Response to Professor Hogendorn

We appreciate the comments and suggestions made by Professor Hogendorn in his peer review of version 2 of the Connect America Cost Model (abbreviated either as CACM or CAM).[1] We are pleased that he acknowledges that the model has "a vastly more accurate method of measuring costs, using both much more detail at the engineering level and a far more precise method of modeling geographic locations" and "is more accurate in its treatment of the road network than any other model [he was] aware of".[2] He has many good comments, and as he acknowledges, many of his comments relate to default input assumptions in the model at the time of his review, as discussed in the model documentation. We note that that the Wireline Competition Bureau (Bureau) has sought further comment on input values, and has not yet adopted any input values for the CAM.

Background

The CAM estimates, for every census block, the cost of providing a voice and broadband-capable network. That cost is levelized, that is, is turned into a constant (or kind of average) monthly cost associated with serving the census block over the network's entire life.[3] Given costs for each block, the model can be used to calculate support.[4] In particular, a future Bureau order will determine a lower "benchmark" that identifies areas that could be economically viable absent subsidies ("the funding threshold"), and an upper cost threshold that delineates those deemed to be extremely high cost. The total subsidy will be equal to the cost of supplying eligible Census blocks that are more expensive to serve than the funding threshold, but are not more expensive than the extremely high cost threshold. The total budget for support in price cap areas was set by the Commission to not exceed $1.8 billion.[5] Thus, changes in cost or support calculations will change the obligations that carriers have to accept to receive funding, but will not change the total amount of funding.

There are four primary points of discussion from the review that we address at length in this response: (1) future changes in profitability for service areas covered,

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[1] While the peer review refers to CACM throughout, this response, consistent with *Connect America Fund et al.*, WC Docket Nos. 10-90, 05-337, Report and Order, 28 FCC Rcd 5301 (Wireline Comp. Bur. 2013) (*CAM Platform Order*), will refer to the model as CAM.

[2] Letter from Christiaan Hogendorn, Associate Professor of Economics, Wesleyan University, to Julie Veach, Chief, Wireline Competition Bureau, FCC, at 3 (February 19, 2013) (Hogendorn).

[3] *CAM Platform Order*, 28 FCC Rcd at 5308, para. 15.

[4] *See Connect America Fund et al.*, WC Docket No. 10-90 et al., Report and Order and Further Notice of Proposed Rulemaking, 26 FCC Rcd 17663, 17715-16, paras. 134-35 (2011) (*USF/ICC Transformation Order*).

[5] *See id.* at 17764, 17725-26, paras. 25, 158-159.

(2) the CAM take rate, (3) pricing, and (4) the exclusion of video revenues. We also briefly discuss other comments at the end of this response. For ease of reference, Professor Hogendorn's comments are provided in italics, and we have, as much as possible, responded to his comments in the order they appear in his review.

Service areas covered

On the demand side, the CACM is used primarily for those areas which do not have broadband service according to the National Broadband Map (NBM). . . . For a run of the CACM, [the] boundary [between unprofitable areas and areas in which at least a monopolist would be viable] is taken as fixed based on current inputs from the NBM. This leads to concern that some of the areas modeled by the CACM would become profitable in the future if demand grows. . . . If in fact demand is growing over the time period, then private investment might occur even without Connect America funding.[6]

Professor Hogendorn implicitly appears to be concerned that support amounts derived from the model might overstate the subsidy required in a territory that is not presently commercially viable, but will become so in the future (though of course the reverse is also possible).[7]

Census blocks could become more viable over time for a variety of reasons: costs could fall, either from falling input prices and/or rising productivity in telecommunications; and revenues could increase, for example, due to demand changes that allow greater retail prices, or cause a shift towards services with higher margins, and/or due to an increase in the number of subscribing households.

Each of these possible changes is discussed in turn, which will inform the Bureau's analysis in adopting the final cost model and funding thresholds. We note that the Bureau has sought comment on what revenue assumptions are appropriate to adopt for the final model.[8] In one or more future orders, the Bureau expects to finalize the input values for the model and set a funding threshold that takes into account reasonable estimates of expected per location levelized revenues.

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[6] Hogendorn at 4-5.

[7] In the quoted paragraph, Professor Hogendorn concludes, "*The CACM documentation that I reviewed indicates a 20-year levelized ARPU and take-rate, so it does not address this problem.*" Levelized demand is discussed here, but also below under the sections titled "Pricing" and "Take rate." The take rate is discussed in the "Take rate" section. The support threshold has not been decided yet, and in any event, is a policy decision not subject to peer review.

[8] Letter from Michael J. Jacobs, Legal Advisor to the Chief, Wireline Competition Bureau, FCC to Marlene H. Dortch, Secretary, FCC, WC Docket No. 10-90 & Attach. at 23-30 (filed June 25, 2013) (WCB June 25 Virtual Workshop Submission Letter), *available at* http://appsint.fcc.gov/ecfs/document/view?id=7520925138 and http://appsint.fcc.gov/ecfs/document/view?id=7520925140.

Costs could fall. The model assumes that input prices remain fixed, and there are no productivity increases. In actuality, these things will likely change, and in a manner that could lead the CAM, for those areas where the subsidy is likely to apply, to at most mildly overstate costs. If it is assumed that, consistent with the *USF/ICC Transformation Order*, the cost model is used to determine support amounts for lines with costs that lie below the top first percentile,[9] then we estimate that subsidies will apply to lines with costs that lie below this upper threshold, and somewhere above the 90th cost percentile. The following table divides the CAM's costs into ten aggregate categories, indicating the proportion each represents of total costs for lines in the 90th to 99th cost percentiles. It also provides estimates of the average growth in the prices of each, and productivity changes.[10] Using a range of extreme values for these forecasts,[11] the table shows that overall costs are likely to fall no more than 2.1 percent, and could even rise by 1.6 percent. While the midpoint of this range, -0.25 percent, is negative, suggesting a small expected cost overstatement, given forecast errors, any number in this range is essentially indistinguishable from zero. Additionally, other factors suggest the CAM understates costs, for example, because the CAM optimizes costs at a high level, so in general will not account for special circumstances that generally work to raise costs, and due to the CAM's assumptions about retail prices and possibly also retail service quality, discussed below.

			Annual price change		Reduce costs by:			
	Baseline ($M)	% of total	Low estimate	High estimate	Low TFP* growth	High TFP* growth	Change: low cost estimate	Change: high cost estimate
Labor	$17,678	70.0%	0.9%	3.6%	0.1%	0.7%	$17,710	$18,301
Fiber	$918	3.6%	-5.0%	-5.0%	0.1%	0.7%	$865	$871
Poles	$497	2.0%	2.0%	2.0%	0.1%	0.7%	$503	$506
Conduit	$804	3.2%	0.0%	0.0%	0.1%	0.7%	$798	$803
Drop	$81	0.3%	-2.0%	-2.0%	0.1%	0.7%	$79	$80
ONT	$859	3.4%	-5.0%	-5.0%	0.1%	0.7%	$810	$816
Fiber pedestals	$442	1.8%	-5.0%	-5.0%	0.1%	0.7%	$417	$419
Splitters	$1,589	6.3%	-5.0%	-5.0%	0.1%	0.7%	$1,499	$1,509
Electronics	$847	3.4%	-30.0%	-10.0%	0.1%	0.7%	$588	$762
Land/Bldgs	$1,526	6.0%	-5.1%	3.4%	0.1%	0.7%	$1,437	$1,577
Total	**$25,240**	**100%**					**$24,706**	**$25,642**
			Percent change from baseline:				**-2.1%**	**1.6%**

[9] *See USF/ICC Transformation Order*, 26 FCC Rcd at 17837, para. 533.

[10] The table, its sources, and the calculations discussed here are explained in more detail in the appendix to this response.

[11] The use of extreme values results in an improbable range of potential price movements, since the lower bound of the range only occurs if all variables simultaneously take on the values that would give the smallest cost increase, and similarly for the upper bound.

* TFP refers to total factor productivity. If TFP increases by one percent, then, holding input prices fixed, the same output could be produced with one percent less expense on inputs.

To the extent that either the lower and/or the upper threshold are raised, (i.e., to the extent support is provided to lines with costs exceeding the top one percent), the range over which prices are likely to move is raised, lowering the extent to which the assumption of zero cost changes potentially understates costs.[12]

Revenues could rise. Material increases in retail prices also seem to be unlikely: for example, in one study, median prices from 2004 to 2009 fell for standalone cable and DSL broadband services for all reported bandwidths, except one in which the median price was essentially unchanged.[13] To the extent that such declines in retail prices are not considered in the setting of the funding benchmark used to determine subsidies, over time the model will increasingly understate the subsidy necessary for profitable supply of service.[14] Similarly, while a shift toward higher margin services cannot be ruled out, historically broadband services have seen a steady increase in service quality, such as bandwidth growth, while bandwidth-adjusted prices have fallen.[15] Such quality increases are costly to provide, but these costs, as they might be incurred over the long life of a fiber network may not be fully accounted for in the model, again leading to an offsetting (though possibly small) understatement of costs. Population growth in rural areas is not likely to be large,[16] so is unlikely to lead to a material increase in revenues.[17]

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[12] For example, if lines with costs in the 95th to 99th percentiles are considered, the potential range of cost variation runs from -1.9% to +1.8% (in comparison, looking at total costs gives a cost variation of -3.5% to +0.8%). This variation occurs because labor is the major cost associated with loop lengths and loop lengths greatly increase in higher cost areas. The data underlying these calculations and further explanation is presented the appendix to this response.

[13] Shane Greenstein and Ryan McDevitt, *Evidence of a Modest Price Decline in US Broadband Services*, 28 Info. Econ. and Policy 200, 206 figs. 2 & 3 (2011), *available at* http://www.sciencedirect.com/science/journal/01676245/23/2. While reported mean prices *across* bandwidths both rose and fell, the annual average rate of increase in the mean standalone cable price was one percent, and the mean standalone DSL rate essentially returned to its 2004 value. *Id.* at 206, 208 & 207 tbl. 3.

[14] Subscription rates, and other assumptions necessary to determine levelized revenue, will be made in a forthcoming Bureau Order, as will be the assumptions necessary to determine the benchmark and the upper threshold.

[15] *Id*. The paper estimates that, taking account of improvements in bandwidth, prices declined between 3 and 10 percent from 2004 to 2009. This does not imply that revenues necessarily fell, since the average price per service *not adjusted for bandwidth* could have risen.

[16] Annual rural population growth in the U.S has probably steadily declined since 2005-2006, from 0.74% to 0.11% in 2010-2011 (a hiccup in 2009-2010 is partly

Moreover, to the extent the funding threshold ultimately selected by the Bureau underestimates the potential for profit, the model-based subsidies only will be available for five years for the carriers that elect to make a state-level commitment. Accordingly, even if over the course of that time period some of the presently unserved areas were to become materially profitable, this would not likely be the case for most geographies in the relevant timeframe for those carriers electing to receive model-based support, and the competitive process envisioned by the Commission at the end of the five years could provide another opportunity to re-size the subsidy. Consequently, carriers are unlikely to be able to receive subsidies in locations they would have entered anyway.[18]

Take Rate

The default take-rate in the CACM is 90%, which seems too high.[19]

Professor Hogendorn's comment regarding the CAM's default take rate of 90 percent at the time he conducted his review appears to focus on whether this is an appropriate assumption regarding subscription levels. At the outset, we note that the Bureau has adjusted the default take rate in the current version of the model to a lower figure and has sought comment on the appropriate take rate to use in the model.[20] The Bureau will finalize the CAM take rate in a future order.

The purpose of the CAM take rate is to determine the number of locations that are actually connected to the network by a drop and optical network terminator (as opposed to just being passed by the network). The CAM take rate necessarily must be higher than current or even expected subscribership rates for at least two reasons.[21] First, at any point in time some locations will be vacant, or the occupiers will not presently wish to purchase broadband service, but this will change over

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explained by adjustments to county population estimates following the 2010 Census). *See* Econ. Research Serv., U.S. Dept. of Agric. (USDA), "Rural America at a glance: 2012 edition," pp. 5-6, *available at* http://www.ers.usda.gov/media/965908/eb-21_single_pages.pdf (last visited June 24, 2013).

[17] Professor Hogendorn also expresses concern that the Commission's estimate of levelized demand may be too low, on which, *see* the discussion under "The subscription rate" below.

[18] Model support also gives providers an incentive to maximize subscriptions, since the amount provided is fixed, while each new subscriber brings substantial revenues, without requiring additional network deployment.

[19] Hogendorn at 5.

[20] *See* WCB Feb. 6, 2013 Virtual Workshop Submission Letter, Attach. at 39-40.

[21] *See* Letter from Michael J. Jacobs, Legal Advisor to the Chief, Wireline Competition Bureau, to Marlene Dortch, Secretary, FCC, WC Docket No. 10-90, Attach. at 39-40 (filed Feb. 6, 2013) (WCB Feb. 6, 2013 Virtual Workshop Submission Letter).

time. Such "churn" means that at any point in time the percent of locations that have last mile facilities always exceeds the subscription rate. Second, because of the preceding point, and to the extent that subscription growth is expected over time, it is reasonable to assume that it is efficient to deploy to more locations than those with current subscribers (for example, because it is often cheaper to deploy to all locations in a street, than to extend service piecemeal to each location as demand requires).[22]

Pricing

The CACM default ARPU [average revenue per unit] inputs are "typical" prices for broadband in America. But the areas being dealt with will only have one provider whereas the "typical" area has facilities-based competition. Economic theory would predict that a monopoly area would have higher prices, and thus higher ARPU and lower take rate, than an area with competition. It may be that the service providers receiving Connect America funding are under either explicit regulation or implicit regulatory pressure to charge the same prices as in areas with competition. Or it may be that many of these service providers also serve areas where there is competition and need to maintain uniform pricing either for marketing purposes or to avoid angering customers. But whatever the reasons, when the model is used the issue of monopoly market structure should be addressed. There should be an explicit justification for why a monopoly would charge anything other than the profit-maximizing monopoly price.[23]

The Telecommunications Act of 1996 establishes the overarching principle that consumers in all areas of the country should have access to services that are reasonably comparable to those in urban areas "at rates that are reasonably comparable to rates charged for similar services in urban areas."[24] It therefore is appropriate for the model to assume an average revenue per location which is not significantly higher than those achievable in areas with competition.

The Bureau has sought comment on what revenue assumptions are appropriate to adopt for the final model.[25] In one or more future orders, the Bureau expects to

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[22] These assumptions produce two effects. On the one hand, the CAM assumes the network is optimally built out at once, when, for example, network drops are not always deployed optimally from an *ex ante* perspective, but rather are built piecemeal, following demand. This leads the CAM to understate costs. On the other hand, where delay is optimal, as might be the case for those drops that are only required at a later date, the CAM will overstate costs because it does not optimally postpone such expenses. The savings due to delay rise with future growth, and especially to the extent to which that growth is back-loaded (which does not seem likely). It is not obvious that one of these two effects dominates the other.

[23] Hogendorn at 4.

[24] 47 U.S.C. § 245(b).

[25] WCB June 25 Virtual Workshop Submission Letter.

finalize the input values for the model and set a funding threshold that takes into account reasonable estimates of expected per location levelized revenues.

The exclusion of video revenues

The CAF2 model overview explicitly states that video equipment is not included in the CACM. This seems entirely appropriate since the funding is for Internet not video. On the other hand, ARPU also excludes video, even though most of the costs of the video will be attributable to the same facilities as the broadband Internet. There should be a video ARPU assumption to help offset the costs of these shared facilities. . . .[26]

Professor Hogendorn appears to suggest that video revenues may not be appropriately accounted for in determining the efficient subsidy. At the outset, we note that the Bureau has not yet made a determination of what types of revenues should be assumed when determining the funding threshold. The decision of whether to assume video revenues in determining the support threshold is a policy decision not subject to peer review.

Moreover, even if video revenues are relevant, they would only be so to the extent that they exceed the incremental cost of video provision, and hence contribute toward shared costs. It is possible that the contribution from video services would be relatively small, and therefore unlikely to distort the CAM subsidy estimates.[27] Being late entrants, incumbent local exchange carriers (ILECs) have a relatively small share of all video subscribers.[28] Because of their video market share, ILECs typically face higher per subscriber programming, consumer premise equipment, and customer acquisition costs than their cable and satellite rivals,[29] reducing their

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[26] Hogendorn at 7.

[27] The choice to model a FTTP network, with or without video revenues, does not imply carriers accepting model subsidies must deploy an FTTP network and offer (or not offer) video services.

[28] The combined shares of all telephone multichannel video distributors (MVPDs) accounted for approximately 8.4 percent of MVPD subscribers at the end of 2011, compared to 6.9 percent at the end of 2010.. The largest of these, Verizon, was the 7th largest MVPD, while the 2nd largest, AT&T, was the 9th largest. *Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, MB Docket No. 12-203, Fifteenth Report, FCC 13-99 at 12-13, paras. 28, 30 (rel. July 22, 2013) (*15th Video Competition Report*). According to one analyst, as of March 2013, telephone MVPD share had risen to closer to ten percent of the market (Leichtman Research Group, press release, May 20, 2013, http://leichtmanresearch.com/press/052013release.html, viewed May 31, 2013).

[29] *15th Video Competition Report*, FCC 13-99 at 34-35, paras. 69-72. SNL Kagan reports that larger MVPDs face lower programming costs. *See* Telco TV Outlook: Competitive analysis of US telco video deployments, 2007 edition, SNL Kagan, June 2007 ("volume discounts and most-favored-nation (MFN) clauses ensuring multichannel giants such as Comcast and Time Warner Cable always pay rates [for

per video subscriber margins. In fact, the per video subscriber contribution from video could be negative, but the operator might still provide the service because it prevents further loss of voice customers to mobile and other rivals.[30] The failure to include a net contribution from video therefore may be unlikely to lead to an overstatement of the necessary subsidy required for a voice and broadband-capable broadband network.

Other Matters

Terminal value (or operating profit). Professor Hogendorn states that the CAM "does not include any terminal value at the end of the 20 year period."[31] The decision of terminal value in the model is a policy decision not subject to peer review. We do note, however, the CAM does effectively include a terminal value. It models costs, and hence also the impact of the funding threshold, sufficiently far into the future that the present values of future costs and revenues approach zero.

Technology choices or "roadmapping". Professor Hogendorn notes in passing that the version of the model he examined included both DSL and fiber-to-the-premise (FTTP) options, and he suggests exploring the FTTP option more extensively. The decision of what network architecture to model is a policy decision not subject to peer review. We note that the *CAM Platform Order* adopted an FTTP approach, consistent with Professor Hogendorn's preference.[32]

Brown-field vs. Green-field Approach. Professor Hogendorn comments in passing the green-field option is "useful . . . for considering the possibility of competitive entry," but he was "not sure why the green-field option would ever be applicable unless there are instances where there is truly no infrastructure in a particular service area."[33] The decision to adopt a green-field over a brownfield approach is a policy decision not subject to peer review.[34]

Voice. Professor Hogendorn appears to be concerned that the model overstates the operating costs associated with broadband service delivered over facilities shared with voice service. The Commission has determined, however, that the Bureau should model the cost of a network capable of providing both voice and broadband

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programming] less than or equal to those charged their competitors. . . . we polled some small operators and found they were paying about 30% more than the average for a dozen networks randomly chosen for our survey.").

[30] For example, this would be true if packaging video with voice (and perhaps broadband) makes, holding other things constant, customers less likely to switch their voice services to another provider.

[31] Hogendorn at 6.

[32] *CAM Platform Order,* 28 FCC Rcd at 5314-16, para. 33.

[33] Hogendorn at 7.

[34] *See CAM Platform Order,* 28 FCC Rcd at 5309-14, paras. 19-32.

services. It therefore is appropriate as a policy matter to include all voice operating costs, as well as broadband operating costs. Further, the CAM does not double count costs shared between voice and broadband services.

Building ahead of demand. Professor Hogendorn observes, "In an environment where demand is growing, service providers may anticipate the growth and prepare for it in a strategic way. . . . The preemption logic suggests that if there will be any increase in demand that makes an area viable, then a service provider may enter that area while an 'investment gap' still exists because it anticipates future profits. The CACM is well-placed to test this. If the CACM shows that areas that already have service have a gap to profitability, then it is possible that firms have built ahead of demand in order to achieve first-mover status. Since the areas under evaluation are very low density, I would expect that any preemptive investment would come from the existing telco trying to beat to market a potential fixed wireless competitor."[35]

We appreciate Professor Hogendorn sharing his thoughts regarding potential preemptive entry. We note that in some instances, entry into otherwise unprofitable areas may have occurred because of past subsidies, or because of other regulatory mandates, such as state requirements. In short, regulation may explain supply in unprofitable locations, rather than the operator's long-term view that the location is profitable. In addition, demand for broadband in those areas could be stronger than average (e.g., due to differences in consumer demographics, which is not captured in the CAM), leading to a stronger business case (just as in other locations it may be weaker than average). As is the case with any model, it is also possible that the CAM overstates costs in some areas (just as it likely understates costs in other areas). Thus, the observation that supply sometimes occurs in areas the cost model finds to be unprofitable is insufficient to demonstrate that the network operator expects that (absent regulatory action) the areas will eventually be profitable.

[35] Hogendorn at 5.

Appendix
The CAM's sensitivity to input price and productivity changes

This appendix tests how sensitive the CAM's costs are to changes in forecasts in input prices and total factor productivity (TFP) growth. It first presents how CAM costs are shared across ten cost categories for three cases: all lines; lines that lie within the 90th to 99th cost percentiles; and lines that lie within the 95th to 99th percentiles. It then provides the assumptions on input prices changes for the ten cost categories, and total factor productivity (TFP) growth, used in the sensitivity tests. Finally, it shows that under these assumptions, which are designed to understate CAM cost growth, overall annual changes to costs for high cost areas are unlikely to significantly differ from zero. Thus, the CAM's assumption of zero changes in costs is unlikely to significantly overstate costs, and may well understate them.

Cost categories and shares

The following table provides the cost shares for the ten basic cost categories of the CAM, in each of three cases: for all lines, for lines within the 90th to 99th cost percentiles, and for lines within the 95th to 99th cost percentiles. The table illustrates that the cost shares of especially labor, but also fiber, poles, conduit, and splitters rise as the focus narrows toward higher cost lines. This is due to increased loop lengths, of which associated labor costs are a significant component. In contrast, the cost share of the other components fall.

Cost categories	All lines	Lines within the 90th to 99th cost percentiles	Lines within the 95th to 99th cost percentiles
Labor	59.6%	70.0%	71.3%
Fiber	2.9%	3.6%	3.6%
Poles	1.2%	2.0%	2.0%
Conduit	2.2%	3.2%	3.4%
Drop	1.4%	0.3%	0.3%
ONT	9.1%	3.4%	2.9%
Fiber pedestals	2.7%	1.8%	1.6%
Splitters*	5.7%	6.3%	6.5%
Electronics	6.4%	3.4%	3.1%
Land/Buildings	8.7%	6.0%	5.3%
Total†	100.0%	100.0%	100.0%

* Approximately 30% of this category is fiber, but the two expenses are not easily separated.
† Individual components may not sum to 100 percent due to rounding.
Source: CAM (version 3.1)

Average annual change in labor costs

Limited information was available to us on cost movement for the ten cost categories just outlined. The following table illustrates that historically, labor costs in telecommunications have tended to experience low positive annual growth, and to grow at lower rates than the national average. The data come from the Bureau of Labor Statistics' Occupational Employment Statistics, where we used average annual wages for the private sector as a whole and the telecommunications industry in particular, for 2002 to 2012. In our sensitivity analysis, we used the average five and ten year annualized rates of change in telecommunications labor costs.

Average annual change in labor costs

Average annual change in labor costs			
All labor		Telecommunications	
Last 5 years	Last 10 years	Last 5 years	Last 10 years
3.61%	3.17%	0.93%	2.10%

Source: http://www.bls.gov/oes

Average annual change in fiber, poles, conduit, drop, ONT, fiber pedestal, splitters, and electronics

We do not have good data sources for the history of price changes for the following inputs: fiber, poles, conduit, drop, ONT, fiber pedestal, splitters, and electronics. However, the CAM's overall cost changes are not particularly sensitive to the individual cost of any of these. For the 90th to 99th cost percentiles, the cost share for each, excepting splitters, does not exceed 4 percent (the cost share of splitters is 6.3 percent).

We believe that fiber prices rarely decline faster than an annualized rate of 5 percent, and so, leaning toward understatement of cost growth, we use a 5 percent decline in fiber prices in our sensitivity tests. USAC's cost modeling contractor (CostQuest) estimated an annual two percent decline in fiber costs based on work it does for its private-sector clients.

We assume the following annual price changes: for poles, 2 percent; conduit, no change; drop costs, -2 percent; and ONT, fiber pedestals and splitters, all -5 percent. These estimates of price changes also come from CostQuest.

We believe electronic costs likely fall by a material amount over time, but do not have data appropriate to this cost category. Accordingly, again leaning toward understatement of cost growth, in our sensitivity tests we apply a range of annual cost declines of -30 to -10 percent to electronics. We believe that this range is likely to underestimate the actual reasonable range of price movements in electronics.[36]

[36] For example, it is estimated that the average annual quality-adjusted price change from 1995 to 1999 for routers was -14%, for switches, -22%, for LAN cards, -18%, and for hubs, -19% (Prices for Local Area Network Equipment, Mark Doms and

Average annual change in property costs

We do not have a price series that could be associated with the cost of land and buildings used in network deployment. As a potential indicator of price changes for this category, the following table lists changes in the price of certain kinds of commercial property. The data come from the Moody's/RCA CPPI Report from April 9, 2013. We used the May price index for all commercial (National), industrial, and core commercial real estate for 2002 to 2012. In our sensitivity analysis we apply the lowest and highest rates of change listed in the table.

Average annual change in property costs					
National		Industrial		Core Commercial	
Last 5 years	Last 10 years	Last 5 years	Last 10 years	Last 5 years	Last 10 years
-4.29%	3.43%	-4.61%	2.63%	-5.10%	3.10%

Source: https://www.rcanalytics.com/Public/rca_indices.aspx

TFP growth

We do not have any estimates for TFP growth in telecommunications. The following table provides TFP estimates for the U.S. economy as a whole. The "TFP-utilization" column produces gains in productivity that reflect capacity utilization. The estimates come from the Federal Reserve Bank of San Francisco's Center for the Study of Income and Productivity, and data for 2012 was not yet available when we accessed the source. Again, in our sensitivity analysis we apply the lowest and highest rates of change listed in the table.

Average annual TFP growth (nation)			
TFP		TFP-utilization	
Last 5 years	Last 10 years	Last 5 years	Last 10 years
0.09%	0.74%	0.25%	0.50%

Source: http://www.frbsf.org/csip/tfp.php (viewed 8 May 2013)

Sensitivity testing

Using the input price and TFP growth assumptions just described, we tested the sensitivity of each of the three cases outlined above to input price and TFP changes: all lines, lines in the 90th to 99th cost percentile, and lines in 95th to 99th cost percentile. Our results are reported in table below. These results are not sensitive to small changes in the input price changes for any of the cost categories, or in the TFP growth estimates.

Scenario analysis

	Assumed annual change in price

Chris Forman, June 2003, pp. 17-20, http://www.frbsf.org/publications/economics/papers/2003/wp03-13bk.pdf, (viewed May 31, 2013).

Cost categories	Low estimate	High estimate
Labor	0.9%	3.6%
Fiber	-5.0%	-5.0%
Poles	2.0%	2.0%
Conduit	0.0%	0.0%
Drop	-2.0%	-2.0%
ONT	-5.0%	-5.0%
Fiber pedestals	-5.0%	-5.0%
Splitter	-5.0%	-5.0%
Electronics*	-30.0%	-10.0%
Land/Buildings	3.4%	-5.1%
	Assumed annual TFP growth	
	Low estimate	**High estimate**
TFP growth	0.1%	0.7%
	Resulting cost range	
Annual net impact on costs	**Low estimate**	**High estimate**
Total costs	-3.5%	0.8%
90th to 99th cost percentiles	-2.1%	1.6%
95th to 99th cost percentiles	-1.9%	1.8%

*Includes FTTP input such as ONT, but not fiber.

While no final decision has been made on funding thresholds, given the fixed budget of up to $1.8 billion in funding for price cap territories, and the Commission's expectation that no more than 1 percent of locations would be above the extremely high-cost threshold,[37] the funding threshold is likely to be well above the 90th cost percentile. Accordingly, the annual cost change range estimated for the 90th to 99th cost percentiles (-2.1 percent to 1.6 percent) may be skewed lower than would be the case for the funding threshold ultimately selected. Moreover, while the midpoint of the annual cost change range is negative, the underlying assumptions used to derive it likely mean the expected net change could be higher than this. This is also true for the annual cost change range estimated for the 95th to 99th cost percentiles, -1.9 to 1.8 percent, with a mid-point that is even closer to zero and positive.

Given the uncertainty inherent in these kinds of forecasts, little weight should be attached to a point estimate. Instead, the range indicates while there may be a somewhat higher probability that the net annual change in telecommunications costs accounting for productivity gains is negative, whatever the change is, it is also likely to be small, and it could be positive. This analysis also shows that this

[37] *See USF/ICC Transformation Order*, 26 FCC Rcd at 17837, para. 533.

outcome is not sensitive to different choices among the subsidized high cost percentiles.