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Via Electronic Filing

July 13, 2012

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth St., S.W.
Washington, DC 20554

Re: Notice of Written Ex Parte Presentation – CG Docket No. 10-213 – Analysis by Gregory L. Rosston regarding CEA's Petition for Waiver of the ACS Rules

Dear Ms. Dortch:

The Consumer Electronics Association ("CEA"), by the undersigned, hereby submits the attached economic analysis of Dr. Gregory L. Rosston ("Rosston Analysis") regarding CEA's pending petition for waiver of the Advanced Communications Service ("ACS") rules (the "CEA Waiver Petition") for IP-TVs and IP-DVPs.[1] As the Rosston Analysis concludes:

> [G]iven the relatively low penetration and expected penetration and use of IP-TVs and DVPs for ACS over the next few years, the available alternatives, and the fact that market forces will work to introduce additional accessibility, imposing the accessibility mandate on IP-TVs and IP-DVPs under the current schedule, rather than waiting a short period of time as requested in the CEA Waiver Petition, could increase the cost to manufacturers and actually reduce the availability and increase the consumer price of ACS on IP-TVs and IP-DVPs for all, including the community most desiring accessibility to ACS.[2]

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[1] CEA, Petition for Waiver, CG Docket Nos. 10-213 & 10-145, WT Docket No. 96-198 (filed Mar. 22, 2012).

[2] Rosston Analysis at 2.

Pursuant to Section 1.1206 of the Commission's rules,[3] this letter and the attached Rosston Analysis are being electronically filed with your office. Please let the undersigned know if you have any questions regarding this filing.

Respectfully submitted,

/s/ **Julie M. Kearney**

Julie M. Kearney
Vice President, Regulatory Affairs

Attachment

[3] 47 C.F.R. § 1.1206.

Gregory L. Rosston
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July 13, 2012

Via Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth St., S.W.
Washington, DC 20554

Re: *CG Docket No. 10-213 – Analysis by Gregory L. Rosston regarding the Consumer Electronics Association Petition for Waiver*

Dear Ms. Dortch:

I have been asked by the Consumer Electronics Association (CEA) to provide a cost-benefit framework and analysis for the Federal Communications Commission (Commission or FCC) in its evaluation of CEA's Petition for Waiver of the rules requiring accessibility for Advanced Communications Services (ACS) on IP-enabled televisions (IP-TVs) and IP-enabled digital video players (IP-DVPs).[4]

Qualifications:

I am Deputy Director of the Stanford Institute for Economic Policy Research and Deputy Director of the Public Policy program at Stanford University. I am also a Lecturer in the Economics Department and Public Policy program at Stanford University and regularly teach a course on economic policy analysis that involves cost-benefit analysis.

I served at the Commission for three and one-half years as the Deputy Chief Economist of the Commission, as Acting Chief Economist of the Common Carrier Bureau and as a senior economist in the Office of Plans and Policy, and recently I served as Senior Economist for Transactions assisting the Commission with its evaluation of the proposed merger of AT&T and T-Mobile. A copy of my c.v. is attached to this letter.

[4] CEA Petition for Waiver, CG Docket Nos. 10-213 & 10-145, WT Docket No. 96-198 (filed Mar. 22, 2012) (CEA Waiver Petition). I understand that the FCC's ACS rules are scheduled to go into effect on October 8, 2013, and the requested waiver is for a period of less than three years after that, until July 1, 2016.

Summary of Conclusions:

CEA has petitioned the FCC for a temporary waiver of its rules, limited to IP-TVs and IP-DVPs, regarding access to ACS in consumer devices by people with disabilities.[5] The Commission faces a potential tradeoff in deciding whether to grant the waiver and defer applicability of the new ACS accessibility requirements for these limited classes of devices: if it mandates inclusion of accessibility features in such devices at the same time these requirements go into effect for other devices that are primarily intended to be used for ACS, then people with disabilities potentially could access ACS over IP-TVs and IP-DVPs if such features are included and do not increase the price of these devices substantially. However, declining CEA's request to defer imposition of accessibility requirements for a limited time could lower availability or increase consumer prices of IP-TVs and IP-DVPs with ACS for all consumers while not increasing access to ACS if there are alternative means to access ACS.

I conclude that, given the relatively low penetration and expected penetration and use of IP-TVs and DVPs for ACS over the next few years, the available alternatives, and the fact that market forces will work to introduce additional accessibility, imposing the accessibility mandate on IP-TVs and IP-DVPs under the current schedule, rather than waiting a short period of time as requested in the CEA Waiver Petition, could increase the cost to manufacturers and actually reduce the availability and increase the consumer price of ACS on IP-TVs and IP-DVPs for all, including the community most desiring accessibility to ACS.

Background and Framework for Analysis:

This letter is intended to highlight some of the potential costs and benefits of not granting the waiver so that the Commission can better understand the tradeoffs it faces in this proceeding. It is impossible to predict with certainty how manufacturers and consumers, both those with disabilities and those without, would react to mandating ACS accessibility requirements for IP-TVs and IP-DVPs at the same time as for devices with ACS as a primary purpose or to predict reactions to a time-limited waiver of such requirements. However, economic analysis and data from the marketplace and from consumer surveys can provide some information that will shed light on some of the likely impacts.[6]

Below, I examine the state of demand, technology, and the availability of substitutes on the costs and benefits of the proposed temporary waiver. This analysis indicates that

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[5] *See Implementation of Sections 716 and 717 of the Communications Act of 1934, as Enacted by the Twenty-First Century Communications and Video Accessibility Act of 2010*, Report and Order and Further Notice of Proposed Rulemaking, 26 FCC Rcd 14557 (2011) (Order).

[6] For purposes of this letter, I follow the definition of ACS in the *Twenty-First Century Communications and Video Accessibility Act of 2010* (CVAA), which defines ACS as (a) interconnected VoIP service; (b) non-interconnected VoIP service; (c) electronic messaging service; and (d) interoperable video conferencing service.

denying the CEA Waiver Petition could reduce the availability and increase the consumer price of ACS on IP-TVs and IP-DVPs. However, the cost should come down over time as developers can modify the software and any necessary IP-TV and IP-DVP hardware over the next few product life-cycles of such devices and incorporate the learning from accessibility for devices with ACS as a primary purpose.

Congress and the Commission have discussed the general benefits of increased accessibility to ACS by individuals with disabilities and those are well documented.[7] However, for the small classes of devices subject to the waiver request, for which ACS is not a primary purpose, the Commission should weigh only the incremental benefits from additional accessibility from these devices in the short time period of the requested waiver against the cost of applying a regulatory mandate for these devices at the same time as for other devices.[8] CEA's request would delay the mandate for IP-TVs and IP-DVPs by less than three years, reducing the costs of ACS and the costs of adding accessibility to ACS.

If mandated accessibility for ACS were costless, requiring it could provide benefits to people needing accessible ACS and would not harm other consumers because the requirement would simply ensure the inclusion of such features with no adverse effect on manufacturers or those consumers who are not seeking accessible products. However, if there are costs of adding ACS functionality to IP-TVs and IP-DVPs, or if the benefits of including such functionality are small because people desiring ACS (including individuals with disabilities) have ready substitutes for IP-TVs and IP-DVPs with built-in ACS functionality, then the costs of applying the rules at the same time to IP-TVs and IP-DVPs, rather than granting the waiver, might outweigh the benefits.

At this point, because other devices with the primary purpose of ACS will have accessibility features, the short-term incremental benefits from requiring accessibility on devices whose primary purpose is not ACS, such as IP-TVs and IP-DVPs, appear to be limited, and the costs could be relatively high. However, limiting the waiver to three years appears to be justified: over time the costs of compliance should diminish as manufacturers have better ability to redesign their products to take account of the new requirements, and the benefits of accessibility could increase if ACS becomes a more integral part of the use of devices designed primarily for video play.[9] As a result, one would expect that the cost-benefit analysis would be different at the end of the waiver period. The remainder of this letter will examine the categories of benefits and costs

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[7] *See* Order, 26 FCC Rcd at 14559-61, ¶¶ 1-4.

[8] As the Commission discussed in its Order, laptops, tablets, and smartphones all provide access to ACS. *See id*. at 14564, ¶ 13. These devices are made explicitly for ACS, while other devices, such as IP-TVs and IP-DVPs are primarily used for video play and have ACS as an additional feature that can enhance their value to consumers.

[9] *See* Arrow, K., "The Economic Implications of Learning by Doing," *Review of Economic* Studies, Vol. 29, 1962, at 5-23, Romer, P. "Endogenous Technological Change," *Journal of Political Economy*, Vol. 98, No. 5, 1990, at 71-102.

from requiring accessibility to ACS on IP-TVs and IP-DVPs at the same time as such requirements begin to apply for devices with ACS as a primary purpose.

Mandating Accessibility Features for ACS in IP-TVs and IP-DVPs: Costs and Benefits:

Costs of mandating ACS accessibility in IP-TVs and IP-DVPs:

There are likely to be costs of mandating imposition of accessibility requirements for ACS on IP-TVs and IP-DVPs during the time period for which CEA requests a waiver. The costs of accessibility come potentially in at least three different forms: 1) costs of developing accessibility for ACS in general; 2) costs of developing accessibility to ACS specifically on IP-TVs and IP-DVPs; and 3) costs from withholding of ACS features in response to the ACS requirements.

Accessibility requirements could cause substantial product changes and television and DVP manufacturers are uncertain, how, if at all, they would change their equipment to comply with the rules.[10] Product developers require time to design systems for their televisions and DVPs. The Commission historically has recognized a period of about two years for the development time for complex consumer electronics equipment.[11] Once an IP piece of equipment is available, then, as the CEA petition states, it is usually sold for another 12 months, for a typical lifecycle of three years.[12]

In its Order, the Commission recognized the need for time to develop equipment and delayed the implementation of the accessibility requirements accordingly. The delay was intended to ensure that developers had time to incorporate accessibility functions in their ACS devices, such as smartphones, laptops, and tablets. Accessibility to ACS in such devices should be available pervasively at the latest by October 2013. However, CEA is requesting an extension of time for IP-TVs and IP-DVPs, devices whose primary purpose is not ACS.

There may be differences in costs to develop accessibility in general for ACS and accessibility of devices whose primary purpose is ACS and those for which the primary purpose is something other than ACS. The costs to make ACS accessible are likely to be of two components – those that are general for all devices and those that are specific to different types of devices.

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[10] *See, e.g.* Comments of Panasonic Corporation of North America, CG Docket No. 10-213 (June 14, 2012).

[11] *See* Order, 26 FCC Rcd at 14603 n. 268, citing *Amendment of the Commission's Rules Governing Hearing Aid-Compatible Mobile Handsets,* WT Docket No. 07-250, Policy Statement and Second Report and Order and Further Notice of Proposed Rulemaking, 25 FCC Rcd 11167, 11185, ¶¶ 49, 50 (2010).

[12] *See* CEA Waiver Petition at 7, 14. *See also* Wortham, J. and V. Kopytoff, "Sell Big or Die Fast," *New York Times* (Aug. 23, 2011) http://www nytimes.com/2011/08/24/technology/technology-devices-either-sell-big-or-die-fast html (noting that "[i]n recent years, technology companies have been cutting their losses with increasing speed").

If all of the costs of accessibility are generic costs and do not depend on the specific type of device, then the incremental cost of making ACS on IP-TVs and IP-DVPs accessible in the same timeframe as devices whose primary purpose is ACS would not be high. Developers would not incur any additional costs and the features would be available. Given the substantially higher expected number of smartphone, laptop, tablet and desktop computer sales over the next couple of years, one expects that if it is possible to make accessibility for such devices and there is no incremental cost to make the same accessibility on other devices whose primary purpose is not ACS, then such feature will be made available on such devices even if the requested waiver is granted.[13] For example, if the exact same version of Skype with accessibility were able to work on all devices, one would expect accessibility on IP-TVs and IP-DVPs in the next couple of years even if the waiver is granted as there would be no additional cost.

I understand that TV and DVP manufacturers have focused on enhancing the video aspects of their devices and not necessarily on ACS features and how accessibility to ACS would be incorporated into these video devices. One reason for this focus may be because IP-TV and IP-DVP manufacturers have a choice to leave pre-installed ACS features off of their devices. In contrast, smartphone, laptop and tablet manufacturers could not sell their devices without ACS. Today, 100 percent of smartphones, tablets and laptops are internet-capable and have ACS features, while "in 2012, CEA forecasts that approximately 27 percent of all TVs shipped to dealers will be capable of connecting to the Internet."[14] Even on this minority of new televisions (and much smaller share of installed base of televisions), most of the Internet functionality is likely to be used for video and audio programming that is not considered ACS, such as access to services like YouTube, Hulu and Pandora. Because ACS is a small attribute of the product at this point in time, television and DVP manufacturers, in contrast to ACS device manufacturers, have not necessarily focused on the ACS capabilities and on the accessibility needs for these types of equipment.

Even when designers of IP-TVs and IP-DVPs understand the parameters regarding required ACS accessibility, product designers will need to figure out how to add such functionality to their IP-TVs and IP-DVPs. It is likely that the cost of accessibility functionality for ACS will decrease over time. As the Commission implicitly recognizes, demanding accessibility tomorrow would be a high cost, one year from now would be a lower cost, and three years from now still lower. The decreasing cost is due to advances in technology and software, the lead time for product design, and learning by doing as

[13] CEA projects that there will be two times as many mobile computers sold in 2012 as high-definition televisions. CEA, "The Evolving Video Landscape," Figures 1 and 2 (April 2012). Note that this does include smartphone or desktop computer sales.

[14] CEA Waiver Petition at 4 n. 17.

producers incorporate the technology in some types of equipment at first and adapt it to more types of equipment over time.[15]

Implementing accessibility could be different (and more expensive) for devices whose primary purpose is not ACS. For example, if accessibility to Skype on a television required modification of the remote control or screen in a different way than on a tablet or laptop, such design would cause additional costs. In this case, without the waiver, TV and DVP manufacturers would have three choices – incur the additional costs and include the additional ACS accessibility features with no price increase, incur the additional costs and increase prices for IP-TVs and IP-DVPs, or exclude the ACS features.

In a competitive market, one would not expect firms to incur additional costs with no price increase. To the extent that the mandate increases costs, one would expect prices to increase. As a result, the second and third choices are important to examine. Manufacturers can be expected to pick the choice that maximizes their profits. Since IP-enabled devices will compete with non-IP-enabled devices when the primary purpose is not ACS, manufacturers will have to be conscious of the cross-price elasticity between the two types of devices when setting prices.[16] The average wholesale price of network-enabled televisions is $1,014 while the average of all digital displays (including network-enabled displays is about half that level at $537,[17] although the network-enabled sets tend to include other features and have larger screens. If the mandates increase prices of IP-enabled devices too much, consumers could switch to non-IP-enabled devices in the short run or delay purchases. Some may use alternatives to connect tablets and laptops to access ACS through their big screen without buying a new IP-enabled television if the price increase is too high. In addition, price increases would harm even those desiring the accessibility to ACS as all prices might increase.

Absent the waiver, inclusion of ACS capabilities will bring with it the costs identified above and thus increased prices. Manufacturers would have to comply with the Commission's rules, so some manufacturers have considered pulling ACS features from their equipment an alternative to increased prices.[18] It is my understanding that an equipment provider could sell a set with ACS pre-loaded on the set or it could simply provide the ability to download services by the end user. If the services are not accessible, then pre-installing them at this point without a waiver might cause the

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[15] In addition to the earlier citations to learning by doing, see, Irwin, D. and P. Klenow, "Learning-by-Doing Spillovers in the Semiconductor Industry," *Journal of Political Economy,* Vol. 102, No. 6, 1994*,* at 1200-1227.

[16] In general, the cross-price elasticity between two products is positive when they are substitutes – the higher a price for one, the more consumers would buy the substitute product. *See* Graves, P. and R. Sexton, "Cross-Price Elasticity and Income Elasticity of Demand: Are Your Students Confused?" *The American Economist*, Vol. 54, No. 2 (2009), at 107-110.

[17] *See* CEA, "2015 Displays and Video Components Forecast," Fig. Total DTV that are Network enabled; Average Factory/Wholesale Price, 2011 (Jan. 2012).

[18] *See, e.g.*, Comments of Panasonic Corporation of North America, CG Docket No. 10-213 (June 14, 2012) at 4, 9.

manufacturer to be in violation of the Commission's rules. But, complying with the rules by denying everyone the ability to purchase a set with ACS pre-installed could have high social costs. Instead of increasing accessibility to ACS, the rule might instead have the perverse effect of reducing easy access to ACS for all, including the community the rules were designed to help.[19]

This perverse effect is well-known. For example, CAFE standards for cars caused more people to buy SUVs that were part of the light truck category and not subject to the same gasoline mileage rules. A similar effect has happened with power plants where requirements that new and refurbished power plants meet stringent emission requirements caused older power plants to remain in service. There are many other examples where imposition of a requirement does not necessarily have its intended effect.

Benefits of mandating ACS accessibility in IP-TVs and IP-DVPs:

Generally in a market economy, benefits of a feature would be measured by willingness-to-pay and then measurement of the external benefits or costs that are not incorporated into the purchasers' decisions, such as pollution, would be added or subtracted to get the net societal benefits.[20] In the case of accessibility features, the first step would be to measure the willingness-to-pay of consumers desiring the features. A second step would be to examine the externalities. In a market without externalities, if the consumers' combined willingness to pay were sufficiently high, then producers would market televisions and DVPs with accessibility to ACS without any need for government regulation. It should be noted that accessibility might not be available on every piece of equipment, but that there would be some producers catering to the demands of different sets of consumers, just as some car manufacturers make wheelchair-accessible vans and others do not. There might be some benefit to people in wheelchairs if all cars were required to be wheelchair accessible, but there would also be obvious costs to such a mandate. It is important to note that willingness-to-pay is not the only measure of societal benefits – there are other factors to consider such as inclusion in society, general human rights, and other attributes that can make it desirable to provide certain goods and services even beyond the willingness-to-pay.[21] For example, the government makes provisions for food and shelter, and has set up systems for subsidies for telephone access for low-income families and other services such as video relay service.

The second standard step in thinking about benefits of mandating accessibility is to consider the positive and negative externalities. There appear to be few, if any, negative externalities to having accessibility to ACS (other than potentially higher costs and

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[19] *See id*. at 9.

[20] *See*, *e.g*., Boardman, A., D. Greenberg, A. Vining, and D. Weimer, Cost-Benefit Analysis: Concepts and Practice, 4th Edition, Prentice Hall: Boston, 2011.

[21] *See, e.g.*, for example, Sen, Amartya, "The Discipline of Cost-Benefit Analysis," in Adler, M. and E. Posner (eds.), Cost-Benefit Analysis: Legal, Economic and Philosophical Perspectives, The University of Chicago Press: Chicago and London, 2001.

prices, which was discussed above). There are possible positive externalities to accessibility to ACS. As more people have ACS capabilities, the "network effects" from ACS may grow. For example, the more people who have Skype access, the higher the value to each user of Skype who can potentially call more Skype users (ignoring any potential congestion or network degradation). In addition, there may be specific network effects for the community who need accessibility to ACS as they may benefit especially highly from being able to connect with other community members who also desire accessibility to ACS. All of these network effects can be expected to grow (potentially at a decreasing rate) as the number of people with access to ACS grows and as the extent of ACS increases over time.[22]

The discussion thus far is applicable to the general availability of access to ACS on all types of devices. The benefits of accessibility for any particular type of device are limited by the availability of substitutes for that device that have accessibility. CEA's limited waiver request is not for all ACS devices, but for IP-TVs and for IP-DVPs. If accessibility is easy (and in fact in some cases superior) on alternative ACS-capable devices, then the benefits from mandating accessibility on IP-TVs and IP-DVPs may be very low. For example, the vast majority of households have smartphones, laptops or tablet computers, all of which are designed primarily for ACS and are subject to the ACS accessibility rules.[23] To the extent that such devices are available, the incremental benefits from accessibility would be small. Many consumers might prefer to use Skype or other video chat services from a laptop or tablet instead of broadcasting their conversations through an entire room on a living room big screen. In those cases, the benefits from access are small. Even in cases where the living room big screen is preferable, the benefit is not the entire benefit of being able to use that screen, but the difference between using the big screen and a smaller laptop or tablet screen.

In addition, there are relatively straightforward mechanisms to connect laptops and tablets to a big screen without additional mandates – in fact even though I am an economist, not an engineer, I have been able to hook up a cable to display my laptop output on our family room television, and to send signals wirelessly from my tablet for playback on the same screen. Others are likely to be able to do the same.

With such low-cost and possibly superior alternatives, the benefits from mandating inclusion of accessibility features in IP-TVs and IP-DVPs at the same time as the accessibility rules begin to apply to products intended for ACS would be limited.

Conclusion:

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[22] *See*, *e.g.*, Katz, M. and C. Shapiro, "Systems Competition and Network Effects," *Journal of Economic Perspectives*, Vol. 8, No. 2, Spring 1994, at 93-115.

[23] It is difficult to find data showing households with one type of device, but not with others. However, the available information shows many more households have connected desktop computers, connected portable computers and smartphones, than have connected televisions and DVPs. See for example, "Connecting the Dots Between Consumers, Content and Consumer Electronics in the Home," CEA Market Research Report, December 2011, Figure 4.

This letter has looked at the current state of demand, technology, and the availability of substitutes on the costs and benefits of the proposed temporary waiver. Imposing the FCC's accessibility mandate under the current schedule rather than waiting a short period of time as requested by CEA could increase the cost to manufacturers and actually reduce the availability and increase the consumer price of ACS for all, including the community most desiring accessibility to ACS. However, the increased cost should decrease over time as developers incur the costs for other devices and can modify the software and also modify IP-TVs and IP-DVPs over the next few product life-cycles. Given the relatively low penetration and expected penetration and use of IP-TVs and DVPs over the next few years, the alternatives, and the market forces to introduce additional accessibility where warranted, granting of a short-term waiver could avoid potentially large upfront costs and not diminish benefits greatly.

Sincerely,

Gregory L. Rosston

Attachment

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Employment

Stanford University, Stanford, CA
- Deputy Director, Stanford Institute for Economic Policy Research, 1999-
- Deputy Director, Public Policy Program, 2006-
- Senior Research Scholar, Stanford Institute for Economic Policy Research, 2004-
- Research Scholar, Stanford Institute for Economic Policy Research, 1997-2004
- Lecturer in Economics/Public Policy, 1997-

Federal Communications Commission, Washington, DC
- Senior Economist for Transactions, 2011 (part-time while at Stanford)
- Deputy Chief Economist, 1995-1997
- Acting Chief Economist, Common Carrier Bureau, 1996
- Senior Economist, Office of Plans and Policy, 1994-1995

Law and Economics Consulting Group, Berkeley, CA
- Senior Economist, 1990-1994

Economists Incorporated, Washington, DC
- Economist/Research Associate, 1986-1988

Education

Stanford University, M.A., Ph.D., in Economics, Specialized in the fields of Industrial Organization and Public Finance. 1986, 1994.

University of California, Berkeley, A.B. in Economics with Honors. 1984.

Papers and Publications

"An Economic Analysis of the Effects of FCC Regulation on Land Mobile Radio," unpublished Ph.D. dissertation, Stanford University. 1994.

"Competition in Local Telecommunications: Implications of Unbundling for Antitrust Policy" in Brock, G., (ed.) Toward a Competitive Telecommunication Industry: Selected Papers from the 1994 Telecommunications Policy Research Conference, LEA Associates, Mahwah, NJ. 1995 (with Harris, R. and Teece, D.).

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"Local Telephone Rate Structures Before and After the Act," *Information, Economics and Policy*, Vol. 17, No. 1. pp 13-34, January 2005 (with Wimmer, B.).

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"The Effect of Private Interests on Regulated Retail and Wholesale Prices," *Journal of Law and Economics,* Vol. 51, No 3. August 2008 (with Savage, S. and Wimmer, B).

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"Household Demand for Broadband Internet Service," Communications of the ACM, February, 2011 (with Scott Savage and Donald Waldman)

"Competitive Implications of the Proposed Acquisition of T-Mobile by AT&T Mobility" Stanford Institute for Economic Policy Research *Policy Brief*, March 2011 (with Roger Noll)

Other Activities

Editorial/Committees

President's Council of Advisors on Science and Technology Working Group on Spectrum, 2011-2012.
Department of Commerce Spectrum Management Advisory Committee, Co-Chair, 2011-
Department of Commerce Spectrum Management Advisory Committee, Member, 2010-,
Telecommunications Policy Research Conference Board, 2009-
Member, Obama Presidential Transition Team, 2008
Co-chair, Obama for President, Economy, Globalization, and Trade Committee, 2008
Associate Editor, *Information, Economics and Policy*, 2008-
Referee for various academic journals.
Telecommunications Policy Research Conference, Program Committee 2002-2004.
Bay Area Economic Profile Academic Review Panel, 2003-2004.
National Research Council Committee on *Wireless Technology Prospects and Policy*, 2003-2011

Testimony and Submissions

FCC Economist Panel on the Economics of Interconnection, May, 1996.
FCC Economist Panel on the Economics of RBOC Entry under §271, July, 1996.
FCC Economist Panel on Competitive Bidding for USF, March, 1997.
Consultant for the World Bank on Telecommunications Policy in Hungary, 1998.
FCC Academic Expert Panel on "A New FCC for the 21st Century," June 1999.
FCC Academic Expert Panel on AT&T—MediaOne Merger, February, 2000.
Principal co-author of 37 Concerned Economists submission on "Promoting Efficient use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets," February 2001
FCC Panel on Wireless Competition, February 2002.
FCC Workshop on Spectrum Policy, July 2002.
San Francisco Telecom Commission on Cable Competition, January 2003.
U.S. Senate Commerce Committee on Spectrum Policy, March 2003.
California State Senate Committee on Banking, Commerce and International Trade on the Economic Effects of Media Consolidation, March 2003.
San Francisco City Board of Supervisors Land Use Committee on Cable Competition, July 2004.
GAO Panel on Spectrum Allocation and Assignment, August, 2005.
Comments and Reply Comments (with Paul Milgrom) on Auction Rules for Advanced Wireless Services, February 2006
FTC Panel on Network Neutrality, February 2007.
FCC *En Banc* Hearing on Network Management, April 2008.
Principal co-author of 71 Concerned Economists submission on "Using Procurement Auctions to Allocate Broadband Stimulus Grants" Submitted to the National Telecommunications Information Agency (NTIA) and Rural Utilities Service (RUS), April, 2009
FCC Broadband Task Force, Workshop on "Benchmarks" September 2009

U.S. House Commerce Subcommittee on Communications, Technology and the Internet, Universal Service hearings, November 2009
FCC Video Relay Service Reform Workshop, December, 2009
FCC Roundtable on Experiments for Universal Service, 2010
Principal co-author of Letter from 112 Economists to President Obama on Spectrum Auctions and Repurposing Spectrum, April, 2011
FCC Universal Service Reform Workshop, April, 2011

Other
Stanford Federal Credit Union, Advisory Board, 2012-
Sustainable Conservation, Advisory Board, 2007-
Nepalese Youth Opportunity Fund, Advisory Board, 2007-
Boards and Advisory Boards for private companies

Awards
Chairman's Distinguished Service Award, FCC, 1997.
University of California, Brad King Award for Young Alumni Service, 1994.
National Performance Review Hammer Award for Reinventing Government, 1994.

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