an online tool to provide semi-annual information on the availability, technology, speed, and location of broadband Internet access at the census block group ("CBG") level. The NBM is a useful tool to track service availability, but it does not provide information on subscriptions or pricing.

The Securities and Exchange Commission ("SEC") requires companies to disclose certain financial and business information on an ongoing basis. The federal securities laws require publicly traded companies to submit annual reports on Form 10-K, quarterly reports on Form 10-Q, and updates on Form 8-K.[32] It is possible to gather

29. *See Instructions for Local Telephone Competition and Broadband Reporting*, FED. COMMNC'NS COMM'N, http://transition.fcc.gov/Forms/Form477/477inst.pdf (last visited Apr. 15, 2014).

30. *Id.*

31. NATIONAL BROADBAND MAP, http://www.broadbandmap.gov (last visited Mar. 26, 2014).

32. *See generally Form 10-Q: General Instructions*, SEC. & EXCH. COMM'N,

information from these documents, but the reports only provide aggregate information that might be used to validate data but not to construct a broadband CPI. For example, ISPs disclose in their SEC reports how many broadband customers they have, but they disclose only aggregate figures and do not provide any breakdown as to geographical markets or service tier.[33]

Consulting firms and other commercial information providers, for example Telogical Systems, also regularly collect data and provide their customers with business information on Internet service availability and pricing. ISPs also have their own internal confidential databases. None of these databases are in the public domain, but some data from these sources could be used to validate information regarding service penetration or prices.

Data Sources	**A**ccessibility	**Data Content**
FCC Form 477 Data Program	Semi-public	Subscriber numbers (census tract level, per speed tier), no pricing info
NTIA/FCC National Broadband Map	Public	Service coverage, max. advertised rates at the CBG level, no pricing info
Company SEC filings	Public	Subscriber numbers & revenues (quarterly, no regional breakdown)
Commercial Information Providers & Business Consulting Firms	Private, for fee	Varies
Proprietary Databases (e.g., CableLabs, Company internal data)	Confidential	Varies

TABLE 2. DATA SOURCES, ACCESSIBILITY, AND CONTENT

3.2 Accounting for qualitative changes and other contract features

How to adequately account for quality change has been one of the controversies in estimating price indices for Internet services. Indeed, one of the greatest problems faced in compiling a price index is the

https://www.sec.gov/about/forms/form10-q.pdf (last visited Apr. 15, 2014); *Form 10-K: General Instructions*, SEC. & EXCH. COMM'N, https://www.sec.gov/about/forms/form10-k.pdf (last visited Apr. 15, 2014); *Form 8-K: Current Report*, SEC. & EXCH. COMM'N, https://www.sec.gov/about/forms/form8-k.pdf (last visited Apr. 15, 2014).

33. Note that most of the DSL ISPs do not disclose revenue details from their residential broadband activities in their SEC reports; they report only revenue from their residential market segment. Contrary to this, cable ISPs do provide some details in their SEC filings regarding revenue from residential broadband activities.

accurate measurement and treatment of quality change due to changing product specifications and consumption patterns.[34]

Greenstein argued that hedonic quality adjustments would be desired to construct an Internet access CPI; he also argued that quality-adjusted indices are better than transactional indices because quality-adjusted indices use systematic methods to consider quality change.[35] Several empirical studies since have concluded that quality adjustments are necessary to create a better price index. Stranger and Greenstein, and Yu and Prud'homme determined that quality-adjusted price indices for Internet access show larger price declines than those of unadjusted indices.[36] Even later, Greenstein and McDevitt found that an Internet access CPI that adequately considered quality changes would have declined by between 1.6 percent and 2.2 percent per year.[37]

Williams recommends that the BLS adopt price adjustments using the predicted-price method based on the Box-Cox model.[38] Williams also constructed a quality-adjusted broadband CPI, based on empirical data, and investigated the difference between this experimental index and the official price index.[39] He concludes that, in order to account for quality movements over time, hedonic adjustments need to be made to the official Internet access CPI.[40] Williams also argues that the Box-Cox regression provides a better estimation of hedonic models than other,

34. There are two fundamentally different types of methodologies to handle the issues related to rapid quality changes: conventional (matched model) techniques and hedonic methods. The detailed review of these techniques lies outside the scope of this paper. *See* Triplett, *supra* note 15.

35. Greenstein, *supra* note 4, at 7-8. Greenstein identified six areas in which Internet access issues should be addressed: service data rate, service availability, contract features, reliability, network effects, and other non-price features.

36. Greg Stranger & Shane Greenstein, *Pricing in the shadow of firm turnover: ISPs during the 1990s*, 26 INT'L J. IND. ORG. 625 (2008); Kam Yu & Marc Prud'homme, *Econometric issues in hedonic price indices: the case of internet service providers*, 42 APPLIED ECON. 1973 (2010), *available at* http://flash.lakeheadu.ca/~kyu/Papers/Yu-Prudhomme2010.pdf.

37. Shane Greenstein & Ryan C. McDevitt, *The Broadband Bonus: Estimating Broadband Internet's Economic Value* (Apr. 2010), http://www.kellogg.northwestern.edu/faculty/greenstein/images/htm/Research/WP/Broadband%20Bonus%20-%20GreensteinMcDevitt-4.pdf.

38. Brendan Williams, *A hedonic model for Internet access Service in the Consumer Price Index*, MONTHLY LABOR REV., July 2008, at 33, *available at* http://www.bls.gov/opub/mlr/2008/07/art3full.pdf. The Box-Cox regression procedure transforms the dependent variable using a specific data transformation function. This technique is useful when normal distribution cannot be assumed.

39. *Id.* at 40-46. The experimental work of Williams showed the value of hedonic adjustment, but found no major differences between the quality-adjusted experimental and official indices. It is important to note, however, that Williams' work focused on the time period of 2005-2006, where broadband only contributed about 36 percent of the overall quotes used to calculate the price index; the rest of the quotes were still for dial-up.

40. *Id.* at 47.

more restrictive functional forms.[41]

While we argue that quality adjustment is necessary, development of a recommended hedonic regression model is outside the scope of this paper. Nevertheless, it is very appealing to investigate the use of the Box-Cox model using validated data from 2010 and onwards, and we consider doing that at a later phase of our research.

4. A SIMPLE EXAMPLE

The first three sections of this paper argue that there is no reliable regional data in the public domain on broadband pricing and service penetration. This section now connects the theoretical concepts presented in the previous sections with a simple example to illustrate the difficulties when calculating a broadband price index with imperfect data.[42]

4.1 CPI for continuing users

Internet markets are very heterogeneous in terms of consumer preferences, technologies used, and service plans provided by the ISPs.[43] Most ISPs offer multiple service packages in their respective coverage areas. The geographical size of the "market" is arbitrary for the purpose of our investigation. We may focus on small geographic areas and consider each census block as a distinct market. Alternatively, we could also study large markets and interpret each state as a separate market. In the former case, it will be extremely difficult to collect reliable information at this very granular level. In the latter case, we give up granularity but will likely be able to collect relevant information.

Broadband CPI can be calculated by measuring price changes and multiplying price changes by the weighting attached to the service packages. To calculate a formula for the broadband price index between 2010-2011 and 2011-2012, we must first approximate the number of customers of the ISPs in each market. Second, we must assign a weight to each of the ISP service packages based on customer penetration figures in each market. From this information, combined with prices, it is possible to calculate the weighted average price of the broadband Internet service in 2010, 2011, and 2012.

It is feasible to gather information on the number of residential

41. *Id.*

42. To keep the example simple, we compare annual price changes between mid-year of 2010, 2011 and 2012.

43. INDUS. ANALYSIS & TECH. DIV., WIRELINE COMPETITION BUREAU, FED. COMMC'NS COMM'N., INTERNET ACCESS SERVICES: STATUS AS OF JUNE 30, 2011 1-12 (2012), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0614/DOC-314630A1.pdf.

broadband customers of the largest ISPs. Public companies report this information in their regular SEC filings. Consulting companies, such as the Leichtman Research Group, also regularly publish broadband subscriber counts of the largest ISPs.[44] However, this is nationwide data and no regional breakdown is available.

Concerning the availability of pricing information, commercial information providers, such as Telogical Systems, regularly collect and organize broadband pricing data and make it accessible to their clients. Although these pricing databases are not in the public domain, they include the relevant information for price index construction.[45] Telogical Systems regularly collects detailed price information of Internet service, and its data can be organized by ISP, geography, and service package. For example, Q2 2010 data from Telogical System shows that Comcast offered several residential service packages in most of its major markets.[46] These service packages range from basic, economy service (1.5Mbps) through mid-tier service (16Mbps) to top-tier service (50Mbps). Pricing information is available, per service tier, on the setup charge, the monthly rate, and promotional charges. We can also learn the specifics about service bundles that include voice and video as well as Internet. This pricing information is necessary, but not sufficient, to calculate the average price per market. Calculation of the average price per each geographical region can only be done if we have some knowledge as to the number of customers subscribing to different service plans, and this is where the exercise must end; it is not possible to calculate average prices because appropriate weights depend on information that is not disclosed by the ISPs.

The U.S. government understands the importance of broadband pricing data collection[47] and has made several attempts to collect market-specific data on blended average speed or average revenue per end-user

44. *See e.g.*, LEICHTMAN RESEARCH GROUP, BROADBAND INTERNET ACCESS & SERVICES IN THE HOME (2013), *available at* http://www.leichtmanresearch.com/research/bband_home_brochure.pdf. Note, that collecting data on the 20 largest ISPs is sufficient because these providers server over 93 percent of the customers.

45. We gratefully acknowledge the use of data from Telogical Systems for our pricing study.

46. Telogical data is not in the public domain and must be purchased. *Residential Telecom Pricing & Alerts*, TELOGICALSYSTEMS, http://www.telogicalsystems.com/products-services/telogical-data-alerts/residential-telecom-pricing-data-alerts/ (last visited Apr. 13, 2014) (providing purchase information).

47. *See e.g.*, Broadband Data Improvement Act, Pub. L. No. 110-305, 122 Stat. 4096 (2008) (codified as amended 47 U.S.C. §§ 1301, 1303, 1304 (2012)) ("The Comptroller General shall conduct a study to consider and evaluate additional broadband metrics or standards that may be used by industry and the Federal Government to provide users with more accurate information about the cost and capability of their broadband connection, and to better compare the deployment and penetration of broadband in the United States with other countries.").

("ARPU").[48] However, the relevant aggregate broadband service pricing data is not available,[49] nor it is being collected today.[50] The question then remains: if the government does not or cannot collect the data, what else can be done?

There are two potential solutions to this problem. The first is to use statistical methods and collect information directly from the field. The second is to set up a structure in which ISPs would be willing to share relevant aggregated data on subscriptions and prices. In the following section, we suggest doing both.

5. BROADBAND AMERICAN PRICING TRENDS STUDY

The first three sections argued that end-users, researchers, policy makers, and the telecom industry as a whole are lacking reliable data on broadband service penetration in the US.[51] The previous section showed by example that none of the existing data sources allow us to make up for the deficiencies of the official Internet access CPI. We now argue that the industry must form an ongoing, rigorous, nationwide study of broadband pricing trends in the United States. As a remedy, we propose to set up an ongoing research effort using industry-wide collaborative efforts. The objective of the efforts would be the creation and maintenance of a Residential Broadband Price Index.[52]

48. The FCC also regularly publishes its Broadband Progress Reports. These reports analyze broadband deployment in the United States using a speed benchmark. These reports have used Form 477 data in the past, but they now rely solely on NBM data. In addition, the Broadband Data Improvement Act requires the FCC to report "information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers." *Id.*

49. The original description of the "State Broadband Data and Development Grant Program" aspired to collect data on the ARPU and subscriber-weighted average speed for each broadband service provider, by county, across the entire United States. A later-issued supplemental guidance made the collection of pricing data "not required". State Broadband Data and Development Grant Program, 70 Fed. Reg. 40,569-70 (Aug. 12, 2009); *see also* NAT'L TELECOMM. AND INFO. ADMIN., RIN 0660-ZA29, STATE BROADBAND DATA AND DEVELOPMENT GRANT PROGRAM (2009), *available at* http://www2.ntia.doc.gov/files/NTIA_MappingFAQ_NOFAClarity.pdf.

50. It may be suggested that the FCC's Form 477 data program can solve the issue regarding the lack of relevant pricing information. The FCC, as part of its larger Data Innovation Initiative, issued a Notice of Proposed Rulemaking on Modernizing the FCC Form 477. Modernizing the FCC Form 477 Data Program, *Notice of Proposed Rulemaking*, 26 F.C.C.R. 1508, 1572 (2011). After two years, however, there is no information regarding when or if the program will be extended to collect relevant pricing data.

51. Individual ISPs, of course, do know their prices and penetration figures and likely have information on their competitors. The industry as a whole, however, does not have aggregate understanding about CPI and other aggregate pricing data.

52. Our broadband pricing trends initiative would leverage the concept of the Measuring Broadband America program. We believe that the methodology used by the program to collect

In the spirit of the Measuring Broadband America program, the suggested pricing trend study would gather data from an all-volunteer broadband end user sample panel. The sample panel would be selected with the goal of covering major ISPs in all the states across six broadband technologies: DSL, cable, fiber-to-the-home ("FTTH"), fixed-terrestrial-wireless, mobile, and satellite.[53] The sample panel would be representative of the U.S. population to ensure that the results would support statistically valid inferences.[54]

Validation of panelists' service tier would be done by collecting actual end-user bills. To ensure the protection of survey respondents' privacy, the sample panel should include volunteers who knowingly and explicitly opt into the research. The study would collect data from end-users and operators on a semi-annual basis. Data collection of the study would be in sync with the data collection periods of the National Broadband Map. The regularly updated technical performance and service availability data from the Measuring Broadband America program and the National Broadband Map would allow us to build a robust quality adjustment model for major regions, cities, and selected rural and remote locations.

A critical component of such a study is the existence of a trusted repository capable of collecting and analyzing pricing data and making aggregate results available. We believe that the Interdisciplinary Telecommunications Program at the University of Colorado have the necessary expertise relevant to the subject, and could act and be viewed as a trusted repository for pricing trend data.

Contrary to the performance measurement program, the participation of the ISPs is not required. Despite this, the study desires to include leading ISPs. ISPs may voluntarily provide price and service penetration data to a trusted repository to ensure that the Broadband America Pricing Trend study brings accurate results. Participating ISPs would be asked to provide information to the trusted depository about their Internet data package(s), the corresponding average monthly price, and their number of customers per service tier(s). ISPs would be asked to provide relevant data semi-annually and at the state level.

The study then would use statistical techniques to validate the survey data results using data provided by the participating ISPs, and use

performance data could also serve as an example for collecting aggregate pricing data.

53. The Measuring Broadband America program currently measures the performance of only five broadband technologies: DSL, cable, FTTH, fixed-terrestrial-wireless, and satellite, but introducing a performance measurement for mobile services has also been considered. Additionally, due to the low number of satellite and fixed terrestrial wireless technology samples, the results from those technologies were not included in the 2011 and 2012 report.

54. Considering the costs of data collection at the time of writing, a sample size of 15,000 participants is called for.

the validated data to construct residential broadband price indices. Of course, all data submitted to the Broadband America Pricing Trends study would be held strictly confidential, and the program would maintain the confidentiality of information at the service provider level. Only aggregations of the data will be made public, to ensure that an individual ISP's data is not identified. Participating ISPs, as an extra incentive, may also be granted access to more detailed regional data—but only to aggregate data; no ISP specific data would be provided to any third party.

The goal of the Broadband America Pricing Trends study is to provide the most accurate economic information available related to pricing trends in the United States. To make this possible, the team would be using a variety of best practices to validate data before constructing the broadband price index. This includes a combination of techniques, including comparing information supplied by end users to data from the broadband service providers, public data, and third-party datasets.

6. SUMMARY AND CONCLUDING REMARKS

Former FCC Chairman Julius Genachowski has remarked that "policymaking is only as good as the facts and data on which decisions are based."[55] Indeed, fact-based communication policy-making is important for two reasons. First, quality data drives quality decisions. Second, factual and public data improves transparency, and transparency can protect against decision-making processes being captured by partial interests.

There are efforts from the US government to collect better economic data related to broadband Internet, but the fact is that, as of 2014, the United States does not have a broadband price index that reliably monitors nationwide broadband price changes. The BLS has been publishing an official Internet price index for over fifteen years, but despite criticism, the official price index still does not consider broadband data rate improvements.

This paper provided an overview of the history of CPI and reviewed the shortcomings of the BLS Internet access CPI. Most of the issues the paper raised are not new discoveries and can be solved by having adequate data available. While some efforts are underway to improve the situation, it is also not clear if, when, or how the U.S. government will start collecting and publishing aggregate pricing information for broadband Internet services.

To augment existing efforts, we presented the concept of a

55. Modernizing the FCC Form 477 Data Program, *supra* note 50, at 1572.

Broadband America Pricing Trends study, a research initiative of the Interdisciplinary Telecommunication Program at the University of Colorado. The objective of the initiative is to regularly publish broadband price indices that can be used by end users, academia, policy makers, and the industry to accurately measure and monitor price trends of broadband Internet service. While the task is not simple, we believe that by leveraging the methodology of the Measuring Broadband America program, and by using a trusted repository, a contemporary and robust broadband price index can be created by joint efforts.