



July 10, 2017

VIA ECFS

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Subject: *Notice of ex parte presentation – WC Docket No. 10-90
CAF Phase II competitive bidding*

Dear Ms. Dortch:

On July 6 and 7, 2017, Hughes Network Systems LLC (“Hughes”) met with staff from the Chairman’s and Commissioners’ offices regarding the above-referenced matter. Hughes met on July 6 separately with Kristine Fargotstein of the Office of Chairman Ajit Pai and Claude Aiken of the Office of Commissioner Mignon Clyburn, and on July 7 with Amy Bender of the Office of Commissioner Michael O’Rielly. Hughes was represented by myself, economist Scott Walsten, Ph.D., of Technology Policy Institute, and L. Charles Keller of Wilkinson Barker Knauer, LLP. In the meeting, Hughes discussed the attached talking points and economic paper, which were distributed at the meeting.

We observed that, in April 2017, Chairman Ajit Pai identified a lack of economic analysis as a key problem with Commission decision-making.¹ He noted that the “public interest standard has become a free pass to adopt rules without a meaningful attempt to determine the net benefits.”² The bid-weighting matrix in the *CAF Weighting Order*³ is a good example of this. As Hughes observed in its pending Petition for Reconsideration,⁴ the current matrix places emphasis on very high speeds and low latencies that is out of proportion to the value that these characteristics have for real consumers in the marketplace. Hughes urges the Commission to adopt a revised bid-weighting matrix that more appropriately weights speed and latency consistent with their consumer utility.

In the meeting, Hughes also distributed the attached paper by Scott Walsten, Ph.D., arguing that the bid weighting matrix should time-to-deployment in the scoring matrix. Just as consumers may place higher value on higher speeds and lower latency,

¹ Remarks of FCC Chairman Ajit Pai, “The Importance of Economic Analysis at the FCC,” Hudson Institute, Washington, DC (April 5, 2017) (“Pai Speech”).

² *Id.* at 3.

³ *Connect America Fund, et al.*, Report and Order and Order on Reconsideration, 32 FCC Rcd 1624 (2017).

⁴ Petition for Reconsideration of Hughes Network Systems, LLC, WC Docket No. 10-90 (filed April 20, 2017).

they also place a higher value on being able to obtain service more quickly. The bid weighting matrix should reflect this.

In response to a question from the staff in the meeting, Dr. Wallsten explained that incorporating this issue into the bid-weighting mechanism would involve an analysis that begins with the formula for net present value (NPV):

$$NPV = \sum_{t=1}^T \frac{C_t}{(1+r)^t}$$

Where t is the time period, T is the total number of time periods, C_t is cash flow in year t , and r is the interest rate. NPV reflects the fact that future dollars are worth less than today's dollars.

Calculating the NPV of the score requires two adjustments. First, the score remains constant over time but is distributed over time. Second, while fewer dollars are worth less than more dollars, lower scores are worth more than higher scores.

Thus, the formula for the adjusted, or NPV, score S^* becomes: $S^* = NPV_S = \sum_{t=1}^T b_t (S * (1+r)^t)$, where S is the score and b_t is the share of buildout achieved by the end of year t .

As an example, consider the FCC's 6-year rollout schedule: 40 percent coverage by the end of year 3 and an additional 20 percent each year. Let's assume a slower beginning, so 10 percent coverage the first year, 10 percent the second, and 20 percent the third. Let's also assume the unadjusted score is 100 and the discount (interest) rate is 3 percent. Thus,

$$\begin{aligned} S^* &= 0.1(100 * (1.03)^1) + 0.1(100 * (1.03)^2) + 0.2(100 * (1.03)^3) \\ &\quad + 0.2(100 * (1.03)^4) + 0.2(100 * (1.03)^5) + 0.2(100 * (1.03)^6) \\ &\cong 112.3 \end{aligned}$$

As Chairman Pai has noted, "using analytics doesn't dictate what your choices will be. But *not* using it means that your decisions are more likely to go wrong."⁵ To maximize the likelihood that the CAF Phase II auction goes right, Hughes urges the Commission to re-align the bid weighting matrix with actual consumer value. It can do this by granting Hughes's Petition and reducing the oversized advantages currently granted for very high speed and very low latency. It also can do so by incorporating weighting in the scoring system to account for speed to market as discussed in Dr. Wallsten's paper.

⁵ Pai speech at 6.

Please direct any questions regarding this filing to the undersigned.

Sincerely,

/s/
Jennifer A. Manner
Senior Vice President, Regulatory Affairs

Attachments

cc: Kristine Fargotstein
Claude Aiken
Amy Bender

**Hughes Network Systems
CAF Phase II Bid Weighting
June 2017**

The quality and scope of satellite broadband services continues to increase at a rapid pace.

- Hughes announced in early June that its EchoStar XIX satellite (also called HughesNet Gen5) was already serving over 200,000 households in just two months of operation.
- Satellite service continues to improve. Gen5 service features include:
 - Full geographic coverage in the continental United States, Puerto Rico and parts of Alaska
 - Faster speeds including and exceeding 25/3 Mbps
 - Greater capacity
 - Improved compression and caching technologies to minimize data usage
 - Features to minimize the impacts of latency
 - Caching and techniques to speed up website loading
- The record shows that satellite broadband customers are just as satisfied as broadband customers on other technology platforms.

The CAF bid-weighting matrix should reflect the Commission's strong new commitment to evidence-based, data-driven economic analysis.

- The current weight for high speed does not reflect actual economic data on consumer speed preferences.
 - No economic or other analysis supports the specific weights currently applied to speed tiers.
 - Satellite providers may be the most efficient providers *in very high-cost areas*, and (contrary to the Power Companies' assertions) nothing in the record refutes that.
 - Satellite providers offer comparable service at a lower cost in areas where terrestrial costs are high.
 - If the Power Companies are right that satellite providers' costs make it impossible to compete in the auction, then they will lose even without a latency penalty.
 - Satellite providers' costs to participate in CAF Phase II will be affected by the capacity limits required by the CAF rules.
- The record does not support such a large latency penalty.
 - Satellite broadband customers are just as satisfied as terrestrial broadband customers.

- The majority of Internet traffic is not latency-sensitive (web browsing, video streaming).
- The latency penalty imposed by the scoring mechanism is arbitrary. The Order made no attempt to explain why a 25 point penalty is more accurate than a 5-point, 10-point, or 50-point penalty.
- The current bid matrix omits an important element of consumer welfare in extending broadband service per the CAF program's goals – time of service.
 - As discussed in Dr. Scott Wallsten's paper, the time when a given activity will occur is a key component of economic analysis.
 - OMB Circular A-4, which sets out how government agencies are to conduct regulatory analyses, directs agencies to consider benefits in the near term more highly than benefits later in time.
 - Different broadband technologies have markedly different speeds to market.
 - Consumers who lack broadband service today will benefit more by receiving service next year than they will by getting it five years from now. The FCC should explain why it takes into account the poorly-studied consumer preferences regarding speed and latency and ignores the well-studied effects of time preferences.
 - The bidding matrix should take into account consumer time preference in the same way OIRA established for regulatory analyses decades ago.

A Proposal to Incorporate Time-to-Deployment Into CAF Phase II Auction Scoring

Scott Wallsten*
June 19, 2017

Introduction

The FCC's CAF Phase II Auction includes a scoring mechanism that weights bids "to reflect the value of higher speed and lower-latency services to consumers."¹ More specifically, the Order says:

We now adopt weights for the Phase II auction performance and latency tiers that will account for the value of higher speeds, higher usage allowances, and low latency, but that will also balance these preferences against our objective of maximizing the effectiveness of our funds to serve consumers across unserved areas with our finite budget.²

In other words, the Commission concluded that two bids of, say \$100, are not of equal value if the proposed services offer different speeds, data allowances, or latency.

Just as consumers may place higher values on higher speed and lower latency, they also surely place higher value on being able to obtain service more quickly. That is, service available tomorrow is worth more than service available in five years.

Therefore, if the Commission's intent is to score bids as a function of the value of the service to consumers, then it should take into account not only speed, data allowance, and latency, but also when the service will become available.

This proposal further explains the rationale for including time-to-deployment in the scoring mechanism as well as a suggestion for how to implement it.

Chairman Pai Wants to Make Economics an Integral Part of FCC Decision-Making

Chairman Pai has made incorporating economic analysis a touchstone of his tenure. A speech he gave in April 2017 explained why economic analysis is critical to regulatory decision-making. Such decision-making should include the CAF Phase II Auction.

* This report was prepared on behalf of Echostar. The opinions expressed are mine and not those of the Technology Policy Institute. My bio and CV are included as an attachment.

¹ Federal Communications Commission, "In the Matter of Connect America Fund ETC Annual Reports and Certifications," Report and Order and Order on Reconsideration, (February 23, 2017), para. 23, https://apps.fcc.gov/edocs_public/attachmatch/FCC-17-12A1.pdf.

² Ibid., para. 14.

The Chairman noted that the regulator cannot make an informed decision about whether a rule will yield net benefits unless it makes an attempt to calculate the expected costs and benefits. He quoted former OIRA head Cass Sunstein, who said,

‘It is not possible to do evidence-based, data-driven regulation without assessing both costs and benefits, and without being as quantitative as possible.’ Hence, it is the duty of regulators to ‘obtain a careful and objective analysis of the anticipated and actual effects of regulations, whether positive or negative. We need to look at evidence and data. We need careful assessments before rules are issued, and we need continuing scrutiny afterwards.’ I agree.”³

The Chairman went on to quote from a paper by economist and former FCC commissioner Harold Furchtgott-Roth, who had introduced the Chairman:

As our host today wrote in his new paper on economics at the FCC, ‘In the dozens of new rules that the FCC promulgates each year, one can find no precise statement that resembles an actual cost-benefit analysis, no projections of benefits or costs over time, no clear weighing of the risks associated with various regulatory outcomes, and no plan for reviewing performance over time.’ This practice significantly raises the odds of policies that do more harm than good, actually producing net negative benefits.”⁴

The Office of Economics and Data that the Chairman has proposed would do more than conduct cost-benefit analyses. He said, “I envision it providing economic analysis for rulemakings, transactions, and auctions....”⁵

CAF Phase II Auction Scoring Mechanism Recognizes that Broadband Attributes Affect Consumer Demand

Auctions—first for spectrum and now for universal service subsidies—are a notable success for the FCC and for economics. Reverse auctions for universal service subsidies in particular are an important step towards bringing economic rationality to the universal service program. The Commission is also beginning to incorporate consumer demand into the universal service program through the scoring mechanism.

While empirical research is necessary to determine what the weights in the scoring system should be, they generally reflect consumer preferences for higher speed, but with decreasing additional willingness to pay as speed increases. Similarly, consumers prefer higher data caps to lower data caps and lower latency to higher latency. The scoring mechanism takes these into account.

In particular, the scoring mechanism is as follows:

³ Ajit Pai, “The Importance of Economic Analysis at the FCC” (Federal Communications Commission, April 5, 2017), https://apps.fcc.gov/edocs_public/attachmatch/DOC-344248A1.pdf.

⁴ Ibid.

⁵ Ibid.

$$score = 100 \frac{subsidy\ requested}{reserve\ price} + performance\ weight + latency\ weight^6$$

The lower the score, the more competitive the bid. Table 1 shows the performance weights the FCC will apply to the bids. While the Commission did not base the weights on any particular empirical analysis, the performance weights are consistent with the general finding that consumers see diminishing marginal returns to increased speeds.⁷

Table 1: Phase II Auction Performance Weights⁸

Performance Tier	Speed	Usage Allowance	Weight
Minimum	≥10/1 Mbps	≥ 150 GB	65
Baseline	≥25/3 Mbps	≥ 150 GB or U.S. median, whichever is higher	45
Above Baseline	≥100/20 Mbps	2 TB	15
Gigabit	≥ 1 Gbps/500 Mbps	2 TB	0

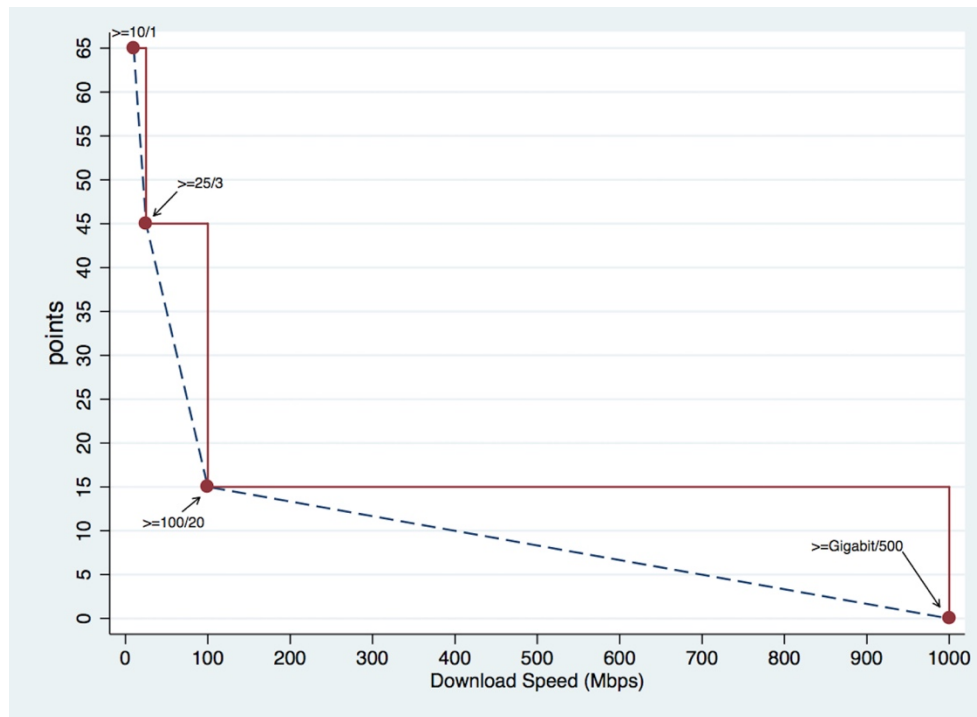
Figure 1 shows the scoring as a function of download speed. The graph highlights the implied decreasing incremental value of higher speeds via the decreasing slope of the line.

⁶ Federal Communications Commission, “In the Matter of Connect America Fund ETC Annual Reports and Certifications,” para. 15.

⁷ 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).

⁸ Federal Communications Commission, “In the Matter of Connect America Fund ETC Annual Reports and Certifications,” para. 17.

Figure 1: Score Penalty Points and Download Speed



The latency penalty, shown in Table 2, similarly reflects the Commission’s belief that consumers prefer lower latency to higher latency, although the Commission declined to conduct any research to estimate how much consumers truly value decreased latency.

Table 2: Phase II Auction Latency Weights⁹

Latency	Requirement	Weight
Low	≤ 100 ms	0
High	≤ 750 ms & “mean opinion score” of ≥ 4	25

Time Until Service is Available Also Affects Consumer Value, But Score Does Not Take Time Into Account

A key component of economic analysis is when a given activity will occur. The sooner something will happen, the more it will matter to people. It is for this reason that economic analyses discount future events. As OMB Circular A-4, which details how government agencies are to conduct regulatory analyses explains,

Benefits and costs do not always take place in the same time period. When they do not, it is incorrect simply to add all of the expected net benefits or costs without taking account of when the actually occur. If benefits or costs are delayed or otherwise separated in time from each other, the difference in timing should be reflected in your analysis....

⁹ Ibid.

The main rationales for the discounting of future impacts are:

- (a) Resources that are invested will normally earn a positive return, so current consumption is more expensive than future consumption, since you are giving up that expected return on investment when you consume today.
- (b) Postponed benefits also have a cost because people generally prefer present to future consumption. They are said to have positive time preference.
- (c) Also, if consumption continues to increase over time, as it has for most of U.S. history, an increment of consumption will be less valuable in the future than it would be today, because the principle of diminishing marginal utility implies that as total consumption increases, the value of a marginal unit of consumption tends to decline.

There is wide agreement with point (a). Capital investment is productive, but that point is not sufficient by itself to explain positive interest rates and observed saving behavior. To understand these phenomena, points (b) and (c) are also necessary. If people are really indifferent between consumption now and later, then they should be willing to forgo current consumption in order to consume an equal or slightly greater amount in the future. That would cause saving rates and investment to rise until interest rates were driven to zero and capital was no longer productive. As long as we observe positive interest rates and saving rates below 100 percent, people must be placing a higher value on current consumption than on future consumption.

To reflect this preference, a discount factor should be used to adjust the estimated benefits and costs for differences in timing. The further in the future the benefits and costs are expected to occur, the more they should be discounted....When, and only when, the estimated benefits and costs have been discounted, they can be added to determine the overall value of net benefits.¹⁰

The scoring mechanism presented in the Order does not take into account time even though winning bidders will likely differ in the time required before offering service. As a result, it will not be possible to compare meaningfully the scores as calculated by the equation presented in the Order. For example, consider two providers each offering 25/3 service, bidding exactly the reserve price, and latency less than 100 ms, but provider A can offer service to only 40 percent of the area in three years while provider B can offer service to 100 percent of the area in three years. Each provider's bid would receive a score of 145, yet we know that provider B's bid yields higher consumer net present value.

While the scoring mechanism does not currently take into account the length of time required for buildout, incorporating into the existing scoring framework is simple.

How to Incorporate Discounting Into the CAF Phase II Auction Scoring Mechanism

Incorporating discounting into the scoring mechanism requires two additional pieces of information: a discount rate and the length of time until the provider can offer service.

How to estimate a social discount rate, or a rate of time preference, has been controversial. For regulatory analyses, however, the Office of Management and Budget recommends agencies bound their estimates using discount rates of three and seven percent.

¹⁰ Office of Management and Budget, "Circular A-4" (Office of Management and Budget, September 17, 2003), https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/.

Providers will not, under the existing rules, include estimates of the time required to offer service, although the Order defines a rollout schedule winning bidders are required to meet. In particular, they must offer service to 40 percent of locations in the area by the end of the third year and another 20 percent each year.¹¹

Given this rollout schedule, the FCC could take either of two approaches for making the time adjustment. First, it could require providers to include a rollout schedule in the bid, presumably in the form of the number of years they will require to achieve particular milestones. Second, if the provider does not specify its own rollout schedule the Commission could assume that the bidder will follow the rollout schedule currently in the Order.

Consider an example in which five providers bid for the same area. To simplify the example, assume that each provider bids exactly the reserve price. The first four bidders all have low latency and offer speeds of 10/1, 25/3, 100/20, and Gigabit/500. The fifth bidder has high latency and offers a speed of 25/3. The first four bidders, however, will build out according to the FCC's stipulated schedule.¹² The fifth bidder can offer service immediately.

As Figure 2 shows, scoring mechanism as presented by the FCC (the “nominal score” in the figure) shows the gigabit service with the lowest score and the high-latency, 25/3 service with the highest score—higher even than the 10/1 offer. Discounting to reflect when service actually becomes available, however, changes the ordering of the bids.

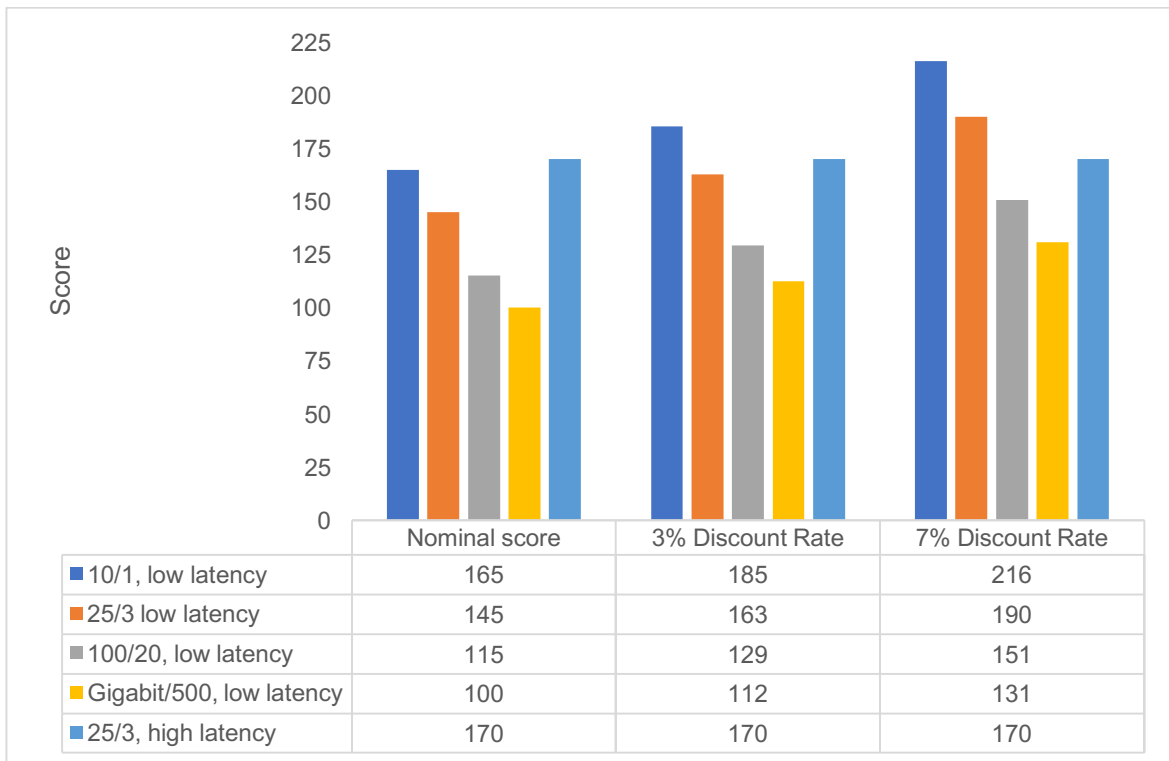
With a three percent discount rate, the high-latency provider's score is less than the provider offering 10/1 service, though still higher than the provider offering 25/3 and low latency. With a seven percent discount rate, the high-latency provider's score is less than the providers offering 10/1 and 25/3. In this example, the gigabit provider still wins, and at seven percent the high-latency provider has the third-lowest score.

In scoring actual bids, the outcomes could be different. This example assumed all bids were equal to the reserve price. In reality, a provider's bid is likely to be a function of the speed offered, reflecting generally higher costs of offering higher speeds. Thus, providers offering different speeds are likely to have different bids. Additionally, some speed tiers may be unfeasible in certain areas.

¹¹ Federal Communications Commission, “In the Matter of Connect America Fund ETC Annual Reports and Certifications,” para. 55.

¹² The first milestone is 40 percent coverage by the end of the third year. For this calculation, I assume 10 percent incremental coverage for the first two years to account for startup time and 20 percent in the third year. Each year after that increases coverage by 20 percent, as per the FCC's rollout schedule.

Figure 2: Scores by Speed and Latency With and Without Discounting



The key point is that introducing time discounting will change the ordering of the bids because it accounts for the lower value to consumers of service available further in the future.

Wallsten Short Bio

Scott Wallsten is President and Senior Fellow at the Technology Policy Institute. He is an economist with expertise in industrial organization and public policy. His research focuses on telecommunications, regulation, competition, and technology policy. He is also a senior fellow at the Georgetown Center for Business and Public Policy. His research has been published in numerous academic journals and his commentaries have appeared in newspapers and news magazines around the world. He was the economics director for the FCC's National Broadband Plan and has been a lecturer in Stanford University's public policy program, director of communications policy studies and senior fellow at the Progress & Freedom Foundation, a senior fellow at the AEI – Brookings Joint Center for Regulatory Studies and a resident scholar at the American Enterprise Institute, an economist at The World Bank, a scholar at the Stanford Institute for Economic Policy Research, and a staff economist at the U.S. President's Council of Economic Advisers. He holds a PhD in economics from Stanford University.

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Education

Stanford University, PhD, economics 1998

Stanford University, MA, economics, 1995

Washington University, BA *summa cum laude*, economics, mathematics (minor), 1992

Employment

Technology Policy Institute, President and Senior Fellow, September 2016 – present.

Technology Policy Institute, Senior Fellow and Vice President for Research, November 2007 – August 2016 (on leave Aug 2009 – Apr 2010)

Georgetown University, Adjunct Professor, Fall 2013.

U.S. Federal Communications Commission, National Broadband Task Force, Economics Director, August 2009 – April 2010

Stanford University, Lecturer, 2007 – 2009.

Progress & Freedom Foundation, Senior Fellow and Director of Communications Policy Studies, November 2006 – November 2007.

AEI-Brookings Joint Center for Regulatory Studies, Fellow 2003-2005, Senior Fellow 2005-2006.

American Enterprise Institute, Resident Scholar, 2003 – 2006.

The World Bank, Economist, 1998 – 2003.

Stanford University, Acting Assistant Professor of Public Policy and Visiting Researcher, Stanford Institute for Economics Policy Research, 1999-2001.

President's Council of Economic Advisers, Staff Economist, 1995-1996.

Other professional affiliations and activities

Senior Fellow, Georgetown University Center for Business and Public Policy, 2007 – present.

Board of Directors, Technology Policy Research Conference, 2014 – present.

Program Committee member, Technology Policy Research Conference, 2010 – 2013.

Faculty, Ronald Coase Institute, multiple years 2001 – present.

Economics & International Trade Team Member, Obama-Biden Presidential Transition, November 2008 – January 2009.

Member, "Sufficient Evidence? Building Certifiably Dependable Systems," National Academies of Sciences Computer Science and Technology Board, 2003 – 2007.

Publications (many available at works.bepress.com/scott_wallsten)

"Arts and Humanities are Key Parts of Ensuring Innovation in America." *Morning Consult*. February 6, 2017.

"Ten Tech Principles to Promote Innovation." With Thomas Lenard. Technology Policy Institute Working Paper. December 14, 2016.

"Comments filed with the Federal Communications Commission on Protecting the Privacy of Customers of Broadband and Other Telecommunications Services." October 17, 2016.

"Comments filed with the National Telecommunications and Information Administration and National Science Foundation on a Broadband Research Agenda." October 12, 2016.

"The Educational Impact of Broadband Subsidies for Schools Under E-Rate." With Thomas W. Hazlett and Benjamin Schwall. Under review at *Journal of Law and Economics*. May 17, 2016.

"An Economic Analysis of the FCC's Privacy Notice of Proposed Rulemaking." With Thomas Lenard. May 25, 2016.

"Is There Really a Spectrum Crisis? Disentangling the regulatory, physical, and technological factors affecting spectrum license value." *Information Economics and Policy*, Vol. 35, May 2016, pp.7-29.

"Comments filed with the Federal Communications Commission in the Matter of Expanding Consumers' Video Navigation Choices; Commercial Availability of Navigation Devices," April 19, 2016.

"Learning from the FCC's Lifeline Broadband Pilot Projects." Technology Policy Institute Working Paper, March 23, 2016.

"For Broadband 'Zero Rating,' It Doesn't Have to be All or Nothing." *The Hill*, January 21, 2016.

"Lightsquared, LTE-U, and the Revenge of the Anti-Commons." *The Hill*, September 25, 2015.

"Comments Filed with the Federal Communications Commission on Lifeline and Link-Up Reform and Modernization." With John Mayo and Olga Ukhaneva. August 31, 2015.

"Has Uber Forced Taxi Drivers to Step Up Their Game?" *The Atlantic*, July 17, 2015.

"Free Markets and Rural Universal Service." With Gregory Rosston. *The Hill*, July 6, 2015.

"Should Absence of Harm be Sufficient for Merger Approval?" *The Hill*, May 28, 2015.

"An Opportunity to Make Transparency the Norm at the FCC." *The Hill*, March 6, 2015.

"FCC Effort to Regulate Internet Ignores History of Past Failures." *The Conversation*, February 25, 2015.

"Administrative Procedures, Bureaucracy, and Transparency: Why Does the FCC Vote on Secret Texts?", Technology Policy Institute Working Paper, February 2015.

"We Don't Need to Define Broadband." *The Hill*, February 2, 2015.

"New Study of Broadband Stimulus is Not So Independent." *The Hill*, January 23, 2015.

"Will Title II Reduce Investment? Who's Asking?" *The Hill*, January 6, 2015.

"Independence, the President and the FCC." *The Hill*, November 17, 2014.

"Can the AT&T-DirecTV Merger End the Universal Service High-Cost Fund? *The Hill*, August 4, 2014.

"Undermining Transparency at the FCC." *The Hill*, June 19, 2014.

"Social Media and Entrepreneurship: The Case of Food Trucks." With Corey Rhyan. Technology Policy Institute Working Paper. June 2014.

"The Broadband Stimulus: A Rural Boondoggle and a Missed Opportunity." With Gregory Rosston. *I/S A Journal of Law and Policy*. Vol 9, No 3. 2014.

"An Economic Analysis of the Proposed Comcast-Time Warner Cable Merger." Technology Policy Institute Working Paper. May 2014.

"How do Attributes of Broadband Plans Affect Price?" With James Riso. *Review of Network Economics*, Vol. 13, Issue 1, March 2014.

"The Real Benefits of Gigabit Broadband Have Nothing to do with Speed." Technology Policy Institute Working Paper. May 2013.

"What Are We Not Doing When We're Online?" NBER Working Paper W19549. October 2013.

"Two Cheers for the FCC's Mobility Fund Reverse Auction." *The Journal of Telecommunications and High Technology Law*, Vol. 11, Issue 2, 2013.

"Unrepentant Policy Failure: Universal Service Subsidies in Voice and Broadband." With Thomas Hazlett. Arlington Economics. 2013.

"Data Caps Aren't Perfect, But That's OK." *Ars Technica*. May 2012.

"Is Xfinity TV Anticompetitive? Let the Courts, not Regulators, Decide." *Economists' Voice*. 2012.

"Comments on the Verizon-SpectrumCo Deal." Comments filed with the FCC on WT Docket No. 12-4. February 2012.

"From Network Externalities to Broadband Growth Externalities: A Bridge Not Yet Built." With John Mayo. *Review of Industrial Organization*, Vol 38, No. 2. March 2011.

"The Path to Universal Broadband: Why We Should Grant Low-Income Subsidies, and Use Experiments and Auctions to Determine the Specifics." With Gregory Rosston. *Economists' Voice*. 2011.

"Internet Usage Trends: Who Loses?" With Laura Martin. *Needham Insights*. November 15, 2011.

"What Gets Measured Gets Done: Stop Focusing on Irrelevant Broadband Metrics." *Communications of the ACM*. Vol. 54, No. 11, November 2011.

"Secondary Spectrum Markets as Complements to Incentive Auctions." With John Mayo. Georgetown Center for Business and Public Policy *Policy Vignette*. June 2011.

"How to Create a More Efficient Universal Service Program by Incorporating Demand and Cost-Effectiveness Analysis." Technology Policy Institute Working Paper. 2011.

"Pricing Strategies in a Digital World." With Laura Martin. *Needham Insights*. March 8, 2011.

"The Universal Service Fund: What do High-Cost Subsidies Subsidize?" February 2011.

"Enabling Efficient Wireless Communications: The Role of Secondary Spectrum Markets." With John Mayo. *Information Economics and Policy*, Vol. 22, Issue 1. March 2010.

"Residential Broadband Competition in the United States." With Colleen Mallahan. FCC OBI Working Paper. 2010. Available at SSRN: <http://ssrn.com/abstract=1684236>.

"The Future of Digital Communications Research and Policy." *Federal Communications Law Journal*. Vol. 63, No.1. December 2010.

"Residential and Business Broadband Prices, Part 2: International Comparisons." With James Riso. Technology Policy Institute Working Paper. December 2010.

"Residential and Business Broadband Prices, Part 1: An Empirical Analysis of Metering and Other Price Determinants." With James Riso. Technology Policy Institute Working Paper. November 2010.

"South Asian Telecommunications Development and the Role of Regional Cooperation." With Caroline Cecot. In *The Service Revolution in South Asia*, Ejaz Ghani, Ed. 2010.

"Net Neutrality, Unbundling, and their Effects on International Investment in Next-Generation Networks." With Stephanie Hausladen. *Review of Network Economics*. Vol. 8, Issue 1. 2009.

"Understanding International Broadband Comparisons: 2009 Update." Technology Policy Institute Working Paper. July 2009.

"An Economic Perspective on a U.S. National Broadband Plan." With Robert Hahn. Comments to the Federal Communications Commission In the Matter of A National Broadband Plan for Our Future. June 2009.

"Measuring the Effectiveness of the Broadband Stimulus Plan." *Economists' Voice*. Vol. 6, Issue 6, May 2009.

"Comments of 71 Concerned Economists: Using Procurement Auctions to Allocate Broadband Stimulus Grants." Lead author with Paul Milgrom, Gregory Rosston, and Andrzej Skrzypacz. April 2009.

"Reverse Auctions and Universal Telecommunications Service: Lessons from Global Experience." *Federal Communications Law Journal*. Vol. 61, No. 2, March 2009.

"Saving the Digital Transition." With Gregory Rosston. *CNET*, January 2009.

"The DTV Coupon Program: A Boon to Retailers, Not Consumers." Technology Policy Institute Policy Perspective. September 2008.

"The Economics of Pacific Bell v. linkLine Communications." *Economists Ink*, Summer 2008.

"Leveraging Communications: ICT as Economic Stimulus: A Plan for the Next Administration." Prepared as a background paper for the 2008 Aspen Institute Conference on Communications Policy. July 2008.

Understanding International Broadband Comparisons. Technology Policy Institute Working Paper. May 2008.

"The Effects of Ownership and Benchmark Competition: An Empirical Analysis of U.S. Water Systems." With Katrina Kosec. *International Journal of Industrial Organization*. Vol. 26, Issue 1. January 2008.

"Broadband and Unbundling Regulations in OECD Countries." First version June 2006; revised January 2008.

"Has Deregulation Affected Investment in Special Access?" August 2007.

“Antitrust policy and Innovation: The Impacts of the National Cooperative Research and Production Act.” June 2007.

“A Regulatory Play in Two Acts.” *Regulation*. Vol. 30, No. 4. Winter 2007 – 2008.

“Managing the Network: Rethink Prices, not Net Neutrality.” Progress Snapshot 3.12. October 2007.

“Doing the Hustle at the FCC.” Progress & Freedom Foundation Progress Snapshot 3.8. July 2007.

“Antitrust, Two-Sided Markets, and Platform Competition: The Case of the XM-Sirius Merger.” Progress & Freedom Foundation Progress on Point 14.14. July 2007.

“Everything You’ve Heard About Broadband in the U.S. is Wrong.” Progress & Freedom Foundation Progress on Point 14.13. July 2007.

“Comments to the Federal Communications Commission Regarding High-Cost Universal Service Support.” Comment filed at the FCC, WC Docket No. 05-337. June 2007.

“Towards Effective U.S. Broadband Policies.” Progress & Freedom Foundation Progress on Point 14.7. May 2007.

A Review of Universities in the Age of Corporate Science: The UC Berkeley-Novartis Controversy. *Nature*, April 12 2007.

“Communications, Broadband, and Competitiveness: How Does the U.S. Measure Up.” Testimony before the U.S. Senate Committee on commerce, Science and Transportation. April 24, 2007.

A Review of The Broadband Problem: Anatomy of a Market Failure and a Policy Dilemma by Charles Ferguson. *Journal of Law, Economics, and Policy*, Vol. 3, No. 2, Spring 2007.

“Great Branding, Bad Policies: The Flaws of Open Access Regulations.” Progress and Freedom Foundation Progress Snapshot 3.5. April 2007.

“Wireless Net Neutrality.” Progress and Freedom Foundation Progress Snapshot 3.2. February 2007.

“The Economics of Net Neutrality.” With Robert Hahn. *Economists’ Voice*. Vol. 3, Issue 6. June 2006.

“Ownership, Investment Climate, and Firm Performance.” With Mary Hallward-Dreimeier and Lixin Colin Xu. *Economics of Transition*. Vol. 14, No. 4. 2006.

“Merger Hangups.” Progress and Freedom Foundation Progress Snapshot 2.28. December 2006.

“The AT&T-BellSouth Merger: The Real Story.” AEI-Brookings Policy Matter. October 2006.

“No More Baseball Giveaways.” *Washington Times*, August 11, 2006.

“What U.S. Broadband Problem?” With Seth Sacher. CNET.com, July 3, 2006.

“What Affects the Quality of Economic Analysis for Life-Saving Investments?” With Robert Hahn and Katrina Kosec. *Risk Analysis*. Vol. 26, Issue 3, June 2006.

“Telecommunications Regulation in U.S. States: Its Rise and Impacts in the Early Twentieth Century.” AEI-Brookings Joint Center Working Paper 06-04. March 2006.

- "Debate over Net Neutrality Misplaced," With Robert Hahn. *Financial Times*, March 26, 2006.
- "The Economic Cost of the Iraq War." *Economists' Voice*. Vol. 3, Issue 2. January 13, 2006.
- "Broadband Penetration: An Empirical Analysis of State and Federal Policies." AEI-Brookings Joint Center Working Paper 05-12. January 2006.
- "Has the Internet Increased Trade? Evidence from Developed and Developing Countries." With George Clarke. *Economic Inquiry*. Vol. 44, No. 3. July 2006.
- "Returning to Victorian Competition, Ownership, and Regulation: An Empirical Study of European Telecommunications." *Journal of Economic History*, Vol. 65, No. 3, September 2005.
- "The Economic Costs of the War in Iraq." With Katrina Kosec. AEI-Brookings Joint Center Working Paper 05-19. September 2005.
- "When the Saints go Marching Out." *Baltimore Sun*, Nov 16, 2005.
- "Punting the Taxpayers." *New York Sun*, March 28, 2005.
- "City's WiFi Network Won't Close Digital Divide." *Philadelphia Inquirer*, February 17, 2005.
- "Regulation and Internet Use in Developing Countries." *Economic Development and Cultural Change*, Vol. 53, No. 2, January 2005.
- "Privatizing Monopolies in Developing Countries: The Real Effects of Exclusivity Periods in Telecommunications." *Journal of Regulatory Economics*, Vol. 26, No. 3, November 2004.
- "The Billion Dollar Pitch: An Analysis of the Ballpark Omnibus Financing and Revenue Act of 2004." With Katrina Kosec. November 2004.
- "A Suite Deal: Plans for D.C. Ballpark a Ripoff." *Washington Times*, October 28, 2004.
- "Cheap Net Phones Face the Threat of a Tax Hangup," with Robert Hahn and Gregory Rosston. *San Jose Mercury News*, June 17, 2004.
- "Telecommunications Policy in India." With Roger Noll. June 2004.
- "High-Tech Cluster Bombs: Why Successful Biotech Hubs are the Exception, Not the Rule." *Nature*, March 11, 2004.
- "Do Science Parks Generate Regional Economic Growth?" AEI-Brookings Joint Center Working Paper 04-04. March 2004.
- "Of Carts and Horses: Regulation and Privatization in Telecommunications." *Journal of Policy Reform*, Vol. 6, No. 4, 2003.
- "Digital Dreams: How Regulations can Widen the Digital Divide." Syndicated worldwide through *Project Syndicate*. December, 2003.
- "Has Private Participation in Water and Sewerage Improved Coverage? Empirical Evidence from Latin America." With George Clarke and Katrina Kosec. December 2003.

"Mr. President, Bring Your Academic Advisers in From the Cold," with Robert Hahn. *Financial Times*, October 30, 2003.

"Congress Shorts Future Terror-Fighting Innovation." AEI-Brookings Joint Center Policy Matters 03-22, July 2003.

"Whose Life Is Worth More? (And Why Is It Horrible to Ask?)," with Robert Hahn. *Washington Post*, June 2, 2003.

"How Globalization Stabilizes Poor Countries." Syndicated worldwide through *Project Syndicate*. May-June, 2003.

"Do Remittances Act Like Insurance? Evidence From a Natural Disaster in Jamaica." With George Clarke. World Bank. January 2003.

"The Investment Climate and the Firm: Firm-Level Evidence From China." With Mary Hallward-Driemeier and Lixin Colin Xu. World Bank Policy Research Working Paper No. 3003. January 2003.

"Telecommunication Reform in Ghana." With Mary Shirley and Luke Haggarty. World Bank Policy Research Working Paper No. 2983. November 2002.

"Universal(ly Bad) Service: Providing Infrastructure Services to Poor and Rural Consumers in Developing Countries." With George Clarke. World Bank Policy Research Paper Number 2868. July 2002.

A Review of The State, Regulation, and the Economy, Magnusson, Lars and Jan Ottoson, Eds. *Journal of Economic History*, Vol. 62, No. 4, December 2002.

A Review of Jonathan Bean, Big Government and Affirmative Action: The Scandalous History of the Small Business Administration. *Journal of Economic History*, Vol. 61, No. 4, December 2001.

"Telecommunications investment and traffic in developing countries: The effects of international settlement rate reforms." *Journal of Regulatory Economics*, Vol. 20, No. 3, pp. 307-323, November 2001.

"An Empirical Test of Geographic Knowledge Spillovers Using Geographic Information Systems and Firm-Level Data." *Regional Science and Urban Economics*, Vol. 31, No. 5, pp. 571-599. September 2001.

"An Econometric Analysis of Telecom Competition, Privatization, & Regulation in Africa and Latin America." *Journal of Industrial Economics*, Vol. 40, No. 1, March 2001.

"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*, Vol. 31, No. 1, Spring 2000.

"Surveying Surveys and Questioning Questions: Learning from World Bank Experience." With Lixin Colin Xu and Francesca Recanatini. World Bank Policy Research Working Paper No. 2307. March 2000.

"Executive Compensation and Firm Performance: Big Carrot, Small Stick." SIEPR Working Paper 99-17. March 2000.

Testimony

“The Role of Government in Promoting R&D.” U.S. Senate Finance Committee, September 2011.

“An Economic Overview of the Implications for Online Video of the Proposed Comcast-NBC Transaction.” FCC Public Hearing, July 2010.

“Reforming the Universal Service Fund High Cost Program.” U.S. House of Representatives, Committee on Energy and Commerce, Subcommittee on Communications, Technology, and the Internet, March 2009.

“Broadband and the Digital Future.” FCC en banc hearing, July 2008.

“The Costs of the Iraq War.” U.S. Congress Joint Economic Committee, February 2008.

“Broadband and Small Business.” U.S. Senate Committee on Small Business and Entrepreneurship, September 2007.

“Communications, Broadband and Competitiveness: How Does the U.S. Measure Up?” U.S. Senate Committee on Commerce, Science, and Transportation, April 2007.

Other Selected Speaking Engagements

Organizer and Moderator, Working Group on Emerging Issues in Unlicensed Spectrum, Aspen, CO, August 2015.

Organizer and Moderator, Working Group on Spectrum Sharing, Aspen, CO, August 2014.

Organizer and Moderator, Working Group on Encouraging Commercial Use of Government Spectrum, Aspen, CO, August 2013.

Organizer and Moderator, Working Group on FCC Incentive Auction, Aspen, CO, August 2011.

Organizer and Moderator, Working Group on Spectrum and Wireless, Aspen, CO, August 2010.

Keynote Speaker, Osinergmin Energy Conference, Lima, Peru, May 2013.

Next-Generation Broadband, Keio University, Japan, June 2011.

Broadband on Demand, Cable Europe, Brussels, Belgium, March 2011.

Broadband competition, Europe Cable Congress, Brussels, Belgium, February 2010.

Net neutrality, Needham & Co., LLC Broadband TechDay, November 2009.

Regulation, Antitrust, and Open Access, Open Mobile Summit, San Francisco, September 2009.

Keynote speaker, conference on network neutrality, Canada Public Policy Forum, November 20, 2008.

Guest on The Kojo Nnamdi Show discussing net neutrality and network management, September 2008.

Guest on The Kojo Nnamdi Show discussing broadband policy, June 2008.

Net Neutrality, University of San Francisco Intellectual Property Law Bulletin Symposium, January 2008.

International Broadband Comparisons, at conference “Telecommunications Infrastructure and Economic Performance,” sponsored by Ministère de l'Education Nationale, de la Recherche et de la Technologie, Paris, October 2008.

Net Neutrality, conference organized by Colombian Telecommunications Regulator, Cartagena, Colombia, October 2008.

Debate on broadband policy, PLI-FCBA 25th Annual Institute on Telecommunications Policy & Regulation, December 2007.

Guest on C-Span, The Communicators, July 7, 2007.

Organizer and moderator, broadband data conference, June 28, 2007.

Debate on broadband policy at the National Press Club, June 15, 2007.

Presentation on broadband and network neutrality, Federal Trade Commission, Broadband Connectivity Competition Policy, 2007.

Roundtable discussion on the state of broadband, NetCaucus State of the Net Conference, 2007.

Wilkinson, Barker, Knauer, LLP on Reverse Auctions, 2006.

London Business School Global Communications Consortium, on Spectrum Policy and Competition, 2006.

Broadband investment, Progress and Freedom Foundation 2006 Aspen Summit.

APEC conference on regulation, Mexico City, 2003.

Honors

Alfred P. Sloan Foundation Dissertation Fellowship, 1997 – 1998.

Phi Beta Kappa.

Omicron Delta Epsilon, International Economics Honor Society.

Percy Tucker Fellow, Washington University Department of Economics