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July 17, 2014

VIA ECFS

Marlene H. Dortch, Esq.
Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, D.C. 20554

Re: ***Applications of AT&T Inc. and DIRECTV for Consent to Assign or Transfer Control of Licenses and Authorizations,*** **MB Docket No. 14-90**
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Dear Ms. Dortch:

Pursuant to the *Joint Protective Order* in the above-referenced proceeding,[1] AT&T Inc. ("AT&T") and DIRECTV (together, the "Applicants") are submitting(a) one copy of a DVD-ROM containing the ***unredacted***, Highly Confidential copy of a presentation prepared by Professors Steve Berry and Phil Haile of Yale University on behalf of the Applicants, and (b) one copy of a hard drive containing the ***unredacted***, Highly Confidential and Confidential copies of data supporting the merger simulation model described in the presentation. Applicants are filing herewith, via ECFS, a ***redacted*** public version of this submission.

As described in the Declaration of Dr. Michael L. Katz filed on June 11, 2014 (the "Katz Declaration"), Professor Katz's nested logit model in this matter is based on a very rich data set. In fact, few parties have presented such a thorough econometric analysis at the outset of the regulatory review process. Now, Professors Steve Berry and Phil Haile have corroborated and extended Professor Katz's work in several respects they believe in their expert opinion to be meaningful. Their conclusions, however, are the same as Professor Katz's – even *before* the significant synergies associated with the transaction:

[1] *Applications of AT&T Inc. and DIRECTV for Consent to Assign or Transfer Control of Licenses and Authorizations*, Joint Protective Order, DA 14-804 (MB rel. June 11, 2014).

- There will be significant downward pressure on the prices of the new AT&T/DTV integrated bundle.

- There will be real, quantifiable downward pricing pressure on the prices of cable bundles, standalone cable broadband, standalone cable video, and the products of other providers.

- Any upward pressure on the prices of remaining products will be modest and more than offset by the downward pricing pressures described above.

- The net effect on consumer surplus will be demonstrably positive.

Then, once the transaction's significant synergies are considered, the effects will be even more favorable to consumers. All this is true because the transaction combines product offerings comprised more of complements than substitutes, resulting in a more competitive bundle of video and broadband in the areas in which AT&T currently provides video. In fact, the pro-competitive effects of the merger are predicted to be *strongest* in the areas in which AT&T currently provides video.

An ***unredacted*** Stamped Highly Confidential copy of this submission is being hand delivered to your office today. Additional copies of the ***unredacted*** submission are being delivered to the Commission staff under separate cover.

Please contact me at (202) 942-6608 or Maureen.Jeffreys@aporter.com if you have any questions. Thank you for your assistance.

Respectfully submitted,

Maureen R. Jeffreys

Maureen R. Jeffreys
Counsel for AT&T Inc.

Enclosures

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Quantitative Analysis of an AT&T-DIRECTV Merger

Steve Berry and Phil Haile
Yale University

(on behalf of AT&T)

July 15, 2014

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The Companies Today

- AT&T offers wireline video, broadband, and phone service in parts of 22 states (parts of 134 DMA®s)[1] and wireless phone service nationwide
- DIRECTV ("DTV") provides DBS video service nationwide
- AT&T and DTV have a joint marketing arrangement to facilitate the sale of synthetic bundles (component prices set independently, w/negotiated bundle discount)
  - AT&T markets DTV video in a bundle with AT&T broadband
  - DTV markets AT&T broadband in a bundle with DTV video

[1] DMA® is a registered trademark of The Nielsen Company. Used under license.

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Post-merger: the combined company will continue to provide these services, but the current synthetic bundle will be replaced by a "true bundle," sold/billed/serviced by the integrated company.

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Complements and Substitutes

AT&T standalone video and DTV video are **substitutes** in areas where both are offered. Absent cost savings, a merger between producers of competing substitutes tends to push **up** prices.

AT&T broadband and DTV video are **complements** because many consumers want both broadband and video services. Even without cost savings, a merger between producers of complements tends to push **down** prices by internalizing a pricing externality.

Because there are pricing pressures in both directions, the overall effect on consumers is ambiguous from theory alone, even before considering equilibrium responses or cost savings from the merger.

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Limited Competition

Competition between AT&T and DIRECTV is limited

- DIRECTV does not offer its own broadband service
- AT&T sells video service in only a subset of its broadband footprint
  - $\approx$ [redacted] million customer service locations for broadband
  - $\approx$ 27 million for video
- $\Longrightarrow$ scope for standard upward pricing pressure from horizontal merger may be limited.

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AT&T Broadband and DTV Video are Complements

Two goods are (gross) complements when their cross-price derivatives are negative. Many households have both video and broadband service, e.g., AT&T BB + DTV. Consider an increase in the price of AT&T BB...

- some households switch away from the AT&T BB + DTV combination; some of these may retain DTV video, but not all
- so unless a substantial number of households also switch from *standalone* AT&T BB to standalone DTV video (implausible), DTV sales fall
- negative cross-price derivatives confirmed by demand estimates.

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Complements and Downward Pricing Pressure

- negative cross-price derivatives imply negative diversion ratios
- exactly as a positive diversion ratio leads to upward pricing pressure from a merger (absent synergies), a negative diversion ratio implies downward pricing pressure.
- this is a type of double-marginalization: each firm currently ignores the benefit a price cut would create for the other; the merger internalizes this externality
- AT&T and DTV do offer a small discount for synthetic bundles, but we will show that the total price of the synthetic bundle is inflated by double marginalization
- eliminating double marginalization puts downward pricing pressure on the AT&T BB + DTV combination.

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Equilibrium Effects

Competition with Cable

- cable providers = primary competitors to AT&T and DTV
- cable typically the largest provider in any given local area
- cable bundles (video+broadband) have largest market shares and currently face limited competition in many areas
- post-merger price reductions for AT&T/DTV (true) bundle will put additional competitive pressure on cable providers, leading to lower prices to many consumers.

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Equilibrium Effects

Competition with other providers (mainly Dish, "other" broadband)

- competitors' standalone products are substitutes for merged firm's standalone and bundle products (and for cable bundle)
- direction of net effect of merger on these competitors' prices is theoretically ambiguous.

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Qualitative and Quantitative Roles of Merger Simulation

- theory alone can never determine *magnitudes* of price effects
- here, even the *direction* of some price effects theoretically ambiguous
  - upward and downward pricing pressures
  - equilibrium responses to both
- merger simulation allows quantitative assessment of post-merger prices, quantities, and consumer welfare
- can incorporate expected cost savings correctly in same framework.

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Merger Simulation: From Katz to Berry-Haile

Michael Katz declaration included a merger simulation.

Our analysis extends his, using additional data sources, more refined modeling of firms and products, and a more flexible demand model.

Results turn out to be broadly similar.

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Overview of the Approach

Demand: random utility discrete choice (nested logit)

- DMA® -level ("market-level") model
  - market-level prices and product unobservables
  - fit model to market-level shares
  - but account for sub-market (sub-DMA®) (ZIP) product availability
- 28 "products" defined by broadband provider×video provider

Supply: standard multiproduct oligopoly price setting model

- simulation: pre-merger vs. post-merger
  - prices, quantities, consumer welfare
  - without and with cost savings.

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Merger Simulation and UPP Analysis

Merger simulation is substantially more informative than the more simple "UPP" analysis even when the latter uses high quality demand estimates. Insight from UPP analysis is especially limited when multiple pricing pressures act in opposite directions. But not all limitations of UPP analysis are avoided.

- still focus on effects through prices and quantities
  - no analysis of long-term investment incentives (e.g., infrastructure upgrades/expansion)
  - no analysis of incentives for content providers
- still abstract from price discrimination (e.g., tier design) or dynamic pricing issues (e.g., switching costs).

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Price Reductions, Product Improvements

1. Downward pricing pressure through merger of complements
   - AT&T/DTV bundle price falls
   - $\Longrightarrow$ downward pressure on prices of many substitutes as well
2. Bundle product improvement: consumers likely prefer true bundles and merger creates one from the synthetic DTV-AT&T bundle
   - $\Longrightarrow$ downward pressure on prices of substitutes

Neither UPP analysis nor merger simulation accounts for the second benefit to consumers.

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Summary of Findings

- Across all specifications, consumer welfare strictly improves
- ATT-DTV bundle price will be substantially lower, which puts downward pricing pressure on cable as well. Post-merger, consumers shift to these lower-priced products. The welfare losses to consumers of some standalone products are more than offset by the gains from price reductions
- The net consumer welfare improvement is especially substantial when we include AT&T video cost efficiencies.

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Summary of Predicted Price Changes

Baseline Merger Simulation Results, No Cost Saving, 3 Nesting Parameters

broadband \ Video	cable	ATT	telco	DTV	Dish	none
cable	-0.11	6.33	-0.51	0.73	-0.18	-0.33
ATT	-1.47	3.76		-7.31	-1.27	-1.42
telco	-0.12		-0.08	0.99	0.08	-0.08
other/none	-0.05	6.71	-0.18	1.07	0.15	0

Price changes in dollars per month.

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Summary of Predicted Price Changes

Baseline Merger Simulation Results, No Cost Saving, 1 Nesting Parameter

broadband \ Video	cable	ATT	telco	DTV	Dish	none
cable	-1.02	4.08	-0.90	3.23	-0.50	-0.64
ATT	1.96	4.41		-16.73	2.76	2.62
telco	-1.04		-0.36	3.48	-0.24	-0.38
other/none	-0.66	4.77	-0.26	3.86	0.14	0

Price change in dollars per month.

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Summary of Consumer Surplus Change Per Household

Table: Summary of CS Change Per Household

	3 Nesting Param.	1 Nesting Param.
Without Cost Savings		
All DMA®s w/ AT&T Availability	$0.08	$0.59
DMA®s w/ AT&T Video Availability	$0.06	$0.63
AT&T Video Zips	$0.10	$0.82
With Cost Savings		
All DMA®s w/ AT&T Availability	$0.94	$1.37
DMA®s w/ AT&T Video Availability	$1.07	$1.55
AT&T Video Zips	$1.77	$2.45

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Roadmap

1. Data
2. Demand Model and Estimation
3. Supply Model and Estimation
4. Counterfactual Simulations

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Data: Quantities (Shares)

Challenge: Necessary to model video and broadband services in one demand system. This requires (DMA® -level) market shares not just for video and broadband providers, but for all possible combinations thereof. No single data source, even for video or broadband market alone.

Solution: Generalized Method of Moments (GMM) share estimates combining data from multiple sources, including a large new survey.

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Data Sources (Shares)

- party subscriber counts for all products offered
- video subscriber counts for copyright payments[2]
- Nielsen survey of video services
- Nielsen survey of internet services
- new survey of >100,000 households on all video/broadband services.

[2] Copyright data obtained from Cable Data Corporation.

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Data: Quantities (Shares)

Combine data from multiple sources:

broadband \ Video	cable	ATT	telco	DTV	Dish	none	Total
cable							
ATT			0				
telco		0					
other							
none							
Total							1

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Data: Quantities (Shares)

Combine data from multiple sources:

1. Subscriber counts from parties

broadband \ Video	cable	ATT	telco	DTV	Dish	none	Total
cable							
ATT		✓	0				✓
telco		0					
other							
none							
Total		✓		✓			1

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Data: Quantities (Shares)

Combine data from multiple sources:

2. Video "marginals" from copyright payment data:

broadband \ Video	cable	ATT	telco	DTV	Dish	none	Total
cable							
ATT		✓	0				✓
telco		0					
other							
none							
Total	✓	✓✓	✓	✓			1

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Data: Quantities (Shares)

Combine data from multiple sources:

3. Video subscriber shares from Nielsen video survey:

broadband \ Video	cable	ATT	telco	DTV	Dish	none	Total
cable							
ATT		✓	0				✓
telco		0					
other							
none							
Total	✓	✓✓	✓	✓	*	*	1
Nielsen	✓("wired")			✓("DBS")		✓	

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Data: Quantities (Shares)

Combine data from multiple sources:

4. broadband subscriber shares from Nielsen BB survey (81 DMA®s)

broadband \ Video	cable	ATT	telco	DTV	Dish	none	Total
cable							✓
ATT		✓	0				✓
telco		0					
other							
none							✓
Total	✓	✓✓	✓	✓	✓	✓	1

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Data: Quantities (Shares)

. Combine data from multiple sources:

5. new survey
   - survey design by Ravi Dhar (Yale SOM) w/consultation from us
   - internet survey panel (Research Now)
   - $\approx$ 100K households
   - demographics
   - asks about current video and broadband services

We will correct for choice-based sampling on internet availability and use the video marginals to get a good measure of "no broadband" cells.

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Data: Quantities (Shares)

Combine data from multiple sources:

5. Dhar survey

broadband \ Video	cable	ATT	telco	DTV	Dish	none	Total
cable	✓	✓	✓	✓	✓	✓	✓
ATT	✓	✓✓	0	✓	✓	✓	✓✓
telco	✓	0	✓	✓	✓	✓	✓
other	✓	✓	✓	✓	✓	✓	✓
none	✓	✓	✓	✓	✓	✓✓	✓
Total	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	1

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Reweighting the Dhar Survey

Participants in the broadband-based survey were not expected to be (and are not) representative in terms of demographics or, especially, broadband use. We therefore reweight the survey observations.

- observation i defined by demographics z_{im} and $b_{im} = 1\{i \text{ has home broadband}\}$
- standard correction: reweight observations by $\gamma(b_{im}, z_{im})$ so that

$$f_{\text{sample}}(b_{im}, z_{im})\,\gamma(b_{im}, z_{im}) = f_{\text{population}}(b_{im}, z_{im})$$

- weights $\gamma(b_{im}, z_{im})$ estimated by GMM: match predicted and actual demographic$\times$home broadband moments from CPS
- external validation: check weighted shares against party shares.

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Combining the Data

GMM estimation of market shares

- party subscriber counts treated as exact (constraints)
- all else as sample shares (estimates)

$\Longrightarrow$ minimize (weighted quadratic) distance between final share estimates and the share data from (i) reweighted Dhar, (ii) copyright, (iii) two Nielsen surveys, subject to matching the party sub counts exactly.

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Market Share Data Set

The availability of market share data dictates the set of geographic markets considered (and treated as representative of the overall merger effects).

For purposes of demand estimation, we limit attention to 129 DMA®s for which we have at least 300 observations in the Dhar survey. (We also omit 2 DMA®s where the GMM procedure returns unreasonably small values for the outside good, giving 127 DMA®s in the demand analysis.)

For the merger analysis, we then limit attention to the subset of these DMA®s in which AT&T currently offers service.

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Conflicting Data Sources and Robustness

Close examination of the market shares from the different data sources reveals sometimes substantial conflict.

For example,

- Nielsen DBS data, aggregated to national level, minus national DTV subscribers gives an implied national number for Dish that exceeds Dish's reported subscribers
- ATT national video subscriber number exceeds the ATT national copyright data number

Our GMM procedure was designed to combine survey results with different sampling error to obtain precise share estimates. But the treatment of differential bias requires more judgment.

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Conflicting Data Sources and Robustness

We have explored two approaches to bias correction in order to assess robustness of our results, presented in detail in an appendix. Summarizing, both create a market-level Dish marginal video moment by distributing the national Dish subscribers across markets according to the distribution implied by the Nielsen market-level surveys. One approach allocates the "excess" Nielsen Dish demand to the "no video" moment. The other proportionately allocates the excess share to cable, other telco and no video moments. The second approach adjusts the copyright numbers upward for cable and other telco, following on the evidence that copyright data underestimates share.

The adjusted numbers are "just" moments – GMM also weights the survey data.

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Price Data

We know of no existing comprehensive data on DMA® level prices of video and broadband products. We have

- prices/plans matched to subscribers from the parties
- web scraped data on other firms and products

Complications include the great variety of products—tiers of service, optional add-ons. There is no "standard product" that can be priced across markets and firms. Also, web scrape often reveals only "introductory prices."

Our solution is to create a hedonic price index for each provider-component-market combination.

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Steps to Create our Price Measures

(additional details in an appendix)

- In each zip code, web scrape for available prices and characteristics (e.g. broadband speed, # of video channels)
- Run a set of hedonic regressions that are intended to create a quality-adjusted DMA® level price to capture cross-market variation within each product component (video, BB, true bundle)type
- Following Griliches (1961) and Diewert, Heravi, and Silver (2009), we use the provider/spatial equivalent of the classic "time dummy hedonic price index." This is a restricted version of the Pakes (2003) approach to fixed-weight hedonic price indices (which has a more flexibly interacted structure than our data can support)
- Recenter the price levels: we center the prices of video, BB, and bundle components so that AT&T prices match AT&T ARPU.

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Cross-Market Price Variation

Our goal is to create a measure that captures (i) the cross-DMA® variation in prices for each product and (ii) changes across DMA®s in the relative prices of different products.

We do not use any sub-DMA® variation in a given product's price because

- neither prices nor shares are well measured at that level
- we do not want to use price variation without corresponding variation in demand unobservables ξ_{jkm}. Allowing sub-DMA® variation in unobservables would require precisely measured sub-DMA® shares.

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Price Levels: Implications

We use a full set of product dummies in the mean utilities. These capture the effects of quality not controlled for already with the hedonic price indices as well as differences between a product's true mean price and that implied by our centering ("normalization")

- it is correct to look at price differences across DMA®s and at "diffs-in-diffs" of prices across products and DMA®s . Price *levels*, especially comparisons across the three hedonic regression groups, are not easily interpretable
- in the demand model, the price level normalizations have no effect on any coefficients other than on the set of product dummies; the level of demand is also unaffected
- estimates of markups are unaffected by the normalization, but the level of prices passes through directly to marginal cost estimates
- in the merger simulation, demand, welfare, markups, and all *changes* in prices are unaffected by the price level normalization

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Challenges in Collecting Prices

Collecting data from the web creates some expected issues.

- Pricing data is interpolated from adjacent ZIP codes for ZIP codes with known service, but no available pricing data (e.g., because address queried already has service).
- For a few provider/market combinations, NTIA data (a key source for coverage) do not have coverage information even though we have pricing information. In these cases where coverage is missing for a given provider-DMA® combination and needed for weighting purposes described above, it is estimated by regression at ZIP level
- If prices or characteristics are missing for a product-DMA® combination where our data shows that the product is available, we use the average prices and characteristics for that product across markets where we do have price and characteristics data.

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Handling Measurement Error in Prices

The price coefficient in our nested logit demand model is identified through a set of effectively linear instrumental variables conditions. The instrumentation will correct for classical measurement error. This is an advantage, in our context, of a model with utilities that are linear in price with a common coefficient across consumers.

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Demand Model Inputs

The primary inputs for demand estimation are the prices and quantities (shares) described above. Below are the estimated average shares for DMA® s in which AT&T offers service.

Internet\Video	cable	ATT	telco	DTV	Dish	none
cable	[redacted]					
ATT						
telco						
other						
none						

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Demand Model Overview

We estimate a demand model in order to quantify the price responses and substitution patterns that determine the effects of the merger. We employ a DMA®-level nested logit demand model, accounting for variation in product availability across ZIP codes within each DMA®.

The model parameters are identified using instrumental variables for cross-DMA® price variation and by treating choice set changes across and within DMA®s as exogenous.

Absent the within-DMA® variation in product availability, the model could be estimated by simple linear IV (TSLS) methods.

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Mean Utilities

Mean (conditional indirect) utility of product jk in market (DMA®) m

$$\delta_{jkm} = x_{jkm}\beta - \alpha p_{jkm} + \xi_{jkm}$$

where

- x_{jkm} is a vector of characteristics (product dummy d_{jk}, max speed offered, max # of channels offered, DMA® attributes w/product interactions)
- p_{jkm} is the price of the product (discussed above)
- ξ_{jkm} is an unobservable demand shock

We treat the "other broadband" (e.g., satellite internet service) price as a national constant.

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The Choice Set, Again

Table: DMA® Product Matrix

Internet j \ Video k	cable	ATT	other telco	DTV	Dish	none
cable		x	x			
ATT			0			
other telco		0				
other	x	x	x	x	x	x
none		x	x			*

The products marked *x* typically have small choice probabilities and in the estimation we do not use moment conditions for the demand unobservables associated with those products. Of the 30 products in the table, this leaves 17 products used in the demand estimation moments. The outside good's (*) share is 1 minus the sum of the other shares; its mean utility is zero.

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Sub-DMA® Product Availability

Within DMA®, households in each ZIP code have access to some subset of the 30 products. For example, some ZIPs may have access to AT&T broadband, but not video, while others have both. All ZIPs have access to the DBS video choices and to the "other" broadband provider. Across the DMA®, we associate the available cable services with the dominant cable provider.

Recall that product prices are measured at the DMA® level. So all price variation is accompanied by variation in demand unobservables (all price variation is econometrically endogenous.)

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Nested Logit Groups

Single-level nested logit model with four groups (nests):

1. video only
2. broadband only
3. both video and broadband
4. the outside good (no video or broadband).

The products in group g are $jk \in \mathcal{JK}_g$.

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Nested Logit Conditional on Choice Set

Let the list of distinct choice sets in DMA® m be $\bar{\chi}_m^\ell$, $\ell = 1, \ldots, L_m$.

We denote the nested logit functional form, conditional on choice set, as

$$\sigma_{jk}(\delta_m, \bar{\chi}_m^\ell, \theta^d) \tag{1}$$

where θ^d is a list of demand parameters (defined below).

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Predicted Shares

Conditional on Choice Set

$$\ln\left(\sigma_{jkm}(\delta_m, \bar{\chi}_m^{\ell}, \theta^d)\right) = \frac{\delta_{jkm}}{1-\psi_g} - \psi_g \ln(D_{g\ell m}) - \ln(1 + \sum_h D_{h\ell m}^{1-\psi_h}) \tag{2}$$

where the "nesting parameter" ψ_g captures the degree of within-group substitution in group g; in a simple specification it is set equal across groups.

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Inclusive Value

Conditional on Choice Set

In (2), $\ln(D_{g\ell m})$ is the "inclusive value" for group g:

$$\ln(D_{g\ell m}) = \ln(\sum_{jk \in \{\mathrm{JK}_g \cap \bar{\chi}^{\ell}_m\}} e^{\delta_{jkm}/(1-\psi_g)}). \tag{3}$$

Note that the "within group" summation in (3) is over the set of products that are both [i] in the group and [ii] in the choice set. The log-share of the outside good (alone in group $g = 0$) is

$$\ln\left(\sigma_{00m}(\delta_m, \bar{\chi}^{\ell}_m, \theta^d)\right) = -\ln(1 + \sum_{h=1}^{3} D_{h\ell m}^{1-\psi_h}).$$

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Share "Inversion"

Conditional on Choice Set

Following Berry (1994),

$$\ln\left(\sigma_{jkm}(\delta_m, \bar{\chi}_m^\ell, \theta^d)\right) - \ln\left(\sigma_{00m}(\delta_m, \bar{\chi}_m^\ell, \theta^d)\right)$$

$$= \delta_{jkm} + \psi_g \ln\left(\sigma_{jkm/g}(\delta_m, \bar{\chi}_m^\ell, \theta^d)\right),$$

where $\sigma_{jkm/g}(\cdot)$ is the "within group share."

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Shares with Sub-DMA® Product Availability

With sub-DMA® variation in product availability, DMA®-level market shares are a weighted average of those conditional on each choice set:

$$s_{jkm}(\delta_m, \psi) = \sum_{\ell} \sigma_{jk}\left(\delta_m, \bar{\chi}_\ell, \theta^d\right) w_m^\ell$$

where the weight w_m^ℓ is the fraction of DMA® households facing choice set ℓ.

The summation over choice sets introduces computational complexity to the demand estimation closer to that of the full Berry, Levinsohn and Pakes (1995) (BLP) model.

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IV Assumptions

Identification of the demand model relies on a standard instrumental variables approach, as in BLP. Instruments include

- exogenous product characteristics
- product/firm/product group dummies
- characteristics/dummies for other products in the choice set ("BLP instruments")
- DMA®-level product availability (e.g., AT&T video coverage) (also BLP instruments)
- other DMA® characteristics (e.g., latitude, income) + interactions with product characteristics

Denoting these instruments by Z_{jkm}, the exclusion restriction is

$$E[\xi_{jkm}(\theta_0^d)|Z_{jkm}] = 0$$

where $\xi_{jkm}(\theta^d)$ gives the value of the jkm unobservable implied by demand parameters θ^d and θ_0^d denotes the true demand parameters.

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Some Intuition for Identification

Unlike many other industries, here there is rich variation across local markets (DMA®s) in the set of providers offering service, and in the coverage of those providers present in a given DMA®. The pattern of market share changes that result from these changes in choice set pins down "nonlinear" demand parameters governing substitution patterns. And the price changes created by the cross-DMA® variation in the local competitive structure allows identification of the "linear parameters," including the coefficient on price.

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Effect of AT&T-Telco Coverage on Rivals' Price and Share

The logic of the identification/estimation is that cross market changes in measures of choice sets (used as "instruments") change prices and shares, revealing demand.

Coefficients on ATT Telco Coverage Instruments in the quasi-first stage regressions

	Price	ln(within group share)
ATT Telco Coverage*(CableBundle)	-12.6696	-0.0363
	(3.8506)	(0.4623)
ATT Telco Coverage*(Cable Video + No BB)	1.7475	-0.6803
	(3.8691)	(0.4646)
ATT Telco Coverage*(Cable Video + Non CableBB)	1.5581	-0.1460
	(3.0119)	(0.3616)
ATT Telco Coverage*(DBS + No BB)	-0.3383	0.4374
	(2.7389)	(0.3289)
ATT Telco Coverage*(DBS + Contains BB)	-1.2116	-0.4734
	(1.7188)	(0.2064)
ATT Telco Coverage*No Video	-0.8009	-0.4685
	(2.5064)	(0.3009)

Full "quasi-first-stage" regression results in the appendix

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Effect of Cable BB Coverage on Rival's Prices and Shares

Coefficients on Cable BB Coverage Instruments
in the quasi-first stage regressions

	Price	ln(within group share)
Cable BB Coverage * Non Cable BB	-11.6273	-0.6495
	(5.0925)	(0.6115)
Cable BB Coverage * No BB	2.2172	0.5946
	(7.7494)	(0.9305)
Cable BB Coverage * ATT Telco BB	-0.2238	-5.6290
	(11.2870)	(1.3553)
Big Cable BB Company * Non Cable BB	-2.8297	-0.1646
	(1.2651)	(0.1519)

Full quasi-first-stage regression results in the appendix

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Parameters

The mean independence assumption then motivates the estimation procedure, which we outline next.

The parameters to be estimated are $\theta^d = (\beta, \alpha, \psi)$, as well as the unobservables ξ.

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BLP Style Estimation

As in BLP, we use a nested fixed point estimation algorithm that chooses ψ to minimize a GMM objective function:

1. begin with a value of ψ
2. solve for all 28 of the δ_{jkm} in each market m (see below)
3. compute (β, α) from (linear) moment conditions on (only) the 17 regular products
4. compute the GMM objective function based on the moments

$$E\left[Z'_{jkm}\xi_{jkm}\right] = 0 \tag{4}$$

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The "special products"

For the small-share "special products" with an "x" in the choice-set table, the estimates of ξ_{jkm} are likely to be very imprecise so we do not use them in the moment conditions (4). This leaves us with 17 "regular product" ξ_{jkm} that we use in the moment conditions.

Because the shares are very small, the calculated δ's for the special products will be very negative and their effect on the calculation of mean utilities for the other 17 products will be very small (each special product δ enters only through the terms $e^{\delta/(1-\psi_g)}$ in the share denominators.) Thus, the imprecisely measured shares of the special products have very little effect on the demand estimates.

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Solving for δ

In step 2 of the algorithm we solve for each vector δ_m, conditional on ψ. Following BLP, with an adjustment for the nested logit, given a value of ψ we can find the δ that fits the 28 shares by iterating, for each market m, on the system of 28 equations

$$\delta'_{jkm} = \delta_{jkm} + (1 - \psi_g)\left[\ln(\tilde{s}_{jkm}) - \ln(s_{jkm}(\delta_{jkm}, \psi))\right] \quad \forall jk.$$

Following Dubé, Fox and Su (2012), the tolerance for convergence is set very tight.

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Solving for the Linear Parameters (β, α)

Let $\tilde{X} = (X, p)$, $\tilde{\beta} = (\beta, \alpha)$. Let y denote the stacked (across regular products and DMA® s) values of δ_{jkm}. Let

$$\xi(\tilde{\beta}) = y - \tilde{X}\tilde{\beta}.$$

The GMM objective function corresponding to 2SLS is

$$F(\tilde{\beta}) = \xi(\tilde{\beta})' Z(Z'Z)^{-1} Z' \xi(\tilde{\beta}). \tag{5}$$

The first-order condition for $\tilde{\beta}$ is

$$\left(\frac{\partial \xi}{\partial \tilde{\beta}}\right)' Z(Z'Z)^{-1} Z' \left(y - \tilde{X}\tilde{\beta}\right) = 0.$$

Recognizing that $\partial \xi / \partial \tilde{\beta} = -\tilde{X}$,

$$\widehat{\tilde{\beta}} = \left(\tilde{X}' Z(Z'Z)^{-1} Z' \tilde{X}\right)^{-1} \tilde{X}' Z(Z'Z)^{-1} Z' y.$$

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GMM Objective Function

In step 3 of the NFP algorithm, we use the preceding equation to compute $\widehat{\tilde{\beta}}$ for the $y(\delta)$ vector corresponding to the current guess of ψ. In step 4, we compute the GMM objective function based on (4), evaluated at $\tilde{\beta} = \widehat{\tilde{\beta}}$.

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Variables in the Utility Functions

The variables that shift mean utility are

- DMA® price index of the product
- proxies for unmeasured quality of the service provider: max speed (for broadband) and max channels (for video), but recall that the price index is quality adjusted
- shifters of DBS reception / demand
- dummies for major firm providers of video and broadband within other telco and cable
- DMA® level demographics interacted with product class
- product dummies (which capture both quality and national average price levels).

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Excluded Instruments

The excluded instruments are, broadly, measures of product quality and availability interacted with product/firm/product group dummies.

The full set of excluded instruments is listed in the "first stage" regression results in the appendix. The right hand side variables in those regressions are, first, the included utility variables and then the excluded instruments. The left hand side variables are the endogenous regressors that would appear in the simple two-stage least squares nested logit model of Berry (1994), that is the model without choice-set variables. These are [i] price and [ii] the within group (nest) shares.

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Parameter Estimates (Main)

Table: 3 Nesting Parameters

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
Price (α)	0.0179	0.0020	**Video Firm Dummies**		
Nesting Parameters (ψ)			Telco - Verizon	0.9428	0.0940
Video Only	0.8421	0.0546	Cable - Time Warner	-0.2618	0.0324
BB Only	0.8473	0.0355	Cable - Comcast	-0.3075	0.0329
Bundle	0.5318	0.0278	Cable - Charter	-0.2233	0.0164
			Cable - Cox	-0.2641	0.0307
Product Characteristics			**BB Firm Dummies**		
Speed	-0.0009	0.0001	Telco - Verizon	-0.0700	0.0206
No. Channels	-0.00002	0.0002	Cable - Time Warner	0.0231	0.0231
DBS $\times$ Latitude	-0.0144	0.0007	Cable - Comcast	-0.0365	0.0266
DBS $\times$ Urban %	-0.8041	0.0610	Cable - Charter	-0.2489	0.0327
DBS $\times$ Owner %	-0.6491	0.1863	Cable - Cox	0.2673	0.0138

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Parameter Estimates (Demographics)

Table: 3 Nesting Parameters

	Est. Coef.	Std. Err.
Age:		
65 or above × BB only	-3.3855	0.1937
65 or above × Video only	1.6345	0.2986
65 or above × Bundle	1.9035	0.2570
Education:		
Master degree or higher × BB only	-1.3212	0.5750
Master degree or higher × Video only	-6.9772	0.9713
Master degree or higher × Bundle	2.4018	0.6291
Income ($000):		
Median HH Income × BB only	0.0221	0.0010
Median HH Income × Video only	0.0103	0.0007
Median HH Income × Bundle	0.0199	0.0008

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Parameter Estimates (Product Dummies)

Table: 3 Nesting Parameters

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
			Cable Video + Cable BB	3.2191	0.3175
DTV Video + Cable BB	3.4721	0.3245	Cable Video + AT&T BB	2.5973	0.3945
DTV Video + AT&T BB	3.6804	0.3227	Cable Video + Telco BB	2.2391	0.3893
DTV Video + Telco BB	3.7214	0.3150	Cable Video + No BB	2.7584	0.2517
DTV Video + No BB	3.8362	0.2208			
			AT&T Video + AT&T BB	2.6381	0.3631
DISH Video + Cable BB	2.9932	0.3200	Telco Video + Telco BB	1.7778	0.3983
DISH Video + AT&T BB	3.3427	0.3224			
DISH Video + Telco BB	3.5273	0.3093	No Video + Cable BB	0.8609	0.1246
DISH Video + No BB	3.6711	0.2053	No Video + AT&T BB	0.9688	0.1374
			No Video + Telco BB	0.9137	0.1339

Note: Product dummies capture both quality differences and differences in average price levels (see previous discussion).

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Parameter Estimates (Main)

Table: 1 Nesting Parameter

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
Price (α)	0.0190	0.0022	**Video Firm Dummies**		
			Telco - Verizon	0.6712	0.0934
Nesting Parameters (ψ)			Cable - Time Warner	-0.2578	0.0358
All Nests	0.6357	0.0224	Cable - Comcast	-0.3267	0.0349
			Cable - Charter	-0.1919	0.0168
Product Characteristics			Cable - Cox	-0.2710	0.0337
Speed	-0.0009	0.0002	**BB Firm Dummies**		
No. Channels	0.0001	0.0002	Telco - Verizon	-0.0688	0.0206
DBS $\times$ Latitude	-0.0150	0.0007	Cable - Time Warner	0.0199	0.0239
DBS $\times$ Urban %	-0.7900	0.0586	Cable - Comcast	-0.0447	0.0270
DBS $\times$ Owner %	-0.4919	0.1907	Cable - Charter	-0.2741	0.0343
			Cable - Cox	0.2716	0.0146

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Parameter Estimates (Demographics)

Table: 1 Nesting Parameter

	Est. Coef.	Std. Err.
Age:		
65 or above × BB only	-2.8917	0.2098
65 or above × Video only	1.0731	0.3069
65 or above × Bundle	1.5301	0.2492
Education:		
Master degree or higher × BB only	-1.2206	0.7048
Master degree or higher × Video only	-7.3435	0.9952
Master degree or higher × Bundle	3.0813	0.5779
Income ($000):		
Median HH Income × BB only	0.0227	0.0012
Median HH Income × Video only	0.0090	0.0008
Median HH Income × Bundle	0.0195	0.0008

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Parameter Estimates (Product Dummies)

Table: 1 Nesting Parameter

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
			Cable Video + Cable BB	3.4323	0.3352
DTV Video + Cable BB	3.8230	0.3341	Cable Video + AT&T BB	3.0819	0.4147
DTV Video + AT&T BB	3.9959	0.3320	Cable Video + Telco BB	2.7682	0.4085
DTV Video + Telco BB	4.0124	0.3241	Cable Video + No BB	2.7159	0.2508
DTV Video + No BB	3.6711	0.2138			
			AT&T Video + AT&T BB	2.9298	0.3777
DISH Video + Cable BB	3.3882	0.3262	Telco Video + Telco BB	2.3760	0.4174
DISH Video + AT&T BB	3.6928	0.3301			
DISH Video + Telco BB	3.8235	0.3177	No Video + Cable BB	0.6109	0.1194
DISH Video + No BB	3.5456	0.1998	No Video + AT&T BB	0.7038	0.1327
			No Video + Telco BB	0.6102	0.1277

Note: Product dummies capture both quality differences and differences in average price levels (see previous discussion).

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Discussion of Demand Results

- The estimated price and nesting parameters are statistically different from zero and have sensible values.
- The remaining coefficients generally have sensible signs. Recall that the levels of the coefficients on the product dummies do not just measure mean "quality" of the product; they also capture differences in the average level of hedonic price index across products.
- The results are qualitatively robust to reasonable changes in the included variables and excluded instruments. Some specifications give more elastic demand, but these yield unreasonably small markups. Because models with multiple nesting parameters are inherently less stable, we include results with a single nesting parameter for robustness. We have also estimated simplified versions of the model by TSLS, yielding qualitatively similar results.

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Diversion Ratios for Party Services (product components)

Table: 3 Nesting Parameters

	DTV Video	AT&T Video	AT&T BB	AT&T Bundle
DTV Video	[redacted]			
AT&T Video				
AT&T Broadband				
AT&T True Bundle				

Diversion to column components from an increase in the price of the row component. Note: AT&T BB and DTV video are complements,

as expected.

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Diversion Ratios for Party Services (product components)

Table: 1 Nesting Parameters

	DTV Video	AT&T Video	AT&T BB	AT&T Bundle
DTV Video	[redacted]			
AT&T Video				
AT&T Broadband				
AT&T True Bundle				

Diversion to column components from an increase in the price of the row component.

Note: AT&T BB and DTV video are complements, as expected.

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Simulation Approach

We do a standard merger simulation, as in Nevo (2000), with Nash equilibrium price-setting multi-product firms. An unusual feature is the presence of complementarities, but this does not change the mechanics of the simulation.

Steps to the simulation:

1. use the observed shares and the estimated demand parameters to estimate pre-merger equilibrium markups which (given prices) imply marginal cost estimates
2. change the ownership structure in the model and solve for a new price vector that satisfies the resulting first-order conditions
3. at these prices, compute the post-merger demand and, importantly, the net change in average consumer welfare.

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Supply Side Pricing

Consumers purchase "products" defined by combination of BB and video service. For firms, however, the natural notion of product is the "product component." There are three types of product components that a firm $f \in \{\text{AT\&T, Comcast, } \ldots\}$ might produce:

1. true bundle ("BU")
2. video ("VV")
3. broadband ("BB")

In the case of a (true) bundle component, the component is also a product. A video or broadband component, however, will typically serve both as a product (e.g., a video-only product) and as one of two components of a product involving video and broadband from different providers.

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Component Prices and Product Prices

Table: Product Prices in a Choice Set

$j \backslash k$	cable	ATT	telco	DTV	Dish	none
cable	p^C_{BUm}	$p^C_{BBm} + p^A_{VVm}$	$p^C_{BBm} + p^T_{VVm}$	$p^C_{BBm} + p^D_{VVm}$	$p^C_{BBm} + p^S_{VVm}$	p^C_{BBm}
ATT	$p^A_{BBm} + p^C_{VVm}$	p^A_{BUm}	-	$p^A_{BBm} + p^D_{VVm} - d$	$p^A_{BBm} + p^S_{VVm}$	p^A_{BBm}
telco	$p^T_{BBm} + p^C_{VVm}$	-	p^T_{BUm}	$p^T_{BBm} + p^D_{VVm} - d$	$p^T_{BBm} + p^S_{VVm}$	p^T_{BBm}
other	$\bar{p}^O_{BB} + p^C_{VVm}$	$\bar{p}^O_{BB} + p^A_{VVm}$	$\bar{p}^O_{BB} + p^T_{VVm}$	$\bar{p}^O_{BB} + p^D_{VVm}$	$\bar{p}^O_{BB} + p^S_{VVm}$	$\bar{p}^O_{BB}$
none	p^C_{VVm}	p^A_{VVm}	p^T_{VVm}	p^D_{VVm}	p^S_{VVm}	0

Note

- price of a product fixed within DMA®
- synthetic bundle prices equal sum of component prices less applicable joint-marketing-agreement discount d.

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Supply Side Pricing Notation

Each firm f produces product components and chooses their prices. Notation:

- p^f_{rm}, price of a product component $r \in \{BU, VV, BB\}$ produced by firm f
- $\mathcal{JK}^f_{rm}$, set of products jk that include firm f's component r.

The table below shows the elements of $\mathcal{JK}^f_{rm}$ for all product components (in the last column), as well as the margin (price minus marginal cost) associated with each product component.

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Table: Components, Margins, and Products

	Product Component (r)	Component Margin	jk pairs (products) in $\mathcal{JK}^f_{rm}$
Cable	BU	$p^C_{BUm} - mc^C_{BUm}$	$j = k = C$
Cable	VV	$p^C_{VVm} - mc^C_{VVm}$	$j \in \{0, A, T, OB\}, k = C$
Cable	BB	$p^C_{BBm} - mc^C_{BBm}$	$j = C, k \in \{0, A, T, D, S\}$
AT&T	BU	$p^A_{BUm} - mc^A_{BUm}$	$j = k = A$
AT&T	VV	$p^A_{VVm} - mc^A_{VVm}$	$j \in \{0, C, OB\}, k = A$
AT&T	BB	$p^A_{BBm} - mc^A_{BBm}$	$j = A, k \in \{0, C, D, S\}$
Telco	BU	$p^T_{BUm} - mc^T_{BUm}$	$j = k = T$
Telco	VV	$p^T_{VVm} - mc^T_{VVm}$	$j \in \{0, C, OB\}, k = T$
Telco	BB	$p^T_{BBm} - mc^T_{BBm}$	$j = T, k \in \{0, C, D, S\}$
DTV	VV	$p^D_{VVm} - mc^D_{VVm}$	any $j, k = D$
Dish	VV	$p^S_{VVm} - mc^S_{VVm}$	any $j, k = S$

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The DTV-AT&T Synthetic Bundle

The margins shown above ignore discounts offered through joint-marketing agreements ([redacted] off if purchased through AT&T; [redacted] off for one year if through DTV; no discount if purchased separately).

We understand that the discount has been negotiated at a corporate-to-corporate level. Thus we model firms as choosing only component prices, but taking account of the effect of the discount where applicable.

We model a fixed discount of $d =$ [redacted] for all purchases DTV synthetic bundles, split equally between DTV and its partner. Thus, e.g., the AT&T BB component margin is reduced by [redacted] when sold as part of the product $jk = AD$. Likewise, the DTV margin on its video service is reduced by [redacted] for products $jk = AD$ and $jk = TD$. We do the same for the DTV-Telco and DTV-Mediacom synthetic bundles.

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Demand for Product Components

Following the discussion of demand, DMA®-level shares are the weighted sum of shares across sub-DMA® choice sets. In particular, share of all DMA®-m households purchasing component r is

$$s_{rm}^{f}(p_m) = \sum_{jk \in \mathcal{JK}_{rm}^{f}} \left[\frac{1}{n_m^0} \sum_{\ell} \sigma_{jk} \left(\delta_m, \bar{\chi}_m^{\ell}; \theta^d \right) w_m^{\ell} \right].$$

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Remarks on Product Component Demand

Whenever a product contains components from two different firms, both firms receive the demand for that product. For example, consider the product with $j = A, k = D$; since each firm produces a component of the product, the shares s^A_{BBm} and s^D_{VVm} both include all the demand for the $jk = AD$ product. An implication is that the sum of $s^f_{rm}(p_m)$ over r and f will generally be bigger than one. This simply reflects the fact that some households purchase components from more than one firm.

The derivatives of $s^f_r(p_m)$ will correctly reflect the overlap (or on-overlap) of choice sets. For example, the cross-price derivative between AT&T and "other telco" will be zero as long as they don't overlap in any choice set.

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Share with Synthetic Bundle Discount

We must account for the households in each DMA® who receive a DTV synthetic bundle discount. We calculate the share of households in receiving a discount of [redacted] from firm f as

$$\phi_m^f(p_m) = \begin{cases} \frac{1}{n_m^0} \sum_\ell \sigma_{AD}\left(\delta_m, s_{im}, \bar{\chi}_m^\ell; \theta^d\right) w_m^\ell, & \text{for } f = A \\ \frac{1}{n_m^0} \sum_\ell \sigma_{TD}\left(\delta_m, s_{im}, \bar{\chi}_m^\ell; \theta^d\right) w_m^\ell, & \text{for } f = T \\ \phi_m^A(p_m) + \phi_m^T(p_m), & \text{for } f = D \\ 0, & \text{else.} \end{cases} .$$

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Profits

Per-capita variable profits for firm f take the standard multi-product form

$$\pi_m^f(p_m) = \sum_{r \in \mathcal{R}_m^f} (p_{rm}^f - mc_{rm}^f) s_{rm}^f(p_m) - \frac{d}{2}\phi^f(p_m). \tag{6}$$

where $\mathcal{R}_m^f$ denotes the set of components produced by firm f in market m.

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First Order Conditions

Differentiating (6), the first-order condition for price p^f_{rm} is

$$\frac{\partial \pi^f_m(p^f_m)}{\partial p^f_{rm}} = s^f_{rm}(p_m) + \left[\sum_{t \in \mathcal{R}^f_m} (p^f_{tm} - mc^f_{rm}) \frac{\partial s^f_{tm}(p_m)}{\partial p^f_{rm}} \right] - \frac{d}{2} \frac{\partial \phi^f_m(p_m)}{\partial p^f_{rm}} = 0.$$

Of course the derivative term on the discount is zero for firms that do not offer the discount.

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Stacked FOCs

Stacking the first-order conditions for each component price chosen in the market, we obtain, similar to BLP,

$$\left(s_m - \frac{d}{2}\frac{\partial \phi_m}{\partial p_m}\right) + \Delta_m(p_m - mc_m) = 0$$

where elements of the matrix Δ_m are equal to either zero or a derivative of the form

$$\frac{\partial s_{tm}^f(p_m)}{\partial p_{rm}^f}.$$

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Solving for Marginal Costs (markups)

Again following BLP, we solve for marginal cost as

$$mc_m = p_m - (\Delta_m)^{-1}\left(s_m - \frac{d}{2}\frac{\partial \phi_m}{\partial p_m}\right). \tag{7}$$

The absolute value of the second term in (7) is the markup. Note that in (7) p_m and s_m are data, while Δ^{-1} and $(\partial\phi_m/\partial p_m)$ also involve the estimated demand parameters (α, ψ).

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Pre-Merger Weighted Average Dollar Markups

Table: 3 Nesting Parameters

	Avg. Markup
DTV Video + Cable BB	[redacted]
DTV Video + AT&T BB	
DTV Video + Telco BB	
DTV Video + No BB	
DISH Video + Cable BB	
DISH Video + AT&T BB	
DISH Video + Telco BB	
DISH Video + No BB	

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Pre-Merger Weighted Average Dollar Markups (continued)

Table: 3 Nesting Parameters

	Avg. Markup
Cable Video + Cable BB	[redacted]
Cable Video + AT&T BB	
Cable Video + Telco BB	
Cable Video + No BB	
AT&T Video + AT&T BB	
Telco Video + Telco BB	
No Video + Cable BB	
No Video + AT&T BB	
No Video + Telco BB	

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Pre-Merger Weighted Average Dollar Markups

Table: 1 Nesting Parameter

	Avg. Markup
DTV Video + Cable BB	[redacted]
DTV Video + AT&T BB	
DTV Video + Telco BB	
DTV Video + No BB	
DISH Video + Cable BB	
DISH Video + AT&T BB	
DISH Video + Telco BB	
DISH Video + No BB	

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Pre-Merger Weighted Average Dollar Markups (continued)

Table: 1 Nesting Parameter

	Avg. Markup
Cable Video + Cable BB	[redacted]
Cable Video + AT&T BB	
Cable Video + Telco BB	
Cable Video + No BB	
AT&T Video + AT&T BB	
Telco Video + Telco BB	
No Video + Cable BB	
No Video + AT&T BB	
No Video + Telco BB	

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Validation of Estimated Markups

The markups above look reasonable. True markups are unknown for most firms and difficult to measure even for AT&T due to ambiguities of cost allocation.

The DTV markup is easier to assess. DTV ARPU analysis reveals a [redacted] price-cost margin on its service. Based on the observed average price of [redacted], this would imply a margin of [redacted]. Our estimated DTV margin is [redacted]. For lower-tier DTV services (priced [redacted]) most attractive to marginal subscribers, [redacted] margin would be [redacted].

$\Longrightarrow$ The available external validation of the markup estimates looks extremely good.

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Post-Merger Products

Using the estimated marginal costs and estimated demand system, we solve for predicted post-merger outcomes. This involves changing the first-order conditions for the product components of AT&T and DTV and solving for a new equilibrium.

Post-merger, the combined firm ATT-DTV (indexed with $f = A$) offers five components: broadband, wired video, satellite video, and two true bundles—one with wired video and one with satellite video. To distinguish between ATT-DTV product components relying on

wired video vs. satellite video, we write VV^* and BU^* to indicate ATT-DTV product components that involve satellite.

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Post Merger Discounts

We assume the merged firm will continue to offer consumers a fixed discount d for synthetic bundles created with "other telco" since AT&T wired video and other telco video typically do not appear in the same choice set.

The post-merger products are shown in the Table below with the map from component prices to product prices.

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Table: Post-Merger Products and Prices

$j \backslash k$	cable	ATT-DTV	telco	ATT-DTV*	Dish	none
cable	p^C_{BUm}	$p^C_{BBm}+p^A_{VVm}$	$p^C_{BBm}+p^T_{VVm}$	$p^C_{BBm}+p^A_{VV*m}$	$p^C_{BBm}+p^S_{VVm}$	p^C_{BBm}
ATT-DTV	$p^A_{BBm}+p^C_{VVm}$	p^A_{BUm}	-	p^A_{BU*m}	$p^A_{BBm}+p^S_{VVm}$	p^A_{BBm}
telco	$p^T_{BBm}+p^C_{VVm}$	-	p^T_{BUm}	$p^T_{BBm}+p^A_{VV*m}-d$	$p^T_{BBm}+p^S_{VVm}$	p^T_{BBm}
other	$\bar{p}^O_{BB}+p^C_{VVm}$	$\bar{p}^O_{BB}+p^A_{VVm}$	$\bar{p}^O_{BB}+p^T_{VVm}$	$\bar{p}^O_{BB}+p^A_{VV*m}$	$\bar{p}^O_{BB}+p^S_{VVm}$	$\bar{p}^O_{BB}$
none	p^C_{VVm}	p^A_{VVm}	p^T_{VVm}	p^A_{VV*m}	p^S_{VVm}	0

For example, the post-merger price for the (now true) bundle of AT&T broadband with DTV video is p^A_{BU*m}. The price of the product involving cable broadband (from firm C) with Dish video is the sum $p^C_{BBm} + p^D_{VVm}$.

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Table: Product Components for ATT-DTV Post Merger

Firm ($f = A$)	Product Component (r)	Component Margin	jk pairs (products) in $\mathcal{JK}^A_{rm}$
ATT-DTV	BU	$p^A_{BUm} - mc^A_{BUm}$	$j = k = A$
ATT-DTV	VV	$p^A_{VVm} - mc^A_{VVm}$	$j \in \{0, C, OB\}, k = A$
ATT-DTV	BB	$p^A_{BBm} - mc^A_{BBm}$	$j = A, k \in (0, C, S)$
ATT-DTV	BU^*	$p^A_{BU^*m} - mc^A_{BU^*m}$	$j = A, k = A^*$
ATT-DTV	VV^*	$p^A_{VV^*m} - mc^A_{VV^*m}$	any $j \neq A, k = A^*$

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Merger Simulation

To perform the simulation, we first modify the first-order conditions to account for the new ownership structure. The first-order conditions take the same form, but with the product component sets $\mathcal{R}_m^f$ updated to account for new ownership. Denote the new matrix of own-firm component share derivatives as $\tilde{\Delta}(p_m)$. As before, this matrix is formed by stacking the new first-order conditions for all the product component prices.

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Post Merger Marginal Costs

The post-merger marginal costs are denoted $\widetilde{mc}_m$. The natural starting points for these are the previously estimated marginal costs, but we also consider the effects of efficiencies, due e.g., to reduction in AT%T video content costs.

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Post-Merger Equilibrium

Following standard practice, to find the new equilibrium prices, we iterate on the system of post-merger first-order conditions

$$p_m = \widetilde{mc}_m + b_m(p_m) \tag{8}$$

where the markup is

$$b_m(p_m) = -\tilde{\Delta}_m^{-1}(p_m)\left(\tilde{s}_m(p_m) - \frac{\partial \phi_m}{\partial p_m}(p_m)\right). \tag{9}$$

$\tilde{s}_m(p_m)$ is the vector of post-merger component shares.

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Post-Merger Equilibrium: AT&T ZIPs

Our main merger simulation operates at the DMA® level. However, we have also run the simulation for households within the AT&T footprint (AT&T ZIP codes) under an assumption of competition at this finer geographic level.

This simulation uses the same estimates of demand and marginal cost, and in the simulation firms still set one price per product-component in each DMA®. However, we model firms as competing in prices for the households in AT&T ZIP codes (those with AT&T video coverage).

We do this under both the pre-merger and post-merger ownership structures. The differences are reported as predicted price changes.

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Consumer Welfare

Given new equilibrium prices, we can compute both pre-merger and post-merger consumer welfare using the usual nested logit formulas, dividing welfare in "utils" by the estimated price coefficient to obtain welfare in dollars.

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Results

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Simulation Results: Without Cost Savings

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Simulation Results - All DMA®s

Table: 3 Nesting Parameters

Δ CS Per Household	$0.08

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$0.73	0.64%
DTV Video + AT&T BB			-$7.31	-6.00%
DTV Video + Telco BB			$0.99	0.87%
DTV Video + No BB			$1.07	1.32%
DISH Video + Cable BB			-$0.18	-0.18%
DISH Video + AT&T BB			-$1.27	-1.00%
DISH Video + Telco BB			$0.08	0.07%
DISH Video + No BB			$0.15	0.22%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - All DMA®s (continued)

Table: 3 Nesting Parameters

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$0.11	-0.11%
Cable Video + AT&T BB			-$1.47	-1.04%
Cable Video + Telco BB			-$0.12	-0.09%
Cable Video + No BB			-$0.05	-0.05%
AT&T Video + AT&T BB			$3.76	3.09%
Telco Video + Telco BB			-$0.08	-0.06%
No Video + Cable BB			-$0.33	-1.07%
No Video + AT&T BB			-$1.42	-3.10%
No Video + Telco BB			-$0.08	-0.20%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - AT&T ZIPs

Table: 3 Nesting Parameters

Δ CS Per Household	$0.10

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$1.43	1.28%
DTV Video + AT&T BB			-$6.96	-5.72%
DTV Video + Telco BB			$1.98	1.76%
DTV Video + No BB			$2.15	2.66%
DISH Video + Cable BB			-$0.39	-0.39%
DISH Video + AT&T BB			-$1.50	-1.30%
DISH Video + Telco BB			$0.16	0.14%
DISH Video + No BB			$0.33	0.47%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - AT&T ZIPs (continued)

Table: 3 Nesting Parameters

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$0.20	-0.18%
Cable Video + AT&T BB			-$1.76	-1.25%
Cable Video + Telco BB			-$0.10	-0.08%
Cable Video + No BB			$0.07	0.08%
AT&T Video + AT&T BB			$3.69	3.05%
Telco Video + Telco BB			-$0.15	-0.12%
No Video + Cable BB			-$0.72	-2.45%
No Video + AT&T BB			-$1.83	-3.98%
No Video + Telco BB			-$0.17	-0.49%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - All DMA®s

Table: 1 Nesting Parameter

Δ CS Per Household	$0.59

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$3.23	2.86%
DTV Video + AT&T BB			-$16.73	-13.69%
DTV Video + Telco BB			$3.48	3.06%
DTV Video + No BB			$3.86	4.79%
DISH Video + Cable BB			-$0.50	-0.49%
DISH Video + AT&T BB			$2.76	2.38%
DISH Video + Telco BB			-$0.24	-0.22%
DISH Video + No BB			$0.14	0.19%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - All DMA®s (continued)

Table: 1 Nesting Parameter

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$1.02	-0.90%
Cable Video + AT&T BB			$1.96	1.39%
Cable Video + Telco BB			-$1.04	-0.76%
Cable Video + No BB			-$0.66	-0.68%
AT&T Video + AT&T BB			$4.41	3.63%
Telco Video + Telco BB			-$0.36	-0.26%
No Video + Cable BB			-$0.64	-2.08%
No Video + AT&T BB			$2.62	5.70%
No Video + Telco BB			-$0.38	-0.96%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - AT&T ZIPs

Table: 1 Nesting Parameter

Δ CS Per Household	$0.82

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$5.57	5.03%
DTV Video + AT&T BB			-$16.83	-13.79%
DTV Video + Telco BB			$5.87	5.21%
DTV Video + No BB			$6.42	7.97%
DISH Video + Cable BB			-$0.61	-0.61%
DISH Video + AT&T BB			$2.42	2.09%
DISH Video + Telco BB			-$0.31	-0.29%
DISH Video + No BB			$0.24	0.35%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results - AT&T ZIPs (continued)

Table: 1 Nesting Parameter

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$1.52	-1.36%
Cable Video + AT&T BB			$1.47	1.05%
Cable Video + Telco BB			-$1.26	-0.95%
Cable Video + No BB			-$0.70	-0.74%
AT&T Video + AT&T BB			$4.20	3.47%
Telco Video + Telco BB			-$0.55	-0.41%
No Video + Cable BB			-$0.85	-2.93%
No Video + AT&T BB			$2.18	4.74%
No Video + Telco BB			-$0.56	-1.47%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results w/ [redacted] Video Component Marginal Cost Savings

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Simulation Results with Cost Savings - All DMA®s

Table: 3 Nesting Parameters

Δ CS Per Household	$0.94

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$0.89	0.79%
DTV Video + AT&T BB			-$6.34	-5.21%
DTV Video + Telco BB			$1.27	1.13%
DTV Video + No BB			$1.54	1.91%
DISH Video + Cable BB			-$0.63	-0.61%
DISH Video + AT&T BB			-$1.04	-0.90%
DISH Video + Telco BB			-$0.25	-0.23%
DISH Video + No BB			$0.02	0.03%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results w/ Cost Savings - All DMA®s (cont'd)

Table: 3 Nesting Parameters

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$0.80	-0.70%
Cable Video + AT&T BB			-$1.60	-1.12%
Cable Video + Telco BB			-$0.80	-0.59%
Cable Video + No BB			-$0.54	-0.55%
AT&T Video + AT&T BB			-$4.88	-4.03%
Telco Video + Telco BB			-$0.20	-0.15%
No Video + Cable BB			-$0.65	-2.06%
No Video + AT&T BB			-$1.05	-2.32%
No Video + Telco BB			-$0.26	-0.69%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results with Cost Savings - AT&T ZIPs

Table: 3 Nesting Parameters

Δ CS Per Household	$1.77

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$1.91	1.71%
DTV Video + AT&T BB			-$5.81	-4.78%
DTV Video + Telco BB			$2.56	2.28%
DTV Video + No BB			$3.15	3.89%
DISH Video + Cable BB			-$1.18	-1.18%
DISH Video + AT&T BB			-$1.42	-1.21%
DISH Video + Telco BB			-$0.52	-0.49%
DISH Video + No BB			$0.06	0.09%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results w/ Cost Savings - AT&T ZIPs (cont'd)

Table: 3 Nesting Parameters

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$1.66	-1.49%
Cable Video + AT&T BB			-$2.20	-1.55%
Cable Video + Telco BB			-$1.30	-0.98%
Cable Video + No BB			-$0.72	-0.75%
AT&T Video + AT&T BB			-$5.15	-4.27%
Telco Video + Telco BB			-$0.46	-0.36%
No Video + Cable BB			-$1.25	-4.20%
No Video + AT&T BB			-$1.48	-3.22%
No Video + Telco BB			-$0.59	-1.60%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results with Cost Savings - All DMA®s

Table: 1 Nesting Parameter

Δ CS Per Household	$1.37

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$3.13	2.77%
DTV Video + AT&T BB			-$15.84	-12.97%
DTV Video + Telco BB			$3.69	3.24%
DTV Video + No BB			$4.18	5.18%
DISH Video + Cable BB			-$0.98	-0.96%
DISH Video + AT&T BB			$3.27	2.81%
DISH Video + Telco BB			-$0.42	-0.38%
DISH Video + No BB			$0.07	0.10%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results w/ Cost Savings - All DMA®s (cont'd)

Table: 1 Nesting Parameter

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$1.71	-1.50%
Cable Video + AT&T BB			$2.04	1.45%
Cable Video + Telco BB			-$1.65	-1.22%
Cable Video + No BB			-$1.16	-1.20%
AT&T Video + AT&T BB			-$4.34	-3.59%
Telco Video + Telco BB			-$0.47	-0.34%
No Video + Cable BB			-$1.05	-3.36%
No Video + AT&T BB			$3.20	6.93%
No Video + Telco BB			-$0.49	-1.24%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results with Cost Savings - AT&T ZIPs

Table: 1 Nesting Parameter

Δ CS Per Household	$2.45

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$5.31	4.80%
DTV Video + AT&T BB			-$15.85	-12.99%
DTV Video + Telco BB			$6.26	5.56%
DTV Video + No BB			$7.07	8.76%
DISH Video + Cable BB			-$1.64	-1.65%
DISH Video + AT&T BB			$2.87	2.48%
DISH Video + Telco BB			-$0.70	-0.65%
DISH Video + No BB			$0.11	0.16%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results w/ Cost Savings - AT&T ZIPs (cont'd)

Table: 1 Nesting Parameter

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$3.09	-2.75%
Cable Video + AT&T BB			$1.06	0.75%
Cable Video + Telco BB			-$2.51	-1.91%
Cable Video + No BB			-$1.70	-1.80%
AT&T Video + AT&T BB			-$4.83	-4.01%
Telco Video + Telco BB			-$0.87	-0.66%
No Video + Cable BB			-$1.76	-5.99%
No Video + AT&T BB			$2.76	5.99%
No Video + Telco BB			-$0.81	-2.15%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Summary of CS Change Per Household

Table: Summary of CS Change Per Household

	3 Nesting Param.	1 Nesting Param.
Without Cost Savings		
All DMA®s w/ AT&T Availability	$0.08	$0.59
DMA®s w/ AT&T Video Availability	$0.06	$0.63
AT&T Video Zips	$0.10	$0.82
With Cost Savings		
All DMA®s w/ AT&T Availability	$0.94	$1.37
DMA®s w/ AT&T Video Availability	$1.07	$1.55
AT&T Video Zips	$1.77	$2.45

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Summary of Simulation Results

- Across all specifications, consumer welfare strictly improves
- As expected, the new ATT-DTV bundle has a substantially lower price, which puts downward pricing pressure on cable as well. Post-merger, consumers shift to these lower priced products. The welfare losses to video-only consumers are more than offset by the gains from downward pricing.
- Although the exact pattern of predicted price changes varies across specifications, the finding of a positive impact on consumers does not.
- The net consumer welfare improvement is especially substantial when we include AT&T video cost efficiencies.

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Conclusion

- We create a new dataset of DMA® level shares, prices, products (and sub-DMA® choice sets) for video and internet products.
- We use this data to estimate a nested logit model of demand with endogenous prices.
- The demand model has sensible and statistically significant estimated coefficients, giving plausible pre-merger markups.
- Simulations of post-merger consumer welfare show that the merger will increase consumer welfare even in the absence of plausible cost efficiencies.

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APPENDICES

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Reweighting

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Reweighting the Dhar Survey Shares

Variable Probability Sampling (e.g., Wooldridge, 1999; Tripathi 2011)

- in DMA® m, N_m households are drawn at random
- a drawn household i participates in the survey w.p.

$$\rho\left(b_{im}, z_{im}\right) = \kappa \exp\left(\eta\left(z_{im}, b_{im}; \theta^{\rho}\right)\right)$$

  where κ is a scale parameter and η is an index function known up to parameters θ^{ρ}
- scale parameter κ is not identified and irrelevant for our purposes, allowing us to set $\kappa = 1$
- note: same ρ across DMA®s, but different (i) sampling intensities N_m, (ii) demographics, and (iii) (endogenous) broadband choices.

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Reweighting

- need to reweight each observation so that its prevalence in the sample matches its prevalence in the population
- let $\mathcal{S}$ denote selection into the sample
- by Bayes' rule $\Pr(b, z|\mathcal{S}, m) = \frac{\Pr(\mathcal{S}|b,z,m)\Pr(b,z|m)}{\Pr(\mathcal{S}|m)}$
- by our data generating process $\Pr(\mathcal{S}|b, z, m) = \frac{N_m}{\bar{N}_m}\rho(b, z)$ where $\bar{N}_m$ is the (true) total number of households in DMA® m
- so $\Pr(\mathcal{S}|m) = \frac{N_m}{\bar{N}_m}\sum_{y,z}\Pr(b, z|m)\rho(b, z)$
- letting $\lambda_m = \sum_{y,z}\Pr(b, z|m)\rho(b, z)$, we then have the key equation

$$\Pr(b, z|\mathcal{S}, m) = \frac{\rho(b, z)}{\lambda_m}\Pr(b, z|m)$$

- $\Longrightarrow$ weight observation i by $\gamma(b_{im}, z_{im}) = \left(\frac{\rho(b_{im},z_{im})}{\lambda_m}\right)^{-1}$ (note: κ cancels).

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Weighting Procedure

- we want to sample from population

$$\begin{aligned}\Pr(z|m) &= \Pr(1,z|m) + \Pr(0,z|m) \\ &= \frac{\lambda_m}{\rho(1,z)}\Pr(1,z|S,m) + \frac{\lambda_m}{\rho(0,z)}\Pr(0,z|S,m)\end{aligned}$$

  where we plugged in the previous result in the second line
- this means that we could sample as if from $\Pr(z|m)$ by repeating the following procedure:
  1. draw a household i from the Dhar sample. This household has (b_i, z_i) with probability $\Pr(b_i, z_i|S,m)$
  2. associate the weight $\frac{\lambda_m}{\rho(b_i,z_i)}$ with this observation
  3. discard b_i
  4. then in our simulated sample, the weighted probability of observing a particular z is

$$\frac{\lambda_m}{\rho(1,z)}\Pr(1,z|S,m) + \frac{\lambda_m}{\rho(0,z)}\Pr(0,z|S,m)$$

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Reweighted DMA® Shares

Using this weighting, a consistent estimator of the market share of product jk in DMA® m is

$$\frac{1}{\sum_{i=1}^{n_m^0} \frac{\lambda_m}{\rho(b_{im}, z_{im})}} \sum_{i=1}^{n_m^0} \frac{\lambda_m}{\rho\left(b_{im}, z_{im}\right)} 1\left\{i \text{ chose product } jk\right\}$$

where n_m^0 is the realized number of households in DMA® m and the summation is over households in DMA® m.

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Reweighted US Shares

- U.S. share of households with home broadband is

$$\sum_m P_m \Pr\left(B_{im} = 1 | m\right)$$

where P_m represents the fraction of all U.S. households located in DMA® m

- to construct an estimate of this share from the survey data, we substitute a consistent estimate

$$\frac{1}{\sum_{i=1}^{n_m^0} \gamma\left(b_{im}, z_{im}\right)} \sum_{i=1}^{n_m^0} \gamma\left(b_{im}, z_{im}\right) 1\left\{B_{im} = 1\right\}$$

for each $\Pr\left(B_{im} = 1 | m\right)$ above (here the summation is over DMA® m households only)

- other U.S. level moments would be constructed similarly.

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Estimating the Weights

GMM

- to estimate the parameters of the weight function ρ, we fit predicted (using the weights above) U.S. demographic$\times$broadband moments to CPS data
- functional form: η is linear in demographics and broadband, with first-order interactions
- included variables: log income (binned), B, interaction (B times log of income bin midpoint)
- moments matched: race, education (binned), age (binned), broadband, full set of bivariate interactions
- parsimonious ρ fits other demographic moments well and avoids strange results for unusual bins.

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Estimated Parameters

	Estimate	Std. Err.
Income $\$0 - 50K$	-2.5512	0.0676
Income $\$50 - 100K$	-1.3840	0.0652
has BB	2.2935	0.1722
BB $\times$ log(Income)	-0.1425	0.0491

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External Validation

Check re-weighted Dhar sample shares against party data:

	all DMA® s				AT&T DMA® s , $>$ 300 obs			
	true	unwtd	wtd	MSE	true	unwtd	wtd	MSE
AA	[redacted]				[redacted]			
$\cdot A$								
$A\cdot$								
$\cdot D$								

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Share Estimation

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Share Estimation Details

Notation

- products denoted by jk index
  - j = home broadband provider ($j = 0$ is "none")
  - k = video provider ($k = 0$ is "none")
- markets (DMA®s) denoted by m
- $\hat{s}_{jkm}$ reweighted share from Dhar survey
- s^o_{jkm} observed party share
  - s^o_{AAm} AT&T bundle
  - $s^o_{\cdot Am}$ AT&T video marginal (sum over all BB, including "none")
  - $s^o_{A\cdot m}$ AT&T BB marginal
  - $s^o_{\cdot Dm}$ DTV video marginal
- s^ℓ_{jkm} share estimate from source ℓ (copyright, 2 Nielsen surveys)
- $\tilde{s}_{jkm}$ our final share estimate (output of this procedure).

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Share Estimation Details

Constraints: for every market m

1. $\sum_{j=0}^{J} \sum_{k=0}^{K} \tilde{s}_{jkm} = 1$
2. $\tilde{s}_{AAm} = s^{o}_{AAm}$
3. $\sum_{k=0}^{K} \tilde{s}_{Akm} = s^{o}_{A \cdot m}$
4. $\sum_{j=0}^{J} \tilde{s}_{jAm} = s^{o}_{\cdot Am}$
5. $\sum_{j=0}^{J} \tilde{s}_{jDm} = s^{o}_{\cdot Dm}$

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Share Estimation Details

Rewrite Constraints

1. $\tilde{s}_{00m} = 1 - \sum_{(j,k)\neq(0,0)} \tilde{s}_{kjm}$
2. $\tilde{s}_{AAm} = s^o_{AAm}$
3. $\tilde{s}_{A0m} = s^o_{A\cdot m} - \sum_{k\neq 0} \tilde{s}_{Akm}$
4. $\tilde{s}_{0Am} = s^o_{\cdot Am} - \sum_{j\neq 0} \tilde{s}_{jAm}$
5. $\tilde{s}_{0Dm} = s^o_{\cdot Dm} - \sum_{j\neq 0} \tilde{s}_{jDm}$

$\Longrightarrow$ Several no-broadband shares known and imposed as hard constraints. This reduces the extent to which we rely on reweighting of Dhar sample to correct for the oversampling of broadband households.

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Share Estimation Details

Idea: Minimize weighted deviations from (i) reweighted Dhar survey shares, (ii) copyright shares, (iii) Nielsen BB survey shares, (iv) Nielsen Video survey shares subject to all constraints implied by the party subscriber counts.
Formally, in each market m

$$\min_{\tilde{s}_m}(\hat{s}_m - \tilde{s}_m)' V_1^{-1}(\hat{s}_m - \tilde{s}_m) \; + \sum_{\ell=2}^{4} \; (s_m^\ell - f^\ell(\tilde{s}_m))' V_\ell^{-1}(s_m^\ell - f^\ell(\tilde{s}_m))$$

where each V_ℓ is an approximation to the covariance matrix of the corresponding share estimates.

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Party Price Data

For the two parties we have census of subscriber prices and plans.

We aggregate prices to the plan and ZIP code level. We do this including only subscribers in their first twelve months of service. These data, when combined with the web-scraped data, yield plan$\times$zip code plan characteristics and introductory prices for all providers.

The prices used for constructing the index are those for the first twelve months of service. (We use the full population of subscribers for constructing ARPU or actual price-cost margins.)

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Hedonic Regression

For broadband-only products:

- run a standard hedonic price regression
  - unit of observation is ZIP×firm×plan, where "plan" refers to a service tier
  - price on LHS; RHS contains
    - firm×DMA® fixed effects
    - piecewise linear spline in broadband speed of the plan
  - weight by number of households in each ZIP code
- the estimated fixed effects then serve as price indices (the classic "time dummy hedonic price indices" for variation over firms and DMA®s instead of over time)

The construction of prices (price indices) for the other products is similar, where the RHS variable for video is number of channels.

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Centering the Hedonic Indices

All that remains is to "center" the prices. This has no effect on price variation but determines the overall level of video, broadband, and bundle prices.

The choice is arbitrary, and traditional practice would be to select characteristics for a standard product to plug into the hedonic function (or a set of products to average over with fixed weights). This would mean adding the same constant to the price indices for all products within a product component category.

We use an equivalent approach that instead centers prices by matching the AT&T price indices to AT&T ARPU for each class of product. Note that this choice has no effect on our measure of the variation in the prices.

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"Quasi-First-Stage" Regressions

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Quasi-First-Stage

We estimated a model with sub-DMA® choice set variation by GMM. That model cannot be estimated by two-stage least squares, and there is no true "first stage" that can be reported for that model.

Nonetheless, to illustrate how our excluded instruments shift the endogenous variables (prices and within-group market shares) we present the regressions that would be the true first stage for a model without sub-DMA® choice set variation.

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Quasi-First-Stage Regression Results

	1 Nesting Parameter	
	price	ln(within group share)
Speed	-0.0316	0.0022
	(0.0130)	(0.0016)
No. Channels	-0.0587	0.0016
	(0.0085)	(0.0010)
DBS*latitude	0.1043	-0.0086
	(0.0639)	(0.0077)
DBS*UrbanPct	-1.5122	-0.5819
	(3.0017)	(0.3604)
DBS*Owner	16.0287	0.3922
	(8.0494)	(0.9665)
ATT Video + ATT BB	176.3160	1.7925
	(12.5087)	(1.5020)
Cable Video + ATT BB	182.7008	-4.2187
	(10.1016)	(1.2129)
Cable Video + Cable BB	146.2806	-2.2756
	(10.2586)	(1.2318)
Cable Video + Telco BB	177.0307	-4.3068
	(10.1440)	(1.2180)
Cable Video + No BB	83.8639	-2.4086
	(18.0016)	(2.1615)
DISH Video + ATT BB	141.6681	-1.2330
	(8.3884)	(1.0072)
Observations	1911	1911

Standard errors in parentheses

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Quasi-First-Stage Regression Results (cont.)

	1 Nesting Parameter	
	price	ln(within group share)
DISH Video + Cable BB	115.1542	-2.1168
	(8.1158)	(0.9745)
DISH Video + Telco BB	137.3422	-0.2212
	(8.3841)	(1.0067)
DISH Video + No BB	69.6635	-0.8632
	(11.0628)	(1.3283)
DTV Video + ATT BB	145.8879	-0.7151
	(8.3232)	(0.9994)
DTV Video + Cable BB	124.3524	-1.4705
	(8.0405)	(0.9654)
DTV Video + Telco BB	141.6979	0.0022
	(8.3092)	(0.9977)
DTV Video + No BB	79.0192	-1.0742
	(10.9999)	(1.3208)
Telco Video + Telco BB	182.2750	-0.1547
	(12.3208)	(1.4794)
No Video + ATT BB	53.6730	0.3311
	(12.5122)	(1.5024)
No Video + Cable BB	27.0417	0.0176
	(12.4363)	(1.4933)
No Video + TelcoBB	49.2297	0.7041
	(12.5129)	(1.5025)
Observations	1911	1911

Standard errors in parentheses

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Quasi-First-Stage Regression Results (cont.)

	1 Nesting Parameter	
	price	ln(within group share)
Telco-Verizon(Video)	-14.2148	2.3412
	(2.5604)	(0.3074)
Cable-Time Warner(Video)	-5.0243	0.1496
	(1.7358)	(0.2084)
Cable-Comcast(Video)	-5.2335	0.0594
	(1.6378)	(0.1967)
Cable-Charter(Video)	-0.8196	-0.1460
	(1.8992)	(0.2280)
Cable-COX(Video)	-1.2926	-0.1663
	(2.1690)	(0.2604)
Telco-Verizon(BB)	-3.4258	-0.0228
	(1.1091)	(0.1332)
Cable-Time Warner(BB)	-1.0782	0.1186
	(1.7159)	(0.2060)
Cable-Comcast(BB)	-8.4285	-0.1472
	(1.5491)	(0.1860)
Cable-Charter(BB)	-13.2520	0.2783
	(1.8589)	(0.2232)
Cable-COX(BB)	-0.6441	0.1499
	(1.8568)	(0.2230)
65Yrs or above * BB only	-42.7769	-3.0586
	(25.5275)	(3.0652)
Observations	1911	1911

Standard errors in parentheses

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Quasi-First-Stage Regression Results (cont.)

	1 Nesting Parameter	
	price	ln(within group share)
65Yrs or above * Video only	7.0493	-0.6222
	(23.4323)	(2.8136)
65Yrs or above * Bundle only	-56.0419	-3.4879
	(14.1403)	(1.6979)
Master degree or higher * BB only	-25.2987	8.9447
	(47.7868)	(5.7379)
Master degree or higher * Video only	23.3072	-3.3841
	(44.9066)	(5.3921)
Master degree or higher * Bundle only	19.6593	0.0698
	(26.3502)	(3.1639)
Median HH Income ($1000) * BB only	0.0383	-0.0269
	(0.1214)	(0.0146)
Median HH Income ($1000) * Video only	0.0121	0.0039
	(0.1133)	(0.0136)
Median HH Income ($1000) * Bundle only	-0.0525	-0.0115
	(0.0677)	(0.0081)
Latitude*NonDBSVideo*Contains BB	-0.0742	0.0086
	(0.0863)	(0.0104)
Latitude*NonDBSVideo*No BB	-0.0400	0.0231
	(0.1570)	(0.0189)
Latitude*No Video	0.0676	0.0130
	(0.1110)	(0.0133)
OwnerPct*NonDBSVideo*Contains BB	4.2121	3.0140
	(10.5796)	(1.2703)
OwnerPct*NonDBSVideo*No BB	37.5576	-0.2003
	(20.5834)	(2.4715)
Observations	1911	1911

Standard errors in parentheses

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Quasi-First-Stage Regression Results (cont.)

	1 Nesting Parameter	
	price	ln(within group share)
OwnerPct*No Video	15.7814	-0.1115
	(13.7808)	(1.6547)
UrbanPct*NonDBSVideo*Contains BB	-7.6919	0.5288
	(3.8780)	(0.4656)
UrbanPct*NonDBSVideo*No BB	-4.3200	1.3314
	(7.3461)	(0.8821)
UrbanPct*No Video	0.0259	0.3057
	(5.1719)	(0.6210)
ATT Telco Coverage*(CableBundle)	-12.6955	-0.0364
	(3.8508)	(0.4624)
ATT Telco Coverage*(Cable Video + No BB)	1.7468	-0.6801
	(3.8693)	(0.4646)
ATT Telco Coverage*(Cable Video + Non CableBB)	1.5651	-0.1458
	(3.0119)	(0.3616)
ATT Telco Coverage*(DBS + No BB)	-0.3384	0.4376
	(2.7390)	(0.3289)
ATT Telco Coverage*(DBS + Contains BB)	-1.2079	-0.4733
	(1.7189)	(0.2064)
ATT Telco Coverage*No Video	-0.7977	-0.4684
	(2.5065)	(0.3010)
ATT Telco BB Coverage*Not ATT Telco BB	9.3522	0.2868
	(3.4973)	(0.4199)
ATT Telco BB Coverage*No BB	0.3970	0.0278
	(4.0871)	(0.4907)
Observations	1911	1911

Standard errors in parentheses

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Quasi-First-Stage Regression Results (cont.)

	1 Nesting Parameter	
	price	ln(within group share)
ATT Telco BB Coverage*CableBundle	3.8911	-0.1257
	(6.8022)	(0.8168)
Cable BB Coverage * Non Cable BB	-11.6305	-0.6495
	(5.0924)	(0.6115)
Cable BB Coverage * No BB	2.2125	0.5946
	(7.7492)	(0.9305)
Cable BB Coverage * ATT Telco BB	-0.2156	-5.6290
	(11.2870)	(1.3553)
Average No. Channels * Contains Video	-0.0275	-0.0050
	(0.0151)	(0.0018)
Average No. Channels * No Video	-0.0357	-0.0036
	(0.0269)	(0.0032)
Max No. Channels * Contains Video	0.0174	0.0009
	(0.0053)	(0.0006)
Max No. Channels * No Video	0.0136	0.0004
	(0.0099)	(0.0012)
Average Speed * Contains Video	-0.0086	0.0092
	(0.0274)	(0.0033)
Average Speed * No Video	-0.0367	-0.0037
	(0.0435)	(0.0052)
Max Speed * Contains Video	0.0574	-0.0022
	(0.0151)	(0.0018)
Max Speed * No Video	0.0312	0.0012
	(0.0273)	(0.0033)
Big Cable Comp. * Non Cable Video	-0.1319	0.0998
	(1.2206)	(0.1466)
Big Cable Comp. * Non Cable BB	-2.8297	-0.1646
	(1.2651)	(0.1519)
Observations	1911	1911

Standard errors in parentheses

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Alternate Market Shares

Above we described challenges in resolving inconsistencies across the multiple sources of data used to construct the full set of shares used in demand estimation.

To assess robustness of the merger simulation results to alternative ways of resolving these conflicts, we have re-run the entire analysis using two different approaches to combining the various data sources.

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Two Alternatives

Both create a market-level Dish video (marginal) moment by distributing the national Dish subscriber count across markets according to the relative shares implied in the Nielsen DMA®-level video surveys.

Alternate Specification 1. Here we allocate the "excess" Nielsen Dish demand to the "no video" moment.

Alternate Specification 2. Here we proportionately allocate the excess share removed from Dish to the cable, other telco, and no video moments using the relative proportions between cable and other telco in the copyright data. This is implemented by adjusting the copyright numbers upward for cable and other telco to match the level of the adjusted Nielsen "wired video" share, consistent with the evidence that copyright data understates these shares.

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Summary – Alternate Specifications

Table: Alternate Specifications

	Alt. Spec. 1	Alt. Spec. 2
Parameter Estimates		
Price (α)	0.0232	0.0199
Nesting Parameters (ψ)		
Video Only	0.7685	0.4904
BB Only	0.5562	0.8861
Bundle	0.4940	0.5598
ΔCS Per HH - w/o Cost Savings		
All DMA®s w/ AT&T Availability	$0.47	$0.07
DMA®s w/ AT&T Video Availability	$0.51	$0.03
AT&T Video Zips	$0.67	$0.13
ΔCS Per HH - w/ Cost Savings		
All DMA®s w/ AT&T Availability	$1.25	$0.94
DMA®s w/ AT&T Video Availability	$1.44	$1.06
AT&T Video Zips	$2.27	$1.84

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Parameter Estimates (Main)

Table: Alternate Specification 1

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
Price (α)	0.0232	0.0033	**Video Firm Dummies**		
Nesting Parameters (ψ)			Telco - Verizon	0.6973	0.1384
Video Only	0.7685	0.0939	Cable - Time Warner	-0.3062	0.0435
BB Only	0.5562	0.0554	Cable - Comcast	-0.5869	0.0361
Bundle	0.4940	0.0313	Cable - Charter	-0.3535	0.0161
			Cable - Cox	-0.6317	0.0298
Product Characteristics			**BB Firm Dummies**		
Speed	-0.0032	0.0002	Telco - Verizon	0.0737	0.0315
No. Channels	0.0003	0.0003	Cable - Time Warner	0.0243	0.0290
DBS $\times$ Latitude	-0.0088	0.0012	Cable - Comcast	-0.1101	0.0340
DBS $\times$ Urban %	-0.7498	0.0862	Cable - Charter	-0.4748	0.0490
DBS $\times$ Owner %	0.3615	0.1899	Cable - Cox	0.2773	0.0146

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Parameter Estimates (Demographics)

Table: Alternate Specification 1

	Est. Coef.	Std. Err.
Age:		
65 or above × BB only	-3.9225	0.2570
65 or above × Video only	-4.5360	0.5238
65 or above × Bundle	-1.8421	0.2666
Education:		
Master degree or higher × BB only	2.0980	0.8594
Master degree or higher × Video only	-4.1551	1.7427
Master degree or higher × Bundle	2.8282	0.9255
Income ($000):		
Median HH Income × BB only	0.0153	0.0014
Median HH Income × Video only	-0.0023	0.0011
Median HH Income × Bundle	0.0158	0.0010

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Parameter Estimates (Product Dummies)

Table: Alternate Specification 1

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
			Cable Video + Cable BB	4.2089	0.4779
DTV Video + Cable BB	3.3398	0.4768	Cable Video + AT&T BB	3.4878	0.5760
DTV Video + AT&T BB	3.5132	0.4762	Cable Video + Telco BB	3.1226	0.5662
DTV Video + Telco BB	3.4309	0.4640	Cable Video + No BB	3.7797	0.3884
DTV Video + No BB	3.6801	0.3238			
			AT&T Video + AT&T BB	3.3000	0.5445
DISH Video + Cable BB	2.7207	0.4588	Telco Video + Telco BB	2.5271	0.5820
DISH Video + AT&T BB	3.0235	0.4716			
DISH Video + Telco BB	3.1452	0.4544	No Video + Cable BB	0.6948	0.1967
DISH Video + No BB	3.3624	0.3036	No Video + AT&T BB	0.7283	0.2149
			No Video + Telco BB	0.5542	0.2117

Note: Product dummies capture both quality differences and differences in average price levels (see previous discussion).

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Parameter Estimates (Main)

Table: Alternate Specification 2

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
Price (α)	0.0199	0.0016	**Video Firm Dummies**		
Nesting Parameters (ψ)			Telco - Verizon	0.6757	0.0992
Video Only	0.4904	0.0613	Cable - Time Warner	-0.1532	0.0465
BB Only	0.8861	0.0331	Cable - Comcast	-0.2596	0.0518
Bundle	0.5598	0.0196	Cable - Charter	-0.1228	0.0318
			Cable - Cox	-0.1757	0.0569
Product Characteristics			**BB Firm Dummies**		
Speed	0.0003	0.0002	Telco - Verizon	-0.1602	0.0215
No. Channels	0.0005	0.0002	Cable - Time Warner	0.1142	0.0275
DBS $\times$ Latitude	-0.0200	0.0009	Cable - Comcast	-0.1358	0.0297
DBS $\times$ Urban %	-0.4627	0.0436	Cable - Charter	-0.2001	0.0310
DBS $\times$ Owner %	-0.7106	0.2299	Cable - Cox	0.2535	0.0239

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Parameter Estimates (Demographics)

Table: Alternate Specification 2

	Est. Coef.	Std. Err.
Age:		
65 or above × BB only	-2.9409	0.1791
65 or above × Video only	3.6057	0.2221
65 or above × Bundle	3.4943	0.2167
Education:		
Master degree or higher × BB only	2.1960	0.5367
Master degree or higher × Video only	-4.9764	0.8924
Master degree or higher × Bundle	8.4064	0.5196
Income ($000):		
Median HH Income × BB only	0.0226	0.0011
Median HH Income × Video only	0.0119	0.0010
Median HH Income × Bundle	0.0148	0.0008

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Parameter Estimates (Product Dummies)

Table: Alternate Specification 2

	Est. Coef.	Std. Err.		Est. Coef.	Std. Err.
			Cable Video + Cable BB	3.0062	0.2565
DTV Video + Cable BB	3.2842	0.2242	Cable Video + AT&T BB	2.5359	0.3134
DTV Video + AT&T BB	3.6235	0.2255	Cable Video + Telco BB	2.1913	0.3093
DTV Video + Telco BB	3.5895	0.2217	Cable Video + No BB	2.1576	0.1759
DTV Video + No BB	2.9887	0.1688			
			AT&T Video + AT&T BB	2.3872	0.2679
DISH Video + Cable BB	2.7385	0.2205	Telco Video + Telco BB	1.9075	0.3027
DISH Video + AT&T BB	3.1987	0.2256			
DISH Video + Telco BB	3.3269	0.2186	No Video + Cable BB	0.6255	0.1148
DISH Video + No BB	2.6853	0.1664	No Video + AT&T BB	0.8337	0.1259
			No Video + Telco BB	0.7647	0.1288

Note: Product dummies capture both quality differences and differences in average price levels (see previous discussion).

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Simulation Results – Alternate Specifications: Without Cost Savings

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Alt Spec Simulation Results - All DMA®s

Table: Alternate Specification 1

Δ CS Per Household	$0.47

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$1.95	1.72%
DTV Video + AT&T BB			-$14.56	-11.92%
DTV Video + Telco BB			$2.12	1.87%
DTV Video + No BB			$2.38	2.96%
DISH Video + Cable BB			-$0.47	-0.47%
DISH Video + AT&T BB			$1.86	1.61%
DISH Video + Telco BB			-$0.30	-0.28%
DISH Video + No BB			-$0.04	-0.05%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Alt Spec Simulation Results - All DMA®s (continued)

Table: Alternate Specification 1

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$0.65	-0.58%
Cable Video + AT&T BB			$1.33	0.95%
Cable Video + Telco BB			-$0.83	-0.62%
Cable Video + No BB			-$0.57	-0.59%
AT&T Video + AT&T BB			$4.00	3.30%
Telco Video + Telco BB			-$0.23	-0.16%
No Video + Cable BB			-$0.44	-1.45%
No Video + AT&T BB			$1.90	4.14%
No Video + Telco BB			-$0.27	-0.68%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Alt Spec Simulation Results - All DMA®s

Table: Alternate Specification 2

Δ CS Per Household	$0.07

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$3.07	2.72%
DTV Video + AT&T BB			-$11.70	-9.57%
DTV Video + Telco BB			$3.47	3.05%
DTV Video + No BB			$3.83	4.74%
DISH Video + Cable BB			-$0.65	-0.65%
DISH Video + AT&T BB			-$1.13	-0.97%
DISH Video + Telco BB			-$0.26	-0.23%
DISH Video + No BB			$0.10	0.14%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Alt Spec Simulation Results - All DMA®s (continued)

Table: Alternate Specification 2

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$0.24	-0.22%
Cable Video + AT&T BB			-$1.15	-0.84%
Cable Video + Telco BB			-$0.28	-0.21%
Cable Video + No BB			$0.07	0.07%
AT&T Video + AT&T BB			$4.83	3.97%
Telco Video + Telco BB			-$0.18	-0.12%
No Video + Cable BB			-$0.75	-2.48%
No Video + AT&T BB			-$1.23	-2.66%
No Video + Telco BB			-$0.36	-0.90%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Simulation Results – Alternate Specifications:
w/[redacted] Video Component Marginal Cost Savings

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Alt Spec Sim Results w/ Cost Savings - All DMA®s

Table: Alternate Specification 1

Δ CS Per Household	$1.25

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$1.96	1.74%
DTV Video + AT&T BB			-$13.65	-11.18%
DTV Video + Telco BB			$2.41	2.12%
DTV Video + No BB			$2.79	3.47%
DISH Video + Cable BB			-$0.97	-0.95%
DISH Video + AT&T BB			$2.35	2.03%
DISH Video + Telco BB			-$0.52	-0.48%
DISH Video + No BB			-$0.14	-0.20%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Alt Spec Sim Results w/ Cost Savings - All DMA®s (cont'd)

Table: Alternate Specification 1

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$1.29	-1.13%
Cable Video + AT&T BB			$1.44	1.03%
Cable Video + Telco BB			-$1.44	-1.07%
Cable Video + No BB			-$1.05	-1.09%
AT&T Video + AT&T BB			-$4.71	-3.90%
Telco Video + Telco BB			-$0.34	-0.25%
No Video + Cable BB			-$0.83	-2.68%
No Video + AT&T BB			$2.49	5.41%
No Video + Telco BB			-$0.39	-0.99%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Alt Spec Sim Results with Cost Savings - All DMA®s

Table: Alternate Specification 2

Δ CS Per Household	$0.94

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
DTV Video + Cable BB	[redacted]		$3.17	2.81%
DTV Video + AT&T BB			-$10.80	-8.84%
DTV Video + Telco BB			$3.67	3.22%
DTV Video + No BB			$4.20	5.21%
DISH Video + Cable BB			-$1.00	-0.99%
DISH Video + AT&T BB			-$0.85	-0.73%
DISH Video + Telco BB			-$0.50	-0.46%
DISH Video + No BB			$0.03	0.04%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

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Alt Spec Sim Results w/ Cost Savings - All DMA®s (cont'd)

Table: Alternate Specification 2

	Pre-Merger Shares	Post-Merger Shares	Δ Price ($)	Δ Price (%)
Cable Video + Cable BB	[redacted]		-$0.99	-0.87%
Cable Video + AT&T BB			-$1.33	-0.94%
Cable Video + Telco BB			-$0.98	-0.73%
Cable Video + No BB			-$0.45	-0.47%
AT&T Video + AT&T BB			-$3.91	-3.23%
Telco Video + Telco BB			-$0.28	-0.20%
No Video + Cable BB			-$1.03	-3.36%
No Video + AT&T BB			-$0.88	-1.92%
No Video + Telco BB			-$0.53	-1.35%

Note: Percent price changes are relative to our quality adjusted hedonic price indices.

Other Attachments Redacted in their Entirety as Confidential and Highly Confidential Information