

**How to Create a More Efficient Broadband Universal Service Program
by Incorporating Demand and Cost-Effectiveness Analysis**

September 2011

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Abstract

The existing high-cost fund suffers from two inherent flaws: it does not incorporate how much consumers value the services being subsidized, and does not measure the incremental, rather than average, effects of the program. This paper proposes a way to incorporate those factors into the Connect America Fund—the proposed high-cost broadband support program—to enable it to operate more efficiently than the existing high-cost program ever could.

In particular, decisions about where to provide subsidies should be based on cost-effectiveness analyses that explicitly take into account not just the cost of providing service but also how much consumers would value the improvement in service the subsidy would bring beyond what is currently available. Incorporating this information requires conducting regular research on consumer willingness-to-pay for different levels of broadband service. This information would be used to help determine what types of service should be subsidized in unserved areas, which areas to fund, and the maximum amount that should be spent on subsidies.

Such an approach would help achieve universal service objectives in a way that provides real benefits to citizens, does not enrich particular firms, and limits total spending.

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1. Introduction

The Federal Communications Commission's (FCC's) intention to design the proposed Connect America Fund (CAF) from the ground up presents a practically unprecedented opportunity to radically increase the efficiency of the universal service program. In particular, CAF should largely abandon the current cost-based approach of Universal Service Fund (USF) high-cost program in favor of a value-based approach in which subsidies are granted on the basis of whether the benefits of the incremental improvements they would fund are worth the cost. This approach, grounded in well-established methods of cost-benefit and cost-effectiveness analysis, provides a rational, data-driven framework for informing decisions about when subsidies are sensible, based on how consumers in high-cost areas themselves value the subsidized service.

This paper proposes a framework for the CAF that promotes efficiency by basing subsidies (1) on how much consumers themselves value broadband service rather than only on how much companies say it costs to provide service and (2) on the value of incremental—rather than average—service improvements attributable to the subsidies over the status quo.

A pure cost-benefit test is not appropriate for CAF. Absent large externalities, subsidizing service in high-cost areas is a net economic cost—if it were not, no subsidies would be necessary. A policy decision to subsidize broadband in such areas means that as a society we are willing to pay some costs to ensure a minimum level of service to as many people as possible. The question is how much. Understanding the expected benefits to consumers provides a way to make an informed decision about whether a particular subsidy is worthwhile and how subsidies in one area compare to subsidies in another.

This framework would be new to universal service policy, but is well-suited to answering important outstanding questions by using established tools of cost-benefit analysis and is consistent with President Obama's call for agencies proposing a new rule to make “a reasoned determination that its benefits justify its costs.”¹

For example, the National Broadband Plan estimated that bringing terrestrial service offering 4 mbps downstream and 1 mbps upstream to the last 5.3 percent of housing units would cost \$24 billion, of which \$14 billion was needed to build out to the very last 250,000 households.² The

¹ Barack Obama, *Improving Regulation and Regulatory Review*, Executive Order (The White House, January 18, 2011), <http://www.whitehouse.gov/the-press-office/2011/01/18/improving-regulation-and-regulatory-review-executive-order>. Specifically, the order says that agencies should “(1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.”

² Federal Communications Commission, *National Broadband Plan: Connecting America* (Washington, DC, March 2010), [http://www.broadband.gov/Section 8.1](http://www.broadband.gov/Section%208.1).

cost for more robust service increases radically—the Plan estimated that bringing 100 mbps service to unserved areas would cost \$350 billion.^{3,4} The relevant questions are how much, as a society, is it worth spending to bring broadband to unserved areas, and how much should we spend in each area?

None of the proposals in the NPRM make it possible to answer these questions, but the tools for “making a reasoned determination” exist. Benefit-cost analysis, commonly used by executive branch agencies as one tool for evaluating whether proposed rules are good for the nation, routinely take into account how much citizens value the effects of a rule by incorporating willingness-to-pay (WTP) as a measure of benefits into their analyses. So, for example, we do not generally undertake a large, expensive transportation project such as a new highway unless the cost of building that highway does not exceed how much individuals themselves value, or are willing to pay for, the benefits it will bring in terms of reduced travel time, automobile operating costs, and improved safety.⁵

Evaluating WTP for rules related to the environment and health and safety is difficult and controversial since those evaluations often involve monetizing the value of (a statistical) life.⁶ Using WTP estimates as a tool in evaluating universal service and other telecommunications policy should be more straightforward and less controversial than areas in which the government routinely uses them today. That is, estimating willingness to pay for broadband is conceptually easier and less fraught with ethical concerns than is estimating the value of life.

At a high level, a value-based CAF would base maximum subsidy levels in part on consumer WTP for broadband, rather than simply on providers’ reported or estimated costs. So, as a stylized example, if households are WTP \$80 per month on average for broadband and a particular unserved area has 1000 households who would be new broadband subscribers, then a subsidy should not exceed \$80,000 per month since any amount above that exceeds the value consumers themselves obtain.

That example is overly simplistic in many ways. Most importantly, the subsidy cannot be based *solely* on WTP or benefit cost analysis because providers already offer service in any areas in which consumers are willing to pay enough to cover costs. That is, if willingness to pay exceeded costs then the area would not be “unserved” except when the externalities of providing service are large. For various reasons, however, the externalities of improving service in most “unserved” areas are likely to be small.⁷

³ W. David Gardner, “National Broadband Could Cost \$350 Billion,” *Information Week Government*, September 30, 2009, <http://www.informationweek.com/news/government/mobile/220300595>.

⁴ Federal Communications Commission, *National Broadband Plan: Connecting America* Section 8.1.

⁵ See, e.g., U.S. Dept. of Transportation, Federal Highway Administration, Impact Methodologies, Cost-Benefit Case Studies, at http://www.fhwa.dot.gov/planning/toolbox/costbenefit_forecasting.htm (last visited July 11, 2011).

⁶ Robert W. Hahn, “Designing Smarter Regulation with Improved Benefit-Cost Analysis” (SSRN, 2008); Robert William Hahn et al., *Do federal regulations reduce mortality?* (Washington, DC: AEI-Brookings Joint Center for Regulatory Studies: available in the United States from the AEI Press, 2000); Joseph E. Aldy and W. Kip Viscusi, “Age Variations in Workers’ Value of Statistical Life,” *NBER Working Paper*, 2004; W. Kip Viscusi and Joseph E. Aldy, “The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World,” *The Journal of Risk and Uncertainty* 21, no. 1 (2003): 5-76.

⁷ High-speed Internet likely exhibits indirect network externalities in that more people with access creates a bigger market for services that require broadband, which increases incentives for entrepreneurs and others to create new

Because providing service in unserved areas is, almost by definition, a net cost, benefit-cost analysis, *per se*, is not appropriate. Instead, we can use the same tools to conduct cost-effectiveness analyses to help provide a rational way of deciding where to provide subsidies and how much. Understanding how much consumers value Internet service that is better than what is already available to them (typically satellite broadband service in “unserved” areas) will help policymakers decide when subsidies are likely to be worthwhile and how to allocate them.

The details of such an approach are, of course, more complicated than in the simplistic example above, and this paper discusses those details below. Despite those complications, this approach can be done. In fact, it has been done. Economists Rosston, Savage, and Waldman estimated household WTP for different attributes of broadband, finding that a typical household was WTP about \$80 a month for a “fast”, “reliable” broadband connection.⁸ Their research, from survey to analysis to final paper was accomplished in less than two months, demonstrating that while this sort of work is new, it can be done in a rigorous yet timely manner.

This paper describes in detail how willingness-to-pay, focus on incremental rather than average effects, and consumer driven subsidies can ensure that a future CAF is far more efficient than today’s high-cost fund.

2. The Importance of Marginal Effects and What They Reveal About the Inefficiency of the High-Cost Fund

Economic studies overwhelmingly conclude that the current high-cost program is inefficient,⁹ and the FCC itself points out many reasons why.¹⁰ Yet, the program is even less effective than

services. However, the people who value broadband the least are probably the same people who will also value new bandwidth-intensive services the least, reducing the externalities associated with their subscriptions. Social services provided over the Internet may also generate externalities by reducing costs for agencies that provide those services. However, using those services typically requires neither broadband nor a home connection.

⁸ Gregory Rosston, Scott Savage, and Donald Waldman, “Household Demand for Broadband Internet Service,” *The B.E. Journal of Economic Analysis and Policy* 10, no. 1 (September 9, 2010), <http://www.bepress.com/bejeap/vol10/iss1/art79/>.

⁹ For example, Gregory Rosston and Bradley Wimmer, “The ‘State’ of Universal Service,” *Information Economics and Policy* 12, no. 3 (2000): 261-283; Ross Eriksson, David Kaserman, and John Mayo, “Targeted and Untargeted Subsidy Schemes: Evidence from Postdivestiture Efforts to Promote Universal Telephone Service,” *Journal of Law and Economics* 41, no. 2, Part 1 (1998): 477-502; David Kaserman and John Mayo, “The Question for Universal Telephone Service: The Misfortunes of a Misshapen Policy,” in *Telecommunications Policy: Have Regulators Dialed the Wrong Number?* (Praeger Publishers, 1997); Thomas Hazlett, “Universal Service” Telephone Subsidies: *What Does \$7 Billion Buy?*, 2006; John Mayo, “Universal Service: Can We Do More with Less?,” February 2009, http://www.gcbpp.org/files/EPV/EPV_Mayo_MorewLess.pdf; Frank Wolak, “Can Universal Service Survive in a Competitive Telecommunications Environment? Evidence from the United States Consumer Expenditure Survey,” *Information Economics and Policy* 8, no. 3 (1996): 163-203. See Appendix 2 for a fuller list.

¹⁰ Paragraph 7 of the FCC’s NPRM provides an excellent, succinct overview of many of the inefficiencies that, in the FCC’s words, “riddle both USF and ICC.” Federal Communications Commission, *In the Matter of Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime, Federal-State Joint Board on Universal Service Lifeline and Link-Up*, NPRM, February 9, 2011, para. 7, http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0209/FCC-11-13A1.pdf.

commonly understood. Discussions of the USF high-cost program focus on its average expenditures per line rather than on the relevant measure, which is its effects on the margin—the change in activity caused by the program, rather than just the activity funded by the program.¹¹ For example, the FCC reports that in 2010 1,150 rate-of-return study areas received about \$2 billion for 5.8 million eligible lines, or about \$348 per year per line on average.¹² That number, however, overstates the cost-effectiveness of the program since the true cost-effectiveness is measured by the amount of money spent and the number of lines that exist *only because of that support*.

The FCC acknowledges the importance of marginal effects when it asks, “How will we isolate USF funding as the cause of change in deployment...?”¹³ To be sure, this counterfactual is difficult to estimate and impossible to know with certainty, but no official evaluation has even attempted it for the current USF program.

Nevertheless, other research makes it possible for us to get a sense of the true cost-effectiveness of the current high-cost fund. Rosston and Wimmer (2000) found that eliminating the high-cost fund would decrease the number of telephone subscribers by only one-half of one percent.¹⁴ The FCC reports that 113.5 million households had telephones in 2010.¹⁵ The Rosston-Wimmer results suggest, therefore, that only about 568,000 lines can truly be attributed to the high-cost fund. If we assume the effects are the same today as they were in 2000, the real economic effect of the high-cost fund in 2010 was to increase the number of subscribers to fixed line service by about 568,000. That means the high-cost fund spent approximately \$3,520—not \$348—in 2010 for each marginal line.¹⁶

To be sure, the precise number—\$3,520 per line—should be interpreted cautiously. The marginal effect of high-cost support might be different today than it was in 2000, but given the

¹¹ See, for example, Adam Jaffe, “Building Program Evaluation Into the Design of Public Research Support Programs,” *Oxford Review of Economic Policy* 18 (2002): 22-34; Scott Wallsten, “The Effects of Government-Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research Program,” *Rand Journal of Economics* 31, no. 1 (2000): 82-100.

¹² Federal Communications Commission, *In the Matter of Connect America Fund*, para. 165.

¹³ *Ibid.*, para. 485.

¹⁴ Rosston and Wimmer, “The ‘State’ of Universal Service.”

¹⁵ Industry Analysis and Technology Division, *Telephone Subscribership in the United States* (Federal Communications Commission, May 2011),

http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0519/DOC-306752A1.pdf Table 1.

¹⁶ This estimate is imprecise, of course. First, the Rosston and Wimmer research is more than a decade old, and the effect on the margin of high-cost support on the margin may be different today. However, due to decreasing costs of providing telecommunications services, the effect is likely to be even smaller today. Second, and relatedly, telephone subscribership is more difficult to measure today, as the FCC discusses. In particular, it used to be reasonably accurate to simply divide the number of wired telephone lines by the number of households, but due primarily to mobile telephony and VOIP that is no longer appropriate. The FCC bases its subscribership estimates on surveys by the US Census Current Population survey and is the share of households with access to telephone service of any sort. Because the high cost program remains targeted at households, this appears to be an appropriate measure. *Ibid.*

These results are consistent with other research finding that the primary beneficiaries of the high-cost program appear to be the firms that receive the subsidies.¹⁶ Hazlett, “*Universal Service*” *Telephone Subsidies: What Does \$7 Billion Buy?*; Scott Wallsten, “The Universal Service Fund: What Do High-Cost Subsidies Subsidize?,” Technology Policy Institute Working Paper (Washington, DC, February 2011), http://techpolicyinstitute.org/files/wallsten%20universal_service_money_trail_final.pdf.

decreasing demand for fixed lines the marginal effect is probably smaller today than it was then, suggesting that \$3,520 may be an underestimate. Regardless of the precise number, however, the points are that understanding the effects of a subsidy means knowing the marginal, not the average, effect and that understanding demonstrates that there is more waste in the program than commonly believed.

Yet, the level of inefficiency in the high-cost fund should not be surprising. The basic framework for calculating and distributing high-cost subsidies was derived in the wake of the 1996 Telecommunications Act.¹⁷ In 1999, 1,352 study areas received high-cost support payments.¹⁸ In 2010, 1,442 incumbent areas received high-cost support payments.¹⁹ In other words, not only has total spending on high-cost support increased since the FCC began its current approach, the number of areas designated as high-cost has remained essentially unchanged.

While the geographic definitions have not changed much, supply and demand features of the industry have changed radically since “high-cost” areas were first identified. The FCC implicitly acknowledges this issue in its questions about redrawing study areas.²⁰ The telecommunications industry is characterized by rapid innovation in new products and services as well as decreasing costs and increasing labor productivity. As Figure 1 shows, communications equipment costs fell by about 15 percent from 1999 through 2010, while labor productivity increased by about 35 percent for wireline providers and nearly 350 percent for wireless providers from 1999 through 2008 (the latest data available from the U.S. Bureau of Labor Statistics).

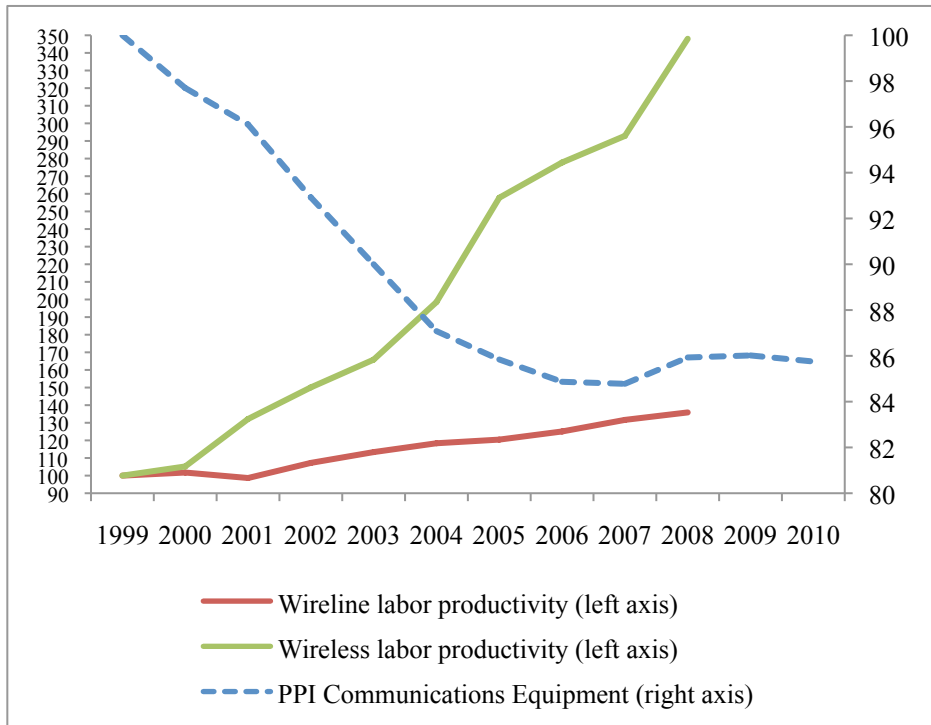
¹⁷ Federal Communications Commission, *In the Matter of Federal-State Joint Board on Universal Service*, Report and Order (Washington, DC, May 7, 1997), http://www.universalservice.org/_res/documents/about/pdf/fcc-orders/1997-fcc-orders/FCC-97-157.pdf.

¹⁸ 1,352 study areas including Puerto Rico and all territories, 1,347 excluding them. Universal Service Administrative Company, *Fourth Quarter Appendices - 1999*, Quarterly Administrative Filings for 1999, 1999, <http://www.usac.org/about/governance/fcc-filings/1999/default.aspx>.

¹⁹ Federal Communications Commission, *In the Matter of Connect America Fund*, para. 165 (Figure 6), 209.

²⁰ *Ibid.*, para. 381-388.

Figure 1: Communications Equipment Producer Price Index and Labor Productivity

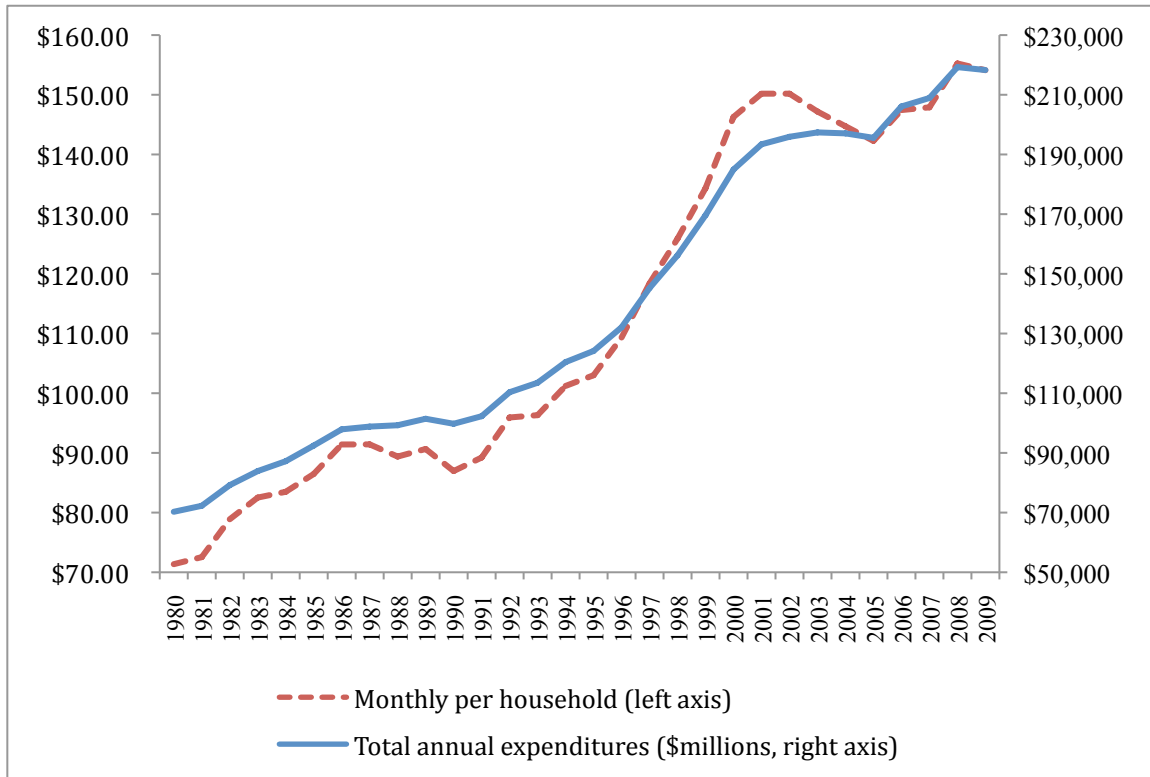


Source: U.S. Department of Labor, Bureau of Labor Statistics, Producer Price Index for NAICS 3342 (communications equipment manufacturing), series ID PCU3342--3342--.

At the same time, demand for telecommunications services has increased.²¹ Figure 2 shows that real (inflation adjusted) expenditures on telephone and Internet service—both total and per household—has increased substantially.

²¹ Though as a percentage of expenditures it remains constant, at a little over two percent.

Figure 2: Consumer Expenditures on Telephone and Internet Service (Constant 2010 Dollars)



Source: FCC (2010).²² Adjusted for inflation using CPI, BLS series CUSR0000SA0.

Given the large changes in the costs of providing telecommunications services and demand for it, it is inconceivable that all of the areas that could not be served profitably when the program began remain unprofitable without subsidies today. Indeed, the widespread presence of unsubsidized firms providing service in “high-cost” areas, as well as the presence of broadband provision by mobile providers and ILECs that has developed without dedicated broadband subsidies, demonstrates that not all areas designated as “high cost” are also uneconomic to serve.

Inflated spending on high-cost subsidies is deeply troubling, but the real economic costs include how the transfers affect provider and consumer behavior. For example, this spending can block entry if it creates “excessively low rates for consumers served by rural and rate-of-return carriers,” as the FCC says.²³

²² Industry Analysis and Technology Division, Wireline Competition Bureau, *Trends in Telephone Service* (Federal Communications Commission, September 2010), http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-301823A1.pdf Tables 3.3, 3.4.

²³ Federal Communications Commission, *In the Matter of Connect America Fund*, para. 172. For example, the FCC notes, “One commenter notes that roughly 20 percent of the residential lines of small rate-of-return companies have monthly rates of \$12 or less and another 22 percent have local rates between \$12 and \$15 per month, while the nationwide average urban rate is \$15.47 according to the most recent reference book of rates published by the FCC.”

The following sections explain in detail how incorporating consumer demand through willingness-to-pay studies and cost-effectiveness analysis can help prevent CAF from facing many of the problems inherent to the current high-cost fund.

3. A Framework for Reform: Replace Cost-Based Subsidies with Value-Based Subsidies

CAF may have significant effects on the overall broadband industry, making it especially important to take care to minimize market distortions. A report by the Columbia University Institute for Tele-Information estimated that in 2009 broadband providers invested about \$30 billion in broadband capital expenditures.²⁴ That same year the USF high-cost fund distributed about \$4.3 billion.²⁵ If CAF remained about the same size as the current high-cost fund and broadband investment remains about the same, CAF could equal about 15 percent of private broadband capital expenditures.²⁶ Given this size, the FCC should not take the potential effect of CAF on the industry lightly.

No program—government or private—can operate completely efficiently, but several factors make the high-cost fund especially inefficient. Some of these factors—such as the inherent subsidy bias towards rural areas created by our political system—cannot be changed, but others can.

Base Subsidies on Expected Benefits, not Just on Estimated Costs

An inherent problem with the current universal service program is that it attempts to base subsidies on the costs of providing service without regard to the value consumers place on that service. As a result, it is not possible to decide which subsidies are more effective than others. The NPRM contains extensive discussion of what costs should be eligible for support and how to model them,²⁷ but never asks how to determine whether those costs are worth the benefits conveyed on new subscribers and society more generally.

Incorporating the value of broadband connectivity provides a way to build a framework to answer these questions and make rational decisions about where to subsidize, how to do it, and how much to spend.

For example, the FCC asks for comment on whether CAF should use the 4 mbps down / 1 mbps up minimum speed standard in the National Broadband Plan,²⁸ as well as asking for:

²⁴ Robert C. Atkinson and Ivy E. Schultz, *Broadband in America: Where It Is and Where It Is Going (According to Broadband Service Providers)* (Columbia Institute for Tele-Information, November 12, 2009), 11.

²⁵ <http://www.usac.org/about/universal-service/fund-facts/fund-facts-all-program-data.aspx> (last accessed May 29, 2011).

²⁶ To be sure, this is somewhat of an apples-to-oranges comparison, since CAF proposes including operating costs and the CITI report includes just capital expenditures (some of which may be for operating costs). Still, it demonstrates that CAF will be a large industry player.

²⁷ Federal Communications Commission, *In the Matter of Connect America Fund*, para. 203, 208-215, 432.

²⁸ *Ibid.*, para. 24.

comment on the key attributes of broadband that will be supported as we reform the current high-cost program and create the CAF. In particular, we seek comment on whether we should characterize broadband by its speed, functional attributes, or in some other way. We note that speed is only one measure of broadband performance. Commenters should discuss additional ways of measuring the broadband services provided to consumers, such as throughput, latency, jitter, or packet loss, for purposes of establishing performance requirements for recipients of universal service funding.²⁹

Most discussion of broadband, including in the NPRM, focuses on what speeds should qualify for universal service support. But as the Commission notes, speed “is only one measure of broadband performance.” Is it the attribute that consumers value most? We don’t know, but analyses of consumer demand can answer the FCC’s question.

The FCC implicitly acknowledges this point when it asks whether it should take into account revenues—which are a function of consumer demand—as well as costs.³⁰ By asking whether it should take into account a measure of consumer demand the Commission acknowledges that without knowing how much consumers value different services it is not possible to make a rational decision about what services to support. That is, without a better understanding of consumer demand, any decision regarding minimum speeds or other qualities eligible for support will be arbitrary.

The FCC notes, “Despite the advantages of including demand-side metrics in the determination of which areas are truly uneconomic to serve, we recognize that there could be difficulties in accurately estimating and modeling revenues.”³¹ Such difficulties, however, are not a reason to avoid trying to estimate a necessary component for determining whether a subsidy is worthwhile. After all, enormous difficulties in measuring the supply side have not deterred the Commission from using supply side estimates as the foundation for a large number of regulations, including those related to universal service.

Although we currently have little information on how much people value the relevant attributes of broadband, the technology for estimating consumer demand is well-established. A recent paper by Scott Savage, Donald Waldman, and Gregory Rosston measures consumer willingness to pay for broadband using repeated discrete choice experiments and a random utility model of household preferences and could serve as a model for this research.³²

Base Subsidies on Incremental, not Average Benefits

As discussed above, the relevant effects of any broadband subsidies are the additional benefits it creates. Internet service is available everywhere in the United States, with satellite broadband providing a baseline level of service. The question is how much people value improving service beyond what is already available to them.

²⁹ Ibid., para. 105.

³⁰ Ibid., para. 103-120, 439.

³¹ Ibid., para. 439.

³² Rosston, Savage, and Waldman, “Household Demand for Broadband Internet Service.”

For example, satellite provider WildBlue currently offers service up to 1.5 Mbps downstream and 256 Kbps upstream. Data transfers at those speeds are capped at 17 GB download and 5 GB upload for any 30 day period, and Wildblue may throttle subscribers' speeds if they exceed the caps.³³ The relevant question, therefore, is not how much households with only satellite service available value broadband but how much they value Internet service better than what satellite already offers them. The more consumers value the improvement, the bigger the benefits from the subsidized service.

Estimating these values in the real world has two challenges.

The first challenge is determining WTP for the baseline level of service. The satellite metrics cited above are based on the service currently available. The more appropriate baseline may be the upgraded service that will soon be available from the satellite companies. The availability of better service from satellite companies will reduce the gap between demand for satellite service and demand for terrestrial service.

Rosston, Savage, and Waldman found that, on average, consumers were willing to pay about \$45 per month to go from slow (basically, dial-up service) to “fast” Internet service, which they defined as adequate for “music, photo sharing, and watching some videos.”³⁴ However, they found that people were willing to pay only another \$3 per month to go from “fast” to “very fast,” which they defined as “good for gaming, watching high-definition movies, and instantly transferring large files.”³⁵

Current satellite service is better than dialup, but slower than most terrestrial service. Additionally, consumers value reliability highly and satellite may not be as reliable as terrestrial service. It is possible, therefore, that consumers place a high value on the difference between satellite and terrestrial services.

Reducing the performance gap between satellite and terrestrial service could significantly reduce the incremental benefits of subsidizing terrestrial service. Because consumers valued improvements beyond “fast” very little, it is possible that WTP for terrestrial service will be no higher than for improved satellite service. In that case, a subsidized terrestrial service would yield no incremental consumer benefits—only additional costs.

The second challenge in estimating incremental consumer welfare is that consumers are not identical—different people value broadband differently. The FCC, for example, divides broadband users into different groups, ranging from basic to advanced users, with each group using progressively more data throughput.³⁶ Advanced users are likely to value broadband significantly more than basic users, who might even be satisfied with a dialup connection.

³³ Based on WildBlue service available in zip code 20912 <http://www.wildblue.com/getWildblue/availability.jsp> as of July 7, 2011.

³⁴ Rosston, Savage, and Waldman, “Household Demand for Broadband Internet Service.”

³⁵ Ibid.

³⁶ Federal Communications Commission, *In the Matter of Connect America Fund*, para. 106.

While these different groups make estimating WTP somewhat more complex, they also add an element of flexibility to how the FCC can incorporate these estimates into its determination of subsidies. For example, one approach would be to group households into different “types” based on actual demographics of each area and estimate unique WTP for a given region. Another approach might be to calculate incremental welfare improvements as if all households were high-demand types, to account for externalities or the possibility that consumers who do not have broadband today may turn out to value it more than they expect once they experience it.

The key point is that understanding how much consumers value the services being subsidized makes it possible to consider whether the subsidies reflect money well spent, which is not possible when basing the subsidy on cost alone.

The next section provides specific recommendations for how to incorporate this framework to serve unserved areas.

4. Applying the Framework to Areas Unserved by Terrestrial Broadband

This section explains how CAF can use this framework in unserved areas. Appendix 1 provides a hypothetical, numerical example of how this framework would work in practice.

Estimates of the population not served by terrestrial providers differ based on data collection methods, estimation methods, and which services qualify as “broadband” (Table 1). The FCC and the NTIA rely on line counts and other data from providers to identify areas without service, but the smaller providers who are most likely to serve rural areas are also the ones least likely to have the resources to respond to requests for data.³⁷ The result is that the extent of areas not served by terrestrial providers is likely measured with a large degree of error. Unfortunately, because these counts and the National Broadband Map are intended to be censuses rather than surveys, there has been no effort to quantify that measurement error.

Table 1: Estimates of the Magnitude of Unserved Areas

Source	Minimum Speed	Unserved	Notes
National Broadband Plan (2010) ³⁸	4 mbps down, 1 mbps up	14 million people (4.5 percent of population), 7 million housing units (5.4 percent)	
National Broadband Map ³⁹	0.768 mbps up, 0.2 mbps up	1.7 percent of population	
National Broadband Map ⁴⁰	3 mbps down, 0.768 mpbs up	4.5 percent of population	

³⁷ Federal Communications Commission, *Seventh Broadband Progress Report and Order on Reconsideration*, May 20, 2011 Appendix F.

³⁸ Federal Communications Commission, *National Broadband Plan: Connecting America*, sec. 8.1.

³⁹ <http://www.broadbandmap.gov/summarize/nationwide>

⁴⁰ <http://www.broadbandmap.gov/summarize/nationwide>

FCC (2011), based on National Broadband Map ⁴¹	3 mbps down, 0.768 mbps up, fixed broadband only	26.2 million people (8 percent of population), 9.2 million households	2.1 million out of 26.2 million are in Puerto Rico
FCC (2011), based on Form 477 county data ⁴²	3 mbps down, 0.768 mbps up, fixed broadband only	12.2 million people (4 percent of population), 4.6 million households	3.9 million of 12.2 million are in Puerto Rico
FCC (2011), based on Form 477 county data ⁴³	3 mbps down, 0.768 mbps up, fixed broadband only	23.9 million people (8 percent of population), 8.9 million households	2.8 million of 23.9 million are in Puerto Rico

Every proposal for subsidizing broadband in unserved areas requires three steps, whether the proposal identifies those steps or not. First, it must identify and define the areas eligible for subsidies. Second, it must have a mechanism for identifying the subsidy levels required in each area to provide service. Third, it must set a maximum payment (typically measured as per-line or per-subscriber) and, in the process, decide which areas will receive funding and which will not.

This paper does not discuss the first issue—how to define the areas—since WTP and measuring incremental benefits can be used regardless of how the areas are defined. Instead, it focuses on the second two and proposes using competitive bidding (reverse auctions) as the first step in identifying the subsidy required to provide service and incorporating WTP to set maximum subsidy levels and rank-order the effectiveness of subsidies in different areas. Nevertheless, it is worth noting that reverse auctions can allow for providers themselves to define the regions.

Reverse Auctions

Regardless of which estimate of the size of unserved areas is correct, it is clear that some areas remain unprofitable to serve with any terrestrial technology for the foreseeable future. Subsidy levels in those areas should be set through reverse auctions, as the Commission proposes,⁴⁴ with the reserve price (the maximum the government is willing to pay) informed by the WTP studies proposed above.

In a reverse auction, firms would submit bids stating the subsidy that they would need to build a network in a given area. Interested companies would bid for the subsidy required to build out a network based on the expected stream of revenues flowing from the expected number of customers and the services they purchase. All else equal, the firm asking for the smallest subsidy would win that subsidy to build out a broadband network.

The FCC has not yet used reverse auctions to provide subsidies for universal telecommunications service, but the U.S. government uses this type of competitive procurement for a large range of other products ranging from simple goods like office supplies to very complex weapons

⁴¹ Federal Communications Commission, *Seventh Broadband Progress Report and Order on Reconsideration* Appendix B.

⁴² *Ibid.* Appendix C.

⁴³ *Ibid.* Appendix D.

⁴⁴ Federal Communications Commission, *In the Matter of Connect America Fund*, sec. VI(E).

systems.⁴⁵ Additionally, other countries have used reverse auctions to fund telecommunications universal service programs with good success.⁴⁶

To be sure, the design and details of the reverse auction matter deeply to the success of the auction. The worst outcome in such auctions in other countries, however, generally meant maintaining the status quo while the more typical result was to reduce subsidies significantly.⁴⁷

The Federal State Joint Board on Universal Service has filed with the FCC its opposition to reverse auctions.⁴⁸ Their primary concern appears to be the expected effect of reverse auctions on current subsidy recipients. The Joint Board's concerns are misplaced and appear to be driven by a misunderstanding of reverse auctions. Most of their concerns, such as whether subsidies would crowd-out private investment, apply to any subsidy mechanism, not solely to reverse auctions. Indeed, in cases such as crowding out, reverse auctions are superior to the status quo to the extent that they would reduce subsidy levels. Other concerns, such as potential bidder collusion, are real issues to be addressed in the auction design, but not a reason to reject auctions. Appendix 2 addresses each of the Joint Board's concerns in detail.

While the Joint Board's concerns are largely misplaced, as with all auctions the details of the auction matter a great deal, as the FCC acknowledges with its detailed discussion of possible auction rules.⁴⁹ Thus, the FCC should approach the design of these auctions with the same care that has gone into its spectrum auctions.⁵⁰ It should draw on its expertise in conducting spectrum auctions and recruit other auction experts to design a process most likely to be effective. Just as the FCC does not want Congress to write the details of the incentive auction rules due to the need to be flexible as the design progresses, so, too, should the FCC be cautious about setting the auctions rules in this rulemaking.

Despite the potential difficulties of implementing them, reverse auctions have a proven track record across the government in other areas and have demonstrated remarkable success in universal service in other countries. It is time to use them here.

⁴⁵ See, for example, <http://www.nytimes.com/2008/03/10/business/worldbusiness/10tanker.html?fta=y> and www.gao.gov/cgi-bin/getrpt?GAO-06-364. Because the federal and state governments are typically required to use competitive bidding, there is a wide range of examples of governments in the U.S. using reverse auctions, including bidding for National Park Service contracts (http://www.concessions.nps.gov/man_contracting.htm), infrastructure maintenance (<http://www.dot.state.fl.us/statemaintenanceoffice/asset.shtm>), and electricity generation (e.g., <http://www.nj.gov/dca/lgs/lpcl/#energy>, <http://www.epa.gov/statelocalclimate/state/state-examples/case-studies.html#ct>). With respect to electricity, the state of Texas found that using reverse auctions reduced its electricity spending by 23 percent <http://fmlink.com/article.cgi?type=Best%20Practices&title=Electricity%20Procurement%26%23151%3BReverse%20Auction%3Cbr%3E%3Ci%3EElectricity%20Auction%20Procurement%3C%2Fi%3E%3Cbr%3EU.S.%20General%20Services%20Administration%2C%202002&pub=GSA&id=40393&mode=source>).

⁴⁶ Scott Wallsten, "Reverse Auctions and Universal Telecommunications Service: Lessons from Global Experience," *Federal Communications Law Journal* 61, no. 2 (March 2009).

⁴⁷ *Ibid.*

⁴⁸ James Cawley et al., *In the Matters of Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers, High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime, Federal-State Joint Board on Universal Service, Lifeline and Link-Up*, Comments by State Members of the Federal State Joint Board on Universal Service, May 2, 2011.

⁴⁹ Federal Communications Commission, *In the Matter of Connect America Fund*, para. 324-346.

⁵⁰ The FCC proposes as much in the NPRM. *Ibid.*, para. 324.

Setting Maximum Subsidy Levels for Unserved Areas and the Role of Satellite

The winning bids will inform the FCC how much money providers believe they need to cover costs beyond what consumers will pay. Even the best-designed auction, however, will still leave three problems to address. First, some areas may attract no bidders, meaning that in those areas the FCC is left with no estimate of the costs of providing terrestrial service. While those areas are the ones least likely to be amenable to any reasonable terrestrial service, in those cases the FCC could employ a cost model to at least obtain an estimate of costs. Second, in many areas the FCC may not receive multiple bids. Where only one provider bids, the subsidy request may be much higher than is truly necessary. Third, once the FCC has received bids or has estimated costs through other means, it must decide the maximum it is willing to spend on subsidies in any area. Multiple bids in a well-designed and well-run auction should bring the requested subsidy down to the amount truly necessary to fund buildout, but even that amount might not be cost-effective given the alternatives.

The FCC can compare the cost-effectiveness of subsidizing different areas by incorporating WTP to estimate the incremental benefits of subsidies in each area. That is, knowing the costs of serving an area is not sufficient information for deciding whether a subsidy is cost-effective.

No part of the country is truly “unserved” with respect to broadband due to the presence of two competing satellite providers. Satellite provides the baseline level of service in areas with no terrestrial providers. This baseline will improve over time as providers launch newer and more advanced satellites. The FCC recognizes that satellite is the appropriate technology to serve the highest-cost areas.⁵¹ The question becomes, then, what is the cutoff for providing subsidies for terrestrial service? Or, as the FCC asks, at what level should it cap subsidies?⁵²

Valuing the incremental improvement above the baseline level of service offered by satellite provides the FCC with a rational mechanism, based on how much consumers themselves value the service, for deciding which subsidies are relatively cost-effective and which are not. Research estimating consumer WTP for different types of broadband will make it possible to determine the incremental increase in consumer welfare potentially realized from subsidizing new terrestrial service.

If consumers value a terrestrial service significantly more than they value satellite service then a subsidy may generate substantial new consumer benefits. If they do not value terrestrial service more than they value satellite service then a subsidy may not generate any additional welfare. The answer to how much consumers value satellite service relative to terrestrial service is crucial and unknown.

As discussed above, a subsidy cap cannot be set on the basis of whether the subsidy would increase net benefits, since the subsidy will almost always entail net costs. Instead, WTP analyses can inform the FCC’s decisions regarding which areas to provide subsidies for terrestrial service.

⁵¹ Ibid., para. 133.

⁵² Ibid., para. 209-214.

The FCC can determine the relative cost-effectiveness of subsidizing each area based on WTP estimates and bids from reverse auctions. The FCC can rank the areas by cost-effectiveness and fund areas until it exhausts the budget. The remaining areas would not receive funding due to their relatively low level of cost-effectiveness.

A related question is what the total budget for unserved areas should be. Given that these subsidies will yield net costs the answer will necessarily be somewhat arbitrary. One way to determine the budget could be for the FCC to decide the maximum net social cost per area it is willing to accept. So, for example, rather than deciding that it should allocate no more than \$3,000 per line as the FCC suggests,⁵³ it could decide that it will not subsidize any area in which the expected costs are more than, say, twice the expected benefits.

Setting a minimum level of cost-effectiveness has important advantages over setting a maximum subsidy. Such an approach allows for the possibility that some places may require large subsidies but also yield large benefits. It similarly acknowledges that some places may ask for seemingly small subsidies that yield very small benefits. Under this framework, CAF could fund a high-cost, high-benefit subsidy instead of low-cost, low-benefit subsidies. A simple cap, while better than nothing, would prevent some areas from receiving subsidies even when the benefits are large while also providing small subsidies in areas even when those small subsidies yield extremely low benefit-cost ratios.

The research methods for uncovering the necessary kind of information are well-established and, as evidenced by the paper by Rosston, Savage, and Waldman, can be done in this context. Because technology advances so quickly the research should be repeated annually or, at least, every two years. For example, satellite broadband continues to improve. It is conceivable that consumers place real value on obtaining broadband better than the current generation of satellites can provide. But the next-generation of broadband satellites will offer much faster service, so the incremental value consumers obtain from a non-satellite option may be small.

Concerns Regarding Satellite Capacity May be Misplaced

The Commission is concerned that while satellite is available everywhere, it does not have sufficient capacity to provide service to all unserved households.⁵⁴ While technically correct, whether this concern is valid depends on the number of *additional* households that would subscribe as a result of CAF. A large additional number of subscribers in areas unserved by terrestrial broadband is unlikely given that people in those areas who value broadband highly already subscribe to satellite.

The relevant question in answering the capacity question is how many more people CAF (and any other program) would realistically induce to subscribe beyond current levels and how that increase compares with current capacity and expected upgrades.

⁵³ Ibid., para. 210.

⁵⁴ Ibid., para. 272, 424; Federal Communications Commission, *National Broadband Plan: Connecting America*, sec. 8.1.

Additionally, using reverse auctions with a cap set by measures of consumer demand means that not all unserved areas would be served by satellite. This approach would create a rational level at which subsidies would no longer be provided for terrestrial service.

5. Make the CAF Flexible, Adjust Subsidies Over Time, and Adopt Rigorous Evaluation

Universal service programs for telecommunications historically have not had to react to change. After all, for decades, dialtone voice service was the only service covered. Broadband technology, however, continues to change rapidly, as do the ways people and businesses use it. Costs are likely to continue to decrease and consumer willingness to pay is likely to continue to increase. The features of broadband people value today may not be the ones they value tomorrow.

If a CAF is to remain effective and efficient over time it must be able to adjust to such changes. Given the difficulties of changing subsidies once they have constituents who will lobby only for expanding those subsidies, mechanisms for change must be built into the system from the beginning.

Several mechanisms, which are not all mutually exclusive, can be used to adjust subsidies.

Re-Evaluate Consumer Willingness-to-Pay Regularly

Consumer demand (willingness to pay) is likely to continue to change with improvements in technology and the growing scope of online services. At the same time, satellite service continues to improve. Improving satellite service and changes in consumer willingness to pay mean the value consumers place on being able to use service other than satellite is also likely to change over time. This underscores the need to re-evaluate consumer WTP on a regular basis – perhaps annually, or at least biennially, as discussed above.

Incorporate Program Evaluation

The current universal service program has not rigorously compared the effectiveness of different types of support mechanisms even after spending \$74 billion since 1998.⁵⁵ Indeed, the program itself has no specific, measurable goals, making such evaluation nearly impossible. The Government Accountability Office noted in 2008:

In the 1996 Act, the Congress established the principles underlying universal service, which provide a clear purpose for the high-cost program. However, since 1998, FCC has distributed over \$30 billion in high-cost funding without developing specific performance goals for the program. Additionally, FCC has not developed outcome-based performance measures for the program. While FCC has begun preliminary efforts to address these shortcomings, its efforts do not align with practices GAO and OMB have identified as useful in developing successful performance goals and measures. In the absence of program goals and data pertaining to the program's performance, the Congress and FCC may be limited in their ability to make informed

⁵⁵ USAC 2010 Annual Report.

decisions about the future of the program.⁵⁶

Similarly, in 2005 the White House Office of Management and Budget rated the high-cost program as “not performing” in part because:

The program lacks measures and goals to assess performance. The program does not measure the impact of funds on telephone subscribership in rural areas or other potential measures of program success, nor does it base funding decisions on measurable benefits.

Program administration lacks sufficient Federal oversight. No memorandum of understanding exists between the Federal Communications Commission and the program's non-Federal Administrator, nor have measurable standards for program administration been established.⁵⁷

The CAF need not fall into the same trap. Fortunately, the FCC acknowledges this issue and devotes considerable attention to it in the NPRM.⁵⁸ The NPRM directly tackles some of the GAO’s and OMB’s criticisms by proposing specific, measurable, outcomes such as changes in the number of housing units that can receive broadband that meets specified criteria.⁵⁹

Design evaluation into the structure of every CAF program.

Measuring changes in areas that receive subsidies, however, is not enough to determine whether the subsidies were responsible for those changes, especially in the presence of an already-upward trend. CAF must have a method that allows it to determine the effects of the subsidies themselves. As the NPRM puts it, “How will we isolate USF funding as the cause of change in deployment, to distinguish from other sources of funding, such as BTOP/BIP?”⁶⁰ Tracking the number of newly broadband-enabled regions or housing units by itself is not the answer because those numbers will continue to increase over time regardless of CAF. The question is how CAF changes that trend. CAF evaluation must, for example, take care to track both subsidized and unsubsidized areas to determine whether the subsidies are affecting the trend.

Identify the Best Data-Collection Method

It is not possible to evaluate programs properly without accurate data. The FCC does not currently have a method to generate sufficiently accurate and reliable data over time to evaluate the effectiveness of these programs.

Telecommunications has a history of counting lines and connections—in other words, attempting to conduct full censuses of deployment. This approach may have been tenable when only a single firm provided service, but it has become increasingly difficult, as recent statistical reports demonstrate. As discussed above, current estimates of the “unserved” population vary from about 14 million to about 26 million people. These estimates vary across data collection methods

⁵⁶ Government Accountability Office, *FCC Needs to Improve Performance Management and Strengthen Oversight of the High-Cost Program*, June 2008, 25.

⁵⁷ <http://www.whitehouse.gov/omb/expectmore/summary/10004451.2005.html>

⁵⁸ Federal Communications Commission, *In the Matter of Connect America Fund Sections VIII and IX*.

⁵⁹ *Ibid.*, para. 485.

⁶⁰ *Ibid.*

(i.e., the FCC’s Form 477 versus the National Broadband Map) and even within data collection methods since different levels of aggregation apparently yield different results.⁶¹

It will not ever be possible to measure availability perfectly. Smaller providers especially do not all have the resources to handle ongoing detailed information requests, which is an especially acute problem given that they are more likely to operate in rural areas. Moreover, NTIA spent about \$312 million on the National Broadband Map⁶²—an expenditure that would be difficult to justify on a regular basis even if everyone agreed it was the best data available.

The first step should be a careful analysis of why Form 477 reports and the National Broadband Map yield different results, why different levels of aggregation of Form 477 data yield different results, and what level of data disaggregation is possible to collect with a reasonable degree of accuracy. Appendix F of the FCC’s Seventh Broadband Progress Report is a good overview of the shortcomings of each approach.⁶³ The FCC should build on issues it outlined in that Appendix to identify a method it can use consistently for measuring broadband deployment.

The FCC’s *Modernizing the FCC Form 477 Data Program* NPRM is an important step for thinking about relevant data to collect, but does not directly address the problem of determining its accuracy.⁶⁴ An inherent problem with this census approach is that it does not provide a way to know how much error is built into the measurement.⁶⁵

One possible solution is to complement the Form 477 data collection efforts with statistically valid household or business surveys targeted at areas in which availability data are difficult to obtain.⁶⁶ Such surveys probably could not identify the details of the types of services available (i.e., households are unlikely to know the range of technologies or speeds available to them, if any), but would help bound the estimates of “unserved” areas and therefore make the data comparable over time.

Recruit Disinterested Third Parties to Conduct Evaluations

Self-evaluations are inherently difficult, especially when also subject to pressure to operate the program in particular ways and reach particular conclusions from evaluations. As David Walker, U.S. Comptroller General from 1998 to 2008 wrote about the Government Accountability Office, “In a city full of interest groups with competing agendas, GAO’s strength is its ability to provide Congress with professional, objective, fact-based, nonpartisan, and nonideological information when it is needed.”⁶⁷

⁶¹ Federal Communications Commission, *Seventh Broadband Progress Report and Order on Reconsideration* Appendices B, C, D, and E.

⁶² http://www.ntia.doc.gov/legacy/budget/NTIA_Budget_FY2012.pdf, Exhibit 10 p. NTIA-134

⁶³ Ibid. Appendix F.

⁶⁴ Federal Communications Commission, *Modernizing the FCC Form 477 Data Program*, Notice of Proposed Rulemaking, February 8, 2011, http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0209/FCC-11-14A1.pdf.

⁶⁵ The Modernizing Form 477 Data NPRM does not even mention measurement error. Ibid.

⁶⁶ Such a survey would presumably help the Commission meet the survey requirement of the Broadband Data Services Improvement Act.

⁶⁷ David M. Walker, “GAO Answers the Question: What’s in a Name?”, July 19, 2004, <http://www.gao.gov/about/rollcall07192004.pdf>.

The difficulties in changing the USF program are a testament to the range of “interest groups and competing agendas” at play in universal service. Only disinterested parties can carry out true, rigorous evaluations of USF and CAF that will be accepted as independent. An obvious candidate for conducting these evaluations is the National Academies of Sciences.

6. Conclusions

The existing high-cost fund is inefficient, ineffective, and badly outdated. It suffers from two inherent flaws: it does not incorporate how much consumers value the services being subsidized, and is not focused on measuring the incremental, rather than average, effects of the program. CAF can overcome both problems and operate far more efficiently than the existing high-cost program ever could.

In particular, decisions about where to provide subsidies should take into account how much consumers value the improvement in service the subsidy would bring beyond what is currently available. Incorporating this information requires conducting regular research on consumer willingness-to-pay for different levels of broadband service. This information would be used to help determine what types of service should be subsidized in unserved areas, which areas to fund, and the maximum amount that should be spent on subsidies.

This approach will help achieve universal service objectives in a way that provides real benefits to citizens, does not enrich particular firms, and limits total spending.

Appendix 1: An Example of Incorporating WTP Into Subsidy Decisions

This example illustrates how policymakers can incorporate consumer willingness-to-pay (WTP) into decisions regarding subsidizing broadband. All numbers in this example are hypothetical, but are comparable in absolute and relative magnitude to results yielded by actual research on WTP.⁶⁸

Consider a hypothetical area with no terrestrial broadband service and 2500 households in income groups as shown in Table 2.

Table 2: Income Distribution of Unserved Area

Annual Income	<\$25,000	\$25,000-\$75,000	>\$75,000
Number of households	1500	700	300

Suppose that policymakers are considering whether to subsidize terrestrial service offering 4Mbps downstream and 1Mbps upstream (4/1). How much would consumers benefit from this service relative to the cost? The answer is not how much benefit consumers would derive from the 4/1 service, but how much better off consumers would be compared to the service already available. That incremental benefit can then be weighed against the cost.

The baseline level of service is satellite broadband. As discussed earlier, satellite today, with a maximum speed of 1.5 - 2Mbps downstream and less than 500Kbps upstream, is substantially slower than the 4/1 proposed terrestrial service. Both satellite providers, however, are on the brink of offering improved service through their new high-throughput (HT) satellites. Neither provider has announced service plans or prices. Let's assume that the service will be similar to terrestrial 4/1, but perhaps somewhat less reliable.

To help make its decision the FCC would conduct detailed WTP studies that yield consumer demand for different types of broadband service by income (

Table 3).

The studies show that consumers value jumps in speed from slow to fast more than they value jumps from fast to very fast and that wealthier consumers are willing to pay more for broadband than are poorer consumers.

Table 3: WTP for Different Broadband Services by Income

	<\$25,000	\$25,000-\$75,000	>\$75,000
Existing satellite	30	60	100
Next-generation HT satellite	40	73	118
Terrestrial 4/1	45	75	120

⁶⁸ Gregory L. Rosston, Scott J. Savage, and Donald M. Waldman, "Household Demand for Broadband Internet Service: Final Report to the Broadband.gov Task Force Federal Communications Commission," SIEPR Discussion Paper 09-008, February 3, 2010, http://siepr.stanford.edu/system/files/shared/Household_demand_for_broadband.pdf.

Per-person consumer surplus is the difference between the price consumers pay and the value (WTP) they derive from the service.⁶⁹ Table 4 shows these calculations. Low- and medium-income consumers do not purchase existing satellite service because the price exceeds their WTP. The lower price and improved service from HT satellite mean that now medium-income as well as high-income consumers would purchase that service, though low-income consumers are still not willing to pay enough to purchase it. All consumers value a 4/1 service by more than the expected price, so they all purchase it and obtain the surplus shown in the table.

Table 4: Per-Person Consumer Surplus by Income and Broadband Service Type

	Price	Income group		
		<\$25,000	\$25,000-\$75,000	>\$75,000
Existing satellite	80	n/a	n/a	20
Next-generation HT satellite	60	n/a	13	58
Terrestrial 4/1	40	5	35	80

With this information we can calculate the incremental consumer benefits of a 4/1 service. Table 5 shows these calculations based on today's satellite service as the status quo.

Table 5: Consumer Surplus from Today's Satellite and Proposed 4/1 Service

Service			Number subscribers and consumer surplus by income group			Consumer surplus	
			<\$25,000	\$25,000-\$75,000	>\$75,000	Total	Incremental
Status quo	Current satellite	Subscribers	0	0	300	6000	
		Consumer surplus	0	0	6000		
Proposal	Terrestrial 4/1	Subscribers	1500	700	300	56000	50000
		Consumer surplus	7500	24500	24000		

Consumer surplus from the status quo is \$6,000 because the 300 wealthiest households subscribe to it and earn \$20 each in consumer surplus. Consumer surplus from a 4/1 service would be \$56,000, or \$50,000 more than the status quo because everyone would subscribe to it, they pay less for it, and value it more than satellite service.

Determining cost-effectiveness requires estimates of the necessary subsidy. This estimate could come from a reverse auction, or could be derived from cost-studies if necessary.

For this example, we assume that the cost of providing the 4/1 service would be approximately three times the revenues a provider can obtain from selling the service.⁷⁰ From these estimates

⁶⁹ Prices here correspond to actual market prices. The price for Wildblue in the table is the monthly price for their plan offering 1.5Mbps downstream and 256kbps upstream as of July 21, 2011 in zip code 20912. In 2009 the price for terrestrial service offering 3-6Mbps was between \$40-\$50 (Wallsten and Mallahan, 2010 Figure 12). I use the low end of that range here for 4/1 service due to the downward trend in prices for slower services. Neither satellite provider has announced plans or prices, so I set the price at \$60 per month to reflect the lower capacity constraints of the newer satellites. Scott Wallsten and Colleen Mallahan, "Residential Broadband Competition in the United States," *SSRN eLibrary*, 2010, <http://ssrn.com/paper=1684236>.

⁷⁰ These estimates are comparable those estimated in a recent OBI working paper. Omnibus Broadband Initiative, *The Broadband Availability Gap*, OBI Technical Paper (Federal Communications Commission, 2010), <http://www.broadband.gov/plan/broadband-working-reports-technical-papers.html> Exhibit 3-M.

we can calculate the subsidy required to provide the service and from that the cost-effectiveness of the subsidy. Table 6 shows the results of these calculations.

Table 6: Cost-Effectiveness of Subsidizing 4/1 Service With Current Satellite as Baseline

Estimated cost	\$300,000
Revenues	\$100,000
Subsidy required	\$200,000
Incremental consumer surplus	\$50,000
Cost-effectiveness	\$0.25

The table suggests that each dollar to subsidize a 4/1 service yields a \$0.25 increase in consumer surplus.

That cost-effectiveness calculation is based on today’s satellite service. We now recalculate it based on assumptions regarding the satellite service that will soon be available.

Table 7 shows total and incremental consumer surplus based on the future HT satellite and proposed 4/1 service.

Table 7: Consumer Surplus from Future Satellite and 4/1 Service

Service			Number subscribers and consumer surplus by income group			Consumer surplus	
			<\$25,000	\$25,000-\$75,000	>\$75,000	Total	Incremental
Future status quo	HT satellite	Subscribers	0	700	300	26500	
		Consumer surplus	0	9100	17400		
Proposal	Terrestrial 4/1	Subscribers	1500	700	300	56000	29500
		Consumer surplus	7500	24500	24000		

Note that the incremental consumer surplus from the 4/1 terrestrial service is smaller than it was when the baseline was current satellite service (\$29,500 versus \$50,000). The smaller increment is because more households will subscribe to HT satellite due to its lower price and households’ higher WTP for it relative to existing satellite service.

With this information we can now estimate the cost-effectiveness of the proposed 4/1 service when HT satellite is the baseline. Table 8 shows WTP for his new service relative to terrestrial options.

Table 8: WTP for HT Satellite and Terrestrial Services

Estimated cost	\$300,000
Revenues	\$100,000
Subsidy required	\$200,000
Incremental consumer surplus	\$29,500
Cost-effectiveness	\$0.15

Thus, with HT satellite as the baseline each subsidy dollar yields only \$0.15 in additional consumer benefits, compared to \$0.25 in additional consumer benefits when the baseline is today’s satellite service.

Next, the FCC can use this information to inform its decisions regarding which areas to subsidize. For the purpose of this example, assume today's satellite is the baseline level of service and the FCC has conducted reverse auctions in all unserved areas and received bids in some, but not necessarily all, of those areas. Although the areas that received no bids are likely to require the biggest subsidies and probably, therefore, are the least likely to receive any, in this example the FCC uses cost models to estimate the required subsidies in those areas.

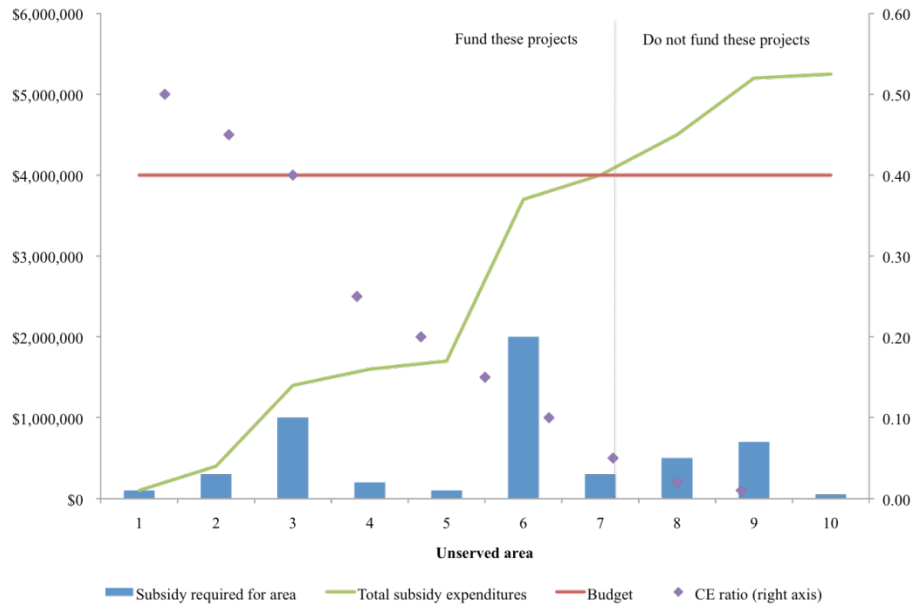
That information, combined with the WTP studies that would have been conducted and demographic data, the FCC can rank unserved areas by cost-effectiveness. Assume the country has ten unserved areas, and the analysis yields the ranking of cost-effectiveness shown in Table 9.

Table 9: Ranking of Cost-Effectiveness of Subsidizing Ten Unserved Areas

Area	Subsidy required	Method of estimating subsidy	cost-effectiveness ratio	Total expenditures
1	\$100,000	reverse auction	0.50	\$100,000
2	\$300,000	reverse auction	0.45	\$400,000
3	\$1,000,000	reverse auction	0.40	\$1,400,000
4	\$200,000	reverse auction	0.25	\$1,600,000
5	\$100,000	reverse auction	0.20	\$1,700,000
6	\$2,000,000	reverse auction	0.15	\$3,700,000
7	\$300,000	reverse auction	0.10	\$4,000,000
8	\$500,000	cost model	0.05	\$4,500,000
9	\$700,000	cost model	0.02	\$5,200,000
10	\$50,000	cost model	0.01	\$5,250,000

If the budget for unserved areas is \$4 million, then CAF would subsidize areas 1-7 and not 8-10, as shown in Figure 3.

Figure 3: Choosing Which Broadband Projects to Subsidize in Unserved Areas



Alternatively, the Commission could set some minimum level of cost-effectiveness that any subsidy would support. For example, it might decide that CAF will not subsidize any project with a cost-effectiveness ratio of less than, say, 0.20. The advantage of this approach over setting a per-line maximum is that it would allow for cases where a high per-line subsidy would yield large benefits (for example, in this hypothetical example area 3 requires one of the largest subsidies but also yields among the highest benefits). The disadvantages include the arbitrary nature of any minimum the FCC chooses, and the increased difficulty in restraining fund growth since it would not have budget constraint.

Appendix 2: Response to Joint Board Opposition to Auctions

The Federal-State Board on Universal Service filed detailed comments on its views regarding reforms.⁷¹ Some of its suggestions are sensible. For example, the Board argues that support should be limited “to cases of demonstrated necessity.” Other suggestions are problematic. In particular, the Board argues against using reverse auctions to subsidize broadband services.

The Board’s rejection of reverse auction appears to be based primarily on concerns that the incumbent might not always win and a misunderstanding of how auctions differ from other distribution mechanisms.

I discuss the issue in detail below.

Reverse Auctions

The Board discusses ten objections to reverse auctions, which can be grouped loosely into three categories.

1. Arguments that apply to all distribution mechanisms, not just auctions.
2. Issues to take into account when designing the auctions, not to reject auctions.
3. Incorrect arguments.

Arguments that apply to all distribution mechanisms, not just auctions

The Board contends that reverse auctions

- Might supplant private capital,
- May not be competitively neutral,
- Have external costs to firms,
- Punish states that have already implemented programs to serve the “low-hanging fruit” of otherwise unserved areas, and
- May lead to declining service quality.

All of those are real issues, but are in no way unique to reverse auctions. To the extent that reverse auctions would reduce subsidies they would, in fact, be less subject to these arguments than the cost-based distribution mechanisms proposed by the Board.

⁷¹ Cawley et al., *In the Matters of Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers, High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime, Federal-State Joint Board on Universal Service, Lifeline and Link-Up.*

Crowd-out private investment

The Board is right to point out that a subsidy should not supplant, or crowd out, private funding. Not crowding out private financing is a necessary condition for successful subsidy programs because replacing private dollars with public dollars yields no net benefit.⁷²

But policymakers should be concerned about crowding out resulting from *any* subsidy mechanism. A common concern about the current universal service distribution mechanism is that it subsidizes firms in many areas where subsidies should be unnecessary—in other words, the current system likely crowds out private funding. The point of an auction is to create a market mechanism where one would not otherwise exist. Reverse auctions for universal service would make providers compete for subsidies. If the auction is designed properly, firms bid subsidies down to the amount actually required to provide service economically. If an area does not require subsidies then the subsidy gets bid down to zero.

In short, crowding out is a concern for any subsidy mechanism, but that concern is a reason to favor reverse auctions, not oppose them.

Competitive neutrality

The Board worries that a reverse auction could disadvantage the incumbent and, therefore, would not be competitively neutral. A reverse auction for a service that does not specify the technology to use will, in fact, disadvantage high-cost technologies. That may be the incumbent. But that is precisely the point of reverse auctions: they are a mechanism to provide the service for the smallest subsidy.

Paradoxically, the Board's own suggestions for maintaining subsidies for the current recipients are, by definition, not competitively neutral. Any provider can potentially win a reverse auction. Additionally, the ILECs' sunk capital gives them certain advantages, as well, so it is incorrect to say they would necessarily be disadvantaged in a reverse auction.

External costs

The Board worries that new entry in subsidized areas could unintentionally impose costs on subsidized ILECs. The Board's concern here does not appear to have anything to do with reverse auctions, but rather the effects of entry on the ILEC. No monopolist wants entry, and monopolies have a long and storied history of using policy to block entry under the guise of protecting stability.⁷³ Regardless of motivations, this complaint is generic to reforms, but not specific to reverse auctions.

⁷² David M. Levy and Nestor E. Terleckyj, "Effects of Government R&D on Private R&D Investment and Productivity: A Macroeconomic Analysis," *Bell Journal of Economics* 14, no. 2 (1983): 551-561; Wallsten, "The Effects of Government-Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research Program."

⁷³ See, for example, Thomas Hazlett, "The Curious Evolution of Natural Monopoly Theory," in *Unnatural Monopolies: The Case for Deregulating Public Utilities* (Lexington, Mass and Toronto: Lexington Books, 1985), 1-25.

Punishes states that proactively promoted broadband

The Board notes that “To the extent that a State has already promoted broadband within its borders, ‘low hanging fruit’ will likely have been harvested first, making it less likely for the State to have residual projects that can pass the dollar-per-household screen.”⁷⁴

The Board’s comment is not an objection to reverse auctions. Rather, it is an objection to any method that would allocate money according to where it would get the biggest bang for the buck.

The Board continues, “Citizens of that State will, nevertheless, be required to make federal universal service fund contributions. Therefore the citizens of a State that has been an early adopter in promoting broadband will likely become net contributors to other States that have done less.”⁷⁵

This objection makes certain intuitive sense. However, this type of inequity applies to the entire universal service program, especially the high-cost fund, where poor urban consumers subsidize all rural, including wealthy, subscribers.

The solution to this problem is not to reject reverse auctions. It is to reduce spending as much as possible and to find a funding mechanism that is both equitable and efficient. Reverse auctions can help reduce spending on subsidies, while the most efficient taxes are those that have the smallest effect on behavior.

The Board concludes its argument by noting “The Commission should seek to avoid creating such a perverse incentive.”⁷⁶ The Board is correct, and the Commission should try to minimize any perverse incentives created by universal service funding. In that respect, reverse auctions are likely to be far superior to the current methods of distributing funds.

Declining service quality

The Board worries that the one-time grant nature of reverse auctions means that service quality would decrease over time. Initial, one-time fixed costs typically present the largest barrier to providing service. Yet the Board is likely correct that some places may require ongoing subsidies to continue providing service.

The question of one-time grants versus ongoing subsidies is not one of auctions versus other mechanisms. Instead, it is a question related to the costs of providing services. Reverse auctions can be used to provide ongoing support by, for example, repeating them after certain time intervals. One problem with the current system is that a single firm receives subsidies potentially

⁷⁴ Cawley et al., *In the Matters of Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers, High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime, Federal-State Joint Board on Universal Service, Lifeline and Link-Up*, 91.

⁷⁵ Ibid.

⁷⁶ Ibid.

forever. Competitive bidding, especially when seen as competition for the market, would eliminate that problem.

Auction design issues

The Board raises several potential problems reverse auctions could face. Reverse auctions are, in fact, not likely to be simple, and the FCC must take care when designing them. But the Board's arguments are issues to be taken into account when designing the auctions, not reasons to reject auctions altogether.

No bidders

The Board worries that some auctions might yield no bidders. In practice, the number of bidders will depend on several factors: the specific services up for bid, the geographic definition of the bidding area, the government's reserve price, and the set of providers allowed to participate in the bidding.

One of the criteria when designing these and other features of the auctions is to take steps to encourage bidders to participate. But finding no bidders for an area does not necessarily mean the auction failed. In many of those cases the auction will have revealed that it is not feasible to provide terrestrial service, and that satellite should be the (subsidized, if necessary) service.

A related concern, though one the Board does not mention, is how to handle the outcome when only the incumbent bids. The incumbent's large installed infrastructure may give it several advantages that discourage others from bidding. On the one hand, this may be an efficient outcome to the extent that those investments are sunk and the incumbent can provide service at the lowest incremental cost. On the other hand, without other bidders the auction may not yield new information on the true costs of providing service. It is partly for this reason the FCC will have to think carefully about its reserve price. One possibility is to calibrate the reserve price not to estimated or reported costs, but to the price of satellite service, as the Board itself implies.⁷⁷

Strategic bidding

The Board worries that bidder collusion, strategic bidding, and how the geographic bidding areas are defined could make it difficult for ILECs to compete effectively in reverse auctions. Any auction must be designed to make collusion difficult and also give careful thought to how bidding areas are defined. Fortunately, because those issues are not unique to reverse auctions a great deal of research and experience now informs auction design on those issues.⁷⁸

⁷⁷ "...the State Members' Plan proposes that support be limited to not more than \$100 per high-cost sector location per month. This allows for some terrestrial service to receive a subsidy higher than the prevailing retail price of satellite service, but it avoids promising support levels that are substantially above that level." p.59

⁷⁸ Cawley et al., *In the Matters of Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers, High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime, Federal-State Joint Board on Universal Service, Lifeline and Link-Up*, 91.

Census blocks

The Board worries that census blocks or groups of census blocks would not generate efficient geographic areas. The Board is correct in that any arbitrarily-defined boundary, including not just census blocks, but also counties, states, or even existing LEC territories, do not reflect economically efficient boundaries for subsidizing service.

Again, however, the issue of how to define the relevant areas is one the auction design should address carefully. The Commission may decide that while Census blocks do not make for the most efficient divisions, they might still be the right choice when considering the total cost of the program. Alternatively, the Commission might decide on other divisions when it is more sensible.

The main point is that these are issues to be handled in the design phase. They are not rational objections to auctions themselves.

Incorrect Arguments: Bidder Uncertainty

The Board argues that reverse auctions are a bad idea because of bidder uncertainty. This argument is specious.

The Board argues that uncertainty regarding factors like “future debt-costs, take-rates, and average revenues per unit,” bidders will incorporate a premium in their bids. Bidders will, in fact, incorporate uncertainty into their bids. But rather than pay this premium, the Board is apparently willing to pay the provider enough to eliminate this uncertainty. That approach is at least as costly, and probably more costly, than providers incorporating it into their bids.

Additionally, any investor, especially in long-lived assets, faces this issue. There is no reason subsidy-recipients should be treated differently in this respect regardless of how the subsidy is distributed