Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Annual Assessment of the Status of	)	MB Docket No. 07-269
Competition in the Market for the	)	
Delivery of Video Programming	)	

FURTHER COMMENTS OF
THE NATIONAL CABLE & TELECOMMUNICATIONS ASSOCIATION

The National Cable & Telecommunications Association (NCTA) hereby submits its Further Comments in the above-captioned proceeding.

In the Supplemental Notice of Inquiry, the Commission seeks "updated information on the impact of the bundling of video services with voice and high-speed data services on competition in the market for the delivery of video programming services to consumers."[1] As discussed below, NCTA is submitting an economic analysis with these comments that demonstrates that the cable industry's transformation "from providers of analog video services to providers of an array of advanced digital communications services,"[2] and its offering of these services on a bundled basis, have promoted competition and enhanced consumer welfare. The study finds that the benefits to consumers from the cable industry's transformation "approach[] *$35 billion annually*."[3]

The Supplemental Notice also seeks updated information on a host of other issues pursuant to the two rounds of comments and reply comments established by the Commission in this proceeding. This procedure was necessary in order for the Commission to include in its 14th

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[1] Supplemental Notice of Inquiry, ¶ 13.

[2] M. Pelcovits & A. Ferguson, MiCRA, "Benefits to Consumers from the Transformation of the Cable Industry" (2009) ("MiCRA"), Attachment A to these comments, at iii.

[3] *Id.*

video competition report to Congress not only data for the most recent year but also data for the intervening two years since issuance of the most recent report. In its initial Notice of Inquiry, the Commission asked for data as of June 30, 2007. The Supplemental Notice of Inquiry asked, in addition, that, where possible, data as of June 30, 2008 be supplied along with the 2007 data in the first round of comments and that data as of June 30, 2009 be supplied in this second round of comments.

In compiling the requested statistical information each year, NCTA relies in part on data from outside sources such as SNL Kagan and company earnings statements. Unfortunately, data as of June 30, 2009 is not yet available from those sources. Some of the information may be released in time to include it in reply comments due on August 28, 2009, and we will, in any event, provide all the data as soon as possible after it becomes available.

We do however, want to take this opportunity to address further the benefits that consumers have gained – and continue to gain – from the provision by cable operators of telephone and high-speed Internet services, in addition to video programming service. To this end, we are attaching to these comments a paper commissioned by NCTA from economists Michael D. Pelcovits and Abigail B. Ferguson of Microeconomic Consulting & Research Associates ("MiCRA"), which identifies and attempts to quantify the consumer benefits from cable operator provision of video, telephone and high-speed Internet services.

As MiCRA shows, cable's offering of these three services – on a standalone or bundled basis – in vigorous competition with telephone companies and others has resulted in enormous cost savings, lower prices and enhancement in value to consumers. And these benefits are *in addition to* the benefits that have accrued over the years from the emergence and establishment of vigorous competition from new video competitors.

First of all, the competitive offering of telephone service by cable operators has resulted in lower telephone costs for *all* consumers, whether or not they purchase telephone and television service from the same provider. MiCRA points out that in a "prior study of the effects of cable competition on voice markets, we estimated a monthly per-customer benefit of $12 from this competitive response."[4]

But the MiCRA paper also highlights, in particular, the benefits that accrue to consumers from the ability and incentive of cable operators to offer discounts to customers who purchase *more than one of the three service offerings*. In offering video, Internet access, and telephone service over their upgraded and rebuilt facilities, cable operators have strong incentives to offer such bundle discounts. As MiCRA explains:

> The marginal cost of providing an additional customer with any of the three services (voice, data, or video) is low because of the large economies of scale in deploying a wireline (or fiber-based) network. Moreover, once a customer has subscribed to one service, the marginal cost of providing that customer with a second and third service is even lower. This is true of the installation costs, since a technician can install all three services in one visit to the customer premise. It is also true for the ongoing costs of serving and billing a customer.[5]

NCTA has previously shown that when consumers purchase cable service in a bundle that also includes high-speed Internet service and telephone service – as they increasingly do – the bundled price is significantly lower than the combined price of much less robust cable, Internet access and telephone services a decade ago. As the MiCRA paper explains, this lower bundled price is beneficial not only to consumers who previously purchased all three services on a standalone basis from cable operators, telephone companies and dial-up Internet service providers, but also it is "a good deal for subscribers, because it encourages many more of them to

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[4] *Id.* at 35.

[5] *Id.* at 15.

buy additional service that they value quite highly – but not highly enough to have bought at the stand-alone price."[6]

For example, some consumers place a high value on cable television service but would only pay a little for Internet service, while others value Internet service very highly but place a small value on cable television service. By offering two or all three of its services at a bundled price, it can profitably attract all those customers who are willing to pay that *total* amount for the three services – even if it could not profitably price each of its services separately at a price low enough to attract those customers to all three services. Bundling in this way increases consumer welfare. It enables customers to purchase services at a price that is lower than the amount that they would be willing to pay for the services.

It is only when the services are offered together at a single package price that these benefits of "reducing heterogeneity in customer valuations"[7] can be realized. That's why it makes no sense to complain, as Montgomery County, Maryland does in this proceeding, that consumers would be even better off "if they could pay the discounted rates for *each* service from *different* providers."[8]

Montgomery County suggests that because consumers who want to take advantage of the price benefits of bundling are required to purchase the particular bundles offered by cable operators or their competitors and cannot pick and choose the services and levels of service to be included in their bundles, "bundling does not advance competition"[9] and does not provide consumers with significant competitive benefits.[10] But as MiCRA explains, bundling in order to

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[6] *Id.* at 16.

[7] *Id.*

[8] Montgomery County, Maryland Comments at 14 (emphasis added).

[9] *Id.* at 12.

[10] *Id.* at 12-15.

maximize value for consumers not only generally advances competition but is a hallmark and manifestation of the vigorous competition that now exists among broadband providers.

Economic modeling shows that "price competition is more intense and consumer welfare is often substantially larger when sellers are allowed to bundle, in contrast to a situation when they can commit to selling all products only on an a la carte basis."[11] Specifically, according to MiCRA, if cable operators and phone companies could not use bundling in order to appeal to customers with different relative valuations of cable, Internet and phone service, each might be more likely to seek to occupy its own market niche, "which could . . . soften price competition."[12]

The MiCRA paper explains (in much more detail than is summarized here) all the ways in which the cable industry's provision of digital video, Internet and telephone services and its offering of these services on a bundled basis, have promoted competition and enhanced consumer welfare. Moreover, using econometric methods described fully in its paper, MiCRA also has attempted to *quantify* these benefits. And it has estimated them to be enormous *–$34.9 billion annually*.[13]

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[11] MiCRA at 19.

[12] *Id. See also* Verizon Comments at 10; AT&T Comments at 6-7.

[13] MiCRA at vi, 36.

This is a success story that Congress could hardly have imagined when it worried about the absence of video competition in 1992 and when it sought to encourage cable operators and telephone companies to enter each other's core businesses in 1996.

Respectfully submitted,

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Attachment A

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Benefits to Consumers from the Transformation of the Cable Industry

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July 29, 2009

* This report was commissioned by the National Cable & Telecommunications Association. The methodology, analysis, and conclusions are the authors' own.

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Benefits to Consumers from the Transformation of the Cable Industry

Executive Summary

Over the past ten years, the cable companies have transformed themselves from providers of analog video services to providers of an array of advanced digital communications services. This transformation required the cable industry to make massive investments in modern digital distribution networks, spending nearly $130 billion since 1998, and over $145 billion since passage of the 1996 Telecommunications Act. Consumers can now choose among a wide variety of products and bundles of services, including digital high-definition video, high-speed data, and digital voice. A typical cable subscriber in 1998 paid $27.00 ($37.00 in 2008 dollars) for a few dozen television channels (composed primarily of local broadcast television, local public, educational and governmental ("PEG") channels, superstations, and a handful of cable networks). In 2008, this same subscriber could purchase a suite of services, for approximately $100 per month, which included digital voice service, high-speed data service, and digital video service offering hundreds of channels of increasingly popular cable network programming, high-definition video quality, and large libraries of on-demand programs.

This paper examines the practices of the cable industry and attempts to respond to certain inquiries by policymakers. Foremost among these questions is whether the transformation of the cable industry over the past decade has benefited consumers, and if so, whether these benefits can be quantified. In sum, we find that consumers have benefited *enormously* from the cable industry's investment in infrastructure and development of new digital services. In fact, we estimate that the total benefits to all U.S. consumers are now approaching $35 billion annually.

Cable companies offer discounts to consumers who purchase multiple services. Increasingly, their subscribers are purchasing these service bundles, with the triple-play of video, data, and voice services gaining in popularity. Economic reasoning aptly explains how bundling by the cable industry benefits consumers. Essentially, bundling enables a service provider to increase total subscription to all of its services by attracting consumers that have a high willingness-to-pay for some components and a lower, but still significant, willingness-to-pay for other services.

For example, a three-product bundle priced at $120 per month may attract two customers, Customer A and Customer B, who attach different values to the three components. Assume, for instance, that Customer A values video service at $55 per month, data service at $30 per month, and voice service at $45 per month. We further assume that Customer B values the components at $50 for video, $50 for data, and $30 for voice. The value of the bundle to each customer exceeds its price. If, however, the cable company did not offer the bundle and simply offered the individual components at $40 each, Customer A would buy only video and voice services and Customer B would buy only video and data services. This would make the consumers and the cable company worse off, since potential subscribers would be deterred from buying services for which their willingness-to-pay exceeds the marginal cost.

Consumers also benefit from competition for bundles between traditional cable companies and the local exchange carriers (e.g., Verizon and AT&T). Economic theory demonstrates how rivals for multiple products will compete more vigorously with bundles than they would if each product or service was sold solely on an unbundled basis.

To measure how consumers fare under the current regime, we employ complex and sophisticated models of service bundling. These models estimate "consumer surplus" as a function of the level of prices and market shares of components and bundled services sold by the cable companies. Consumer surplus is the method used by economists to measure the total

benefits to consumers from their consumption of a product or service, net of their total expenditures. Our first model analyzes consumer surplus in a two-good world composed of video and data services. Results are stated in terms of the change in consumer surplus between the "old" world of analog services and the "new" world of digital services offered by the cable companies. Consumers are divided into "cohorts" corresponding to the services ordered in the "old" and "new" worlds. As shown in the table below, the surpluses range from $6.00 per month for subscribers to analog video service in both the old and new worlds to $30.25 per month for subscribers that upgrade from analog video service in the old world to digital video and digital high-speed data in the new world. The average benefit across all types of cable subscribers is $20.15 per month.

Two-Good Model: Average Change in Consumer Welfare
Using Adjusted Real Prices (2008)

Cohort	Share of Customers	Per Customer Monthly Change in Consumer Surplus
#1: Analog Cable Service	22.7%	$6.00
#2: High-Speed Cable Service	19.7%	$17.22
#3: Digital Video Service	18.0%	$18.67
#4: Bundle of Digital Video/High-Speed Data	39.7%	$30.25
Average (weighted)	100.0%	$20.15

Our second model adds voice service to the other two services and captures the economic benefit from three-product bundling. The addition of voice service to the suite of services offered by the cable companies increases the average cable subscriber's surplus (relative to 1998) by $32.65 per month, compared to $20.15 per month from the two-good

model. This higher level of surplus confirms and reinforces the finding from a prior study by MiCRA that estimated the benefits to consumers from cable competition in voice markets.[*]

In addition to the direct benefits experienced by the traditional cable companies' customers, competing firms' subscribers also benefit from the vigorous competition between the rival firms. In particular, the incumbent local exchange carriers (ILECs) have been forced to compete aggressively to retain old customers and attract new customers for voice and data services. We estimate that the total benefit to all U.S. consumers flowing from the transformation of the cable industry over the last ten years to be $34.9 billion annually.

Along with analyzing the economy-wide benefits, we also examine how these benefits are distributed across income classes. It is well-recognized that broadband data services have penetrated upper-income households much more quickly than lower-income households. Recently, however, penetration rates for lower-income households have increased substantially, reaching close to 50% in the geographic areas (zip codes) with the lowest median household incomes. This demonstrates that the cable industry's investments in digital technology are benefiting Americans of all demographic classes. Subscription to the cable companies' voice services is more evenly distributed across households with penetration rates among households that subscribe to other cable services ranging from 21.4% to 28.9% across the entire distribution of geographic markets divided into ten groups ranked by median household income.

The findings of this paper are highly relevant to the issues facing policymakers today. These principal findings are:

- Consumers as a whole have unequivocally benefited from the transformation of the cable industry over the past ten years and its investment and entry into voice and high-speed data markets. The benefits can be attributed to the cable industry's massive investments in deployment of advanced communications

[*] *Consumer Benefits from Cable-Telco Competition,* Michael D. Pelcovits and Daniel E. Haar, November 2007, http://www.micradc.com/news/publications/pdfs/Updated_MiCRA_Report_FINAL.pdf

infrastructure, which enable provision of new digital video, data, and voice services.

- Bundling has increased penetration of cable's new digital services and benefited the industry and consumers. The industry benefits from its ability to exploit economies of scale and scope in the provision of digital services to the home. Consumers benefit from the advantageous lower prices for the bundles.
- The cable industry's investments in digital technology are benefiting Americans of all demographic classes.

Benefits to Consumers from the Transformation of the Cable Industry

Introduction and Background

The cable industry of today bears little resemblance to the cable industry of the twentieth century. As recently as 1998, nearly all of the cable industry's customers subscribed only to analog video service. Today, even though the size of the industry's customer base is about the same as earlier, the majority of the customers have chosen to buy more than one service from their cable provider. Approximately sixty percent of the cable industry's video customers also buy high-speed data service, and nearly one-third of their customers buy a "triple-play" bundle of video, data, and voice service. The quality of video service provided to most cable customers also has improved significantly. A large and increasing majority of customers subscribe to digital video service, which offers hundreds of channels, high-definition television, and huge libraries of on-demand video programming.

The cable industry made huge investments to transform itself in the face of increased competition for all these services from direct broadcast satellite ("DBS") companies, incumbent local exchange carriers (ILECs), digital broadcast television, DVD rental, and the Internet. In almost all geographic markets, the cable industry faces competition for video service from DBS, and for voice and high-speed Internet service from the ILECs. Increasingly, the ILECs are also competing for video service using upgraded fiber and wireline facilities. For example, Verizon added one million FiOS TV customers in the past year alone to reach a total of 2.2 million TV subscribers, and now offers triple-play bundles to 30 percent of the households in its network footprint.[2]

The transformation of the cable industry over the past ten years has conferred enormous consumer benefits. It is hard to imagine that consumers would prefer to return to the "good old days" of low-definition analog cable television, dial-up Internet service, and monopoly local phone service. And even customers who have retained analog cable service

[2] Verizon Communications Investor Quarterly 1Q 2009, April 27, 2009.

receive benefits such as improved cable network programming, which now attracts a majority of Americans' viewing time. In recent years, the FCC has overlooked all of these consumer benefits, and instead has reported that video prices have been rising to the detriment of consumers.[3]

This report is not a direct rebuttal to the FCC's Report, but rather aims to fill an information void. Such information is essential to the Commission's effort to report accurately on the prices that consumers are paying for cable video service, as well as to assess fully the changes in the level of competition in video markets. Rather than judging cable companies as frozen in time, we examine how the industry serves its customers today and ask whether customers have benefited from the transformation of the services delivered. In short, we attempt to measure the consumer benefit from changes over time in the quality and quantity of cable industry services. Since the majority of customers subscribe to at least one digital service (i.e., video, data, or voice), it is necessary to estimate the value consumers attach to these services compared to the alternatives that were available as recently as ten years ago. This is a difficult task, in large part due to the widespread subscription to service bundles, which now account for a large and growing share of the cable industry's customers. Consumption of bundles complicates the task of measuring consumer benefits, because the value of the individual components of the bundle cannot be readily observed or inferred from the prices charged for the bundle. Therefore, to measure the benefits generated by these bundled services, we have employed more sophisticated and stylized economic models. This paper presents the results of these models. The goal of the modeling is to estimate the <u>change</u> in consumer benefits over the past ten years accruing to the more than 60 million residential subscribers to cable service.

Consumers in the markets served by the cable industry also benefit, even if they choose to purchase services from other companies. The cable industry's investment in new technology, which enabled its entry into new markets, has forced incumbent firms to invest in new technology and to set more competitive prices. This impact has been felt most strongly in the local voice markets, which were closed to competitive entry for a long period of time. It has also

[3] FCC, *Report on Cable Industry Prices*, MM Docket No. 92-266, January 16, 2009 (hereafter "FCC Report on Prices")

stimulated the traditional telephone companies to enter video markets, and to improve the quality of high-speed data services, in order to compete with the cable companies across-the-board, all of which benefits consumers.

We believe our research provides useful and important information that is responsive to a number of policy questions concerning the role of the cable industry in today's communications and information markets, including the following:

1. Have consumers as a whole benefited from the transformation of the cable industry over the past ten years?
2. Have consumers benefited from the availability of bundled offerings from cable companies?
3. Are the benefits from new services and new service bundles shared across all demographic groups?
4. Have consumers been harmed by the increase in the nominal price of stand-alone analog video services?

The report is organized as follows. First, we describe how the cable industry has been transformed over the last ten years from a technological and business standpoint, as well as from the vantage point of the consumer. Then, we provide an overview of the economics of bundling and explain the methodology used to model the demand for the cable bundles. After presenting the results of our model, we analyze whether the benefits are shared widely across demographic groups. Finally, we present the policy lessons that can be learned from our economic analysis.

Transformation of the Cable Industry

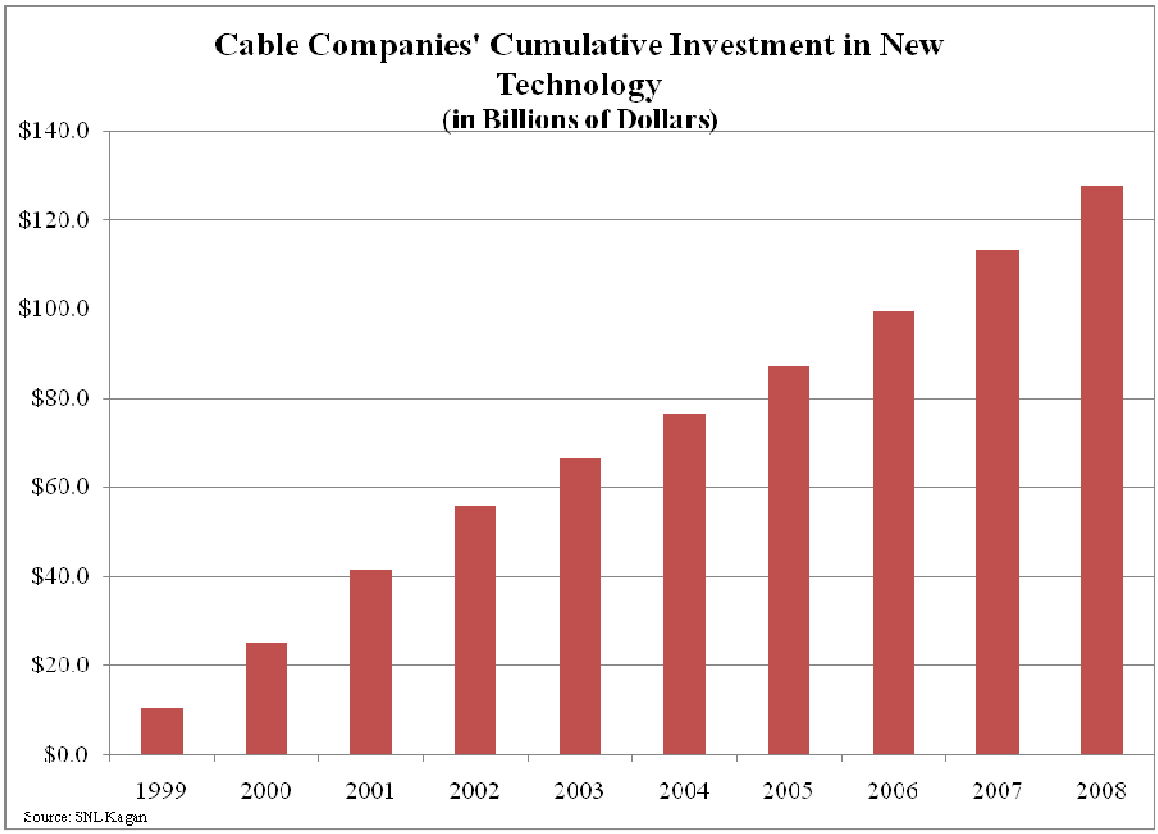
The cable industry has largely reinvented itself over the last ten years by investing nearly $130 billion in digital networks. Analog coaxial cable systems and networks have been replaced by digital hybrid-fiber-coax ("HFC") systems, which enable cable companies to provide an entirely new menu of services. We describe these changes in brief and then provide data on the changes in subscribership to the different service offerings of the cable companies.

Investment, Technology, and Capabilities of the Cable Industry

Prior to the mid-1990s, the cable industry operated coaxial cable systems, which connected the cable company's video programming equipment located at the cable head-end to all subscribers using coaxial cable. The channel capacity of these systems was limited by the spectrum capacity of the coaxial cable – generally not more than 750MHz -- and the substantial size of the spectrum used by each analog channel -- 6 MHz. The hypothetical maximum of these systems was approximately 120 channels, but most systems provided fewer channels.

The cable industry invested heavily over the last ten to fifteen years to transform itself from a one-way analog video provider to a provider of multiple services over a two-way digital broadband platform capable of providing voice, video, and high-speed data services. As shown in *Figure 1* below, investment was at least $10 billion in <u>each</u> of the last ten years. Total investment during this period was $129 billion.

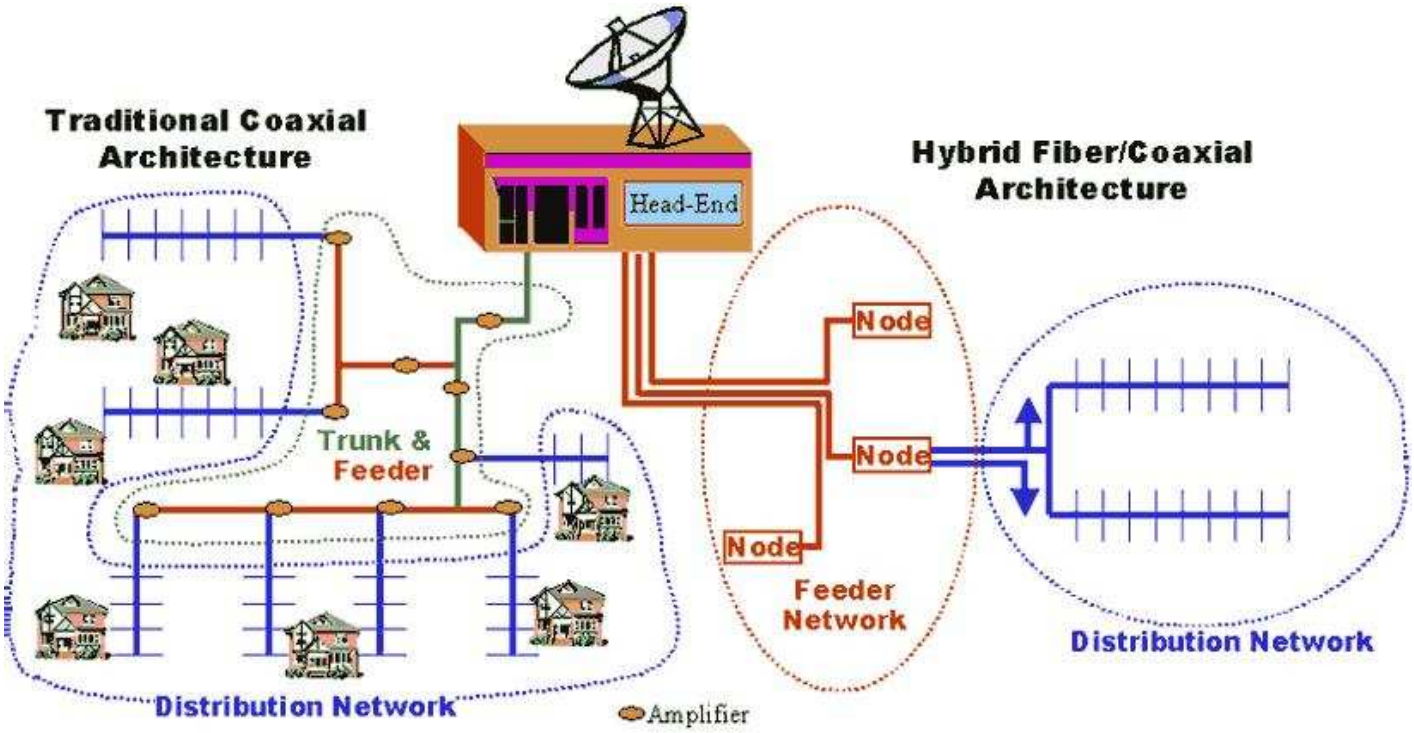
Figure 1



The primary purpose of these investments was to convert cable systems to digital hybrid-fiber-coax ("HFC") systems. To accomplish this objective, the industry laid fiber optic cable to neighborhood nodes, each serving about 500 homes, and installed new electronics throughout the network. This required the installation of hundreds of thousands of fiber nodes nationwide.[4] *Figure 2* below depicts the basic elements of the old versus the new cable system transmission architecture.

[4] Comcast, the largest cable system in the nation, has 115,000 fiber nodes in its network. See, Thomson StreetEvents, "CMCSA - Comcast Corporation at UBS Global Media and Communications Conference, Final Transcript," December 8, 2008.

Figure 2



The new cable system architecture is capable of providing -- in addition to conventional analog video channels -- hundreds of digital television channels, including many in high-definition. While the old transmission architecture provided only one-way broadcast service, the new HFC system is digital and provides two-way communications. This requires the system components to direct unique digital information streams to the right customer. For example, a voice "packet" traveling on the HFC system must be sent only to the subscriber that is part of the conversation. The transformation of a "broadcast" distribution network into a "narrowcasting" distribution network enables cable companies to provide a host of new services, including video-on-demand, high-speed data, and digital voice.

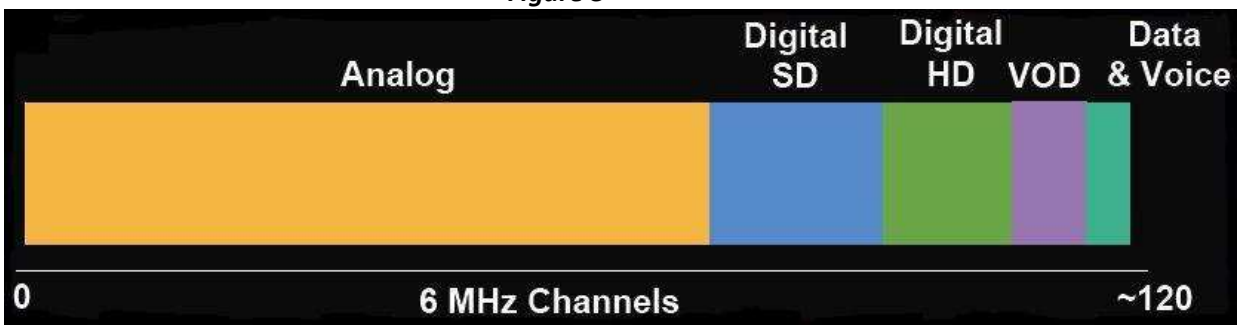
The changes in the technology used in cable systems have enabled the companies to offer data services at ever-increasing speeds and functionality. The industry standard, developed by CableLabs and deployed in almost all cable systems, is termed Data Over Cable Service Interface Specification (DOCSIS). The first version (DOCSIS 1.0) was issued in 1997 and

made the interoperability of cable technology a reality for cable operators and cable subscribers. By providing an open specification that allowed many manufacturers to produce cable modems, the price of cable modems fell from $500 to $50. Later developments enabled cable operators to configure service quality guarantees on data rates. DOCSIS 2.0 increased upstream throughput to 30 Mbps. The most recent standard, DOCSIS 3.0, is being deployed widely and will allow cable providers to provide data rates in the hundreds of megabits, and potentially, gigabits per second.[5]

Efficiency Issues with the New Cable System Architecture

The cable industry's investment in new technology has not eliminated scarcity of available bandwidth. More than one-half of the spectrum available on a modern cable system's coaxial distribution cable is still utilized by a relatively small number of analog channels, compared to the hundreds of digital channels, high-speed data services, and voice services using the other half of the spectrum (see *Figure 3* below).[6] Consequently, cable companies have been constrained regarding the quantity and quality of digital services that they can offer to customers.

Figure 3



Cable companies are developing new methods to increase the capacity of their digital systems. Nevertheless, the capacity currently used by analog channels could be used to increase capacity greatly for a wide range of digital services valued by a growing number of consumers. This implies that the opportunity cost of analog cable service has become quite

[5] CableLabs, *DOCSIS – Project Primer, http://www.cablemodem.com/primer/*

[6] Figure 3 is adapted from Comcast Corporation, Presentation at UBS Global Media and Communications Conference, December 8, 2008., http://www.cmcsk.com/phoenix.zhtml?c=118591&p=irol-eventarchives2008

large, which should over time lead to an increase in the relative price of analog cable service. Though we do not observe an increase in these prices (in inflation and quality-adjusted terms), we believe such an increase would be fully consistent with economically efficient behavior in a fully competitive market, not an indication of the exercise of market power. Therefore, policymakers should not be alarmed or concerned if the price of analog video service increases in the future. Indeed, a price restructuring would reflect the effect of competition forcing a firm to align its price structure more closely with its underlying cost structure. It would be unwise to attempt to thwart these competitive forces by imposing regulations to maintain analog rates that do not reflect opportunity costs.

Subscriber Data

There have been three major trends in the pattern of cable subscription over the last ten years. First, digital video is rapidly supplanting analog video as the primary service supplied to customers. As shown in *Figure 4* below, digital video has increased from less than one million subscribers in 1998 to over forty million in 2008, representing almost two-thirds of all video subscribers. The second trend is the rapid growth in high-speed data subscribers. The cable industry pioneered competition in high-speed data markets and now provides high-speed data service to forty million subscribers over broadband facilities. Subscriptions to high-speed service grew rapidly beginning in the late 1990s and continuing to the present. Third, subscriptions to cable voice service grew rapidly starting in the year 2004. Prior to this time, cable systems offered voice service that used circuit-switched technology. Cox was unique among the major cable companies in aggressively pursuing a voice strategy using circuit-switched technology in most major markets. The roll-out of IP-based digital voice service, which provides a more efficient means of providing voice service, has led all of the major cable companies to offer voice service (or, in the case of Cox, expand its substantial offerings). Cable phone service has grown by leaps and bounds in the last three years and is now provided to nearly thirty percent of cable subscribers.

Figure 4
Total Cable Customers
(in Millions)

Year	Total Video Customers	Digital Video Customers	Cable Phone Customers	High-Speed Data Customers
1998	65.1	1.4	0.1	0.5
1999	65.9	4.9	0.3	1.5
2000	66.6	8.5	1.0	4.0
2001	66.9	14.5	1.5	7.3
2002	66.1	19.3	2.5	11.6
2003	66.0	22.5	3.0	16.5
2004	65.4	25.4	3.8	21.4
2005	65.4	28.5	5.9	26.1
2006	65.4	32.6	9.5	31.1
2007	64.9	37.1	15.1	35.7
2008	63.7	40.4	19.6	39.3

Sources:

SNL Kagan; National Cable & Telecommunications Association; FCC High-Speed Services for Internet Access Report, 10/07; FCC Statistical Report on Average Rates for Basic Service, Cable Programming Service, and Equipment, 1/09.

Cable companies provide a variety of options for each service and bundle. Bundled services are priced between $5.00 and $50.00 lower than the sum of the prices of the components. Promotional prices are also common. As an example of the discount structure prevailing in the industry, we have reproduced a menu of services offered by Cox Communications in Orange County, California in *Figure 5* below.[7] All of these packages include video, data, and phone service. The quality of each service varies across each of these packages, ranging from a "good" bundle of analog video, basic phone service, and 1.5Mbps data service to a "best" bundle of digital HD video service with premium channels and equipment, full-featured phone service with unlimited calling, and 25 Mbps data service.

[7] The bundles of other major cable companies are summarized in the Appendix.

Figure 5

Cox Bundles - *pricing effective 03/1/2009*

	GOOD	BETTER	BEST	EVERYTHING
Standard Price	$92.53	$125.98	$163.33	$210.28
Monthly Bundle Price	**$87.53**	**$115.98**	**$148.33**	**$185.28**
Monthly Bundle Savings	**$5.00**	**$10.00**	**$15.00**	**$25.00**
Yearly Bundle Savings	**$60.00**	**$120.00**	**$180.00**	**$300.00**
TV				
Standard Cable	✔	✔	✔	✔
Digital Cable		✔	✔	✔
Digital Programming Packages - Discovery Network Channels. Tiers: Movie, Family & Variety, Sports & Info or Paquete Latino			1	3
DVR Service			HD-DVR	HD-DVR
High Definition Service with HD Plus HD Plus includes HDNet, HDNet Movies & HD Theater				✔
Premium Services Choose from HBO, Cinemax, Showtime or Starz				2
Digital Receiver		✔	✔	✔
PHONE				
One Phone Line - Zone 3 calls included	✔	✔	✔	✔
Calling Features Package		Active Lifestyle	Active Lifestyle	Solutions
Long Distance		✔	✔	✔
Unlimited Long Distance			✔	✔
INTERNET				
Value Service - (1.5Mbps/256kbps)	✔			
Preferred Service - (12Mbps/1Mbps - with PowerBoost)		✔	✔	
Premier Service - (25Mbps/2Mbps - with PowerBoost)				✔
Spam, Virus, Email Protection	✔	✔	✔	✔

Source: http://ww2.cox.com/residential/orangecounty/pricing-and-special-offers/bundle-pricing-and-plans.cox

High-speed data subscribers of cable companies are also provided with many valuable functions and features included with the companies' high-speed data service. Time Warner Cable provides its Road Runner customers with complete Internet Security Suite Software, which includes firewall, anti-virus, anti-spyware, and anti-spam protection, with free product updates and upgrades.[8] Cable companies also provide many new features as free or add-on components to their digital video services. For example, Time Warner Cable provides a new free digital cable feature called "Start Over" service. Start Over allows viewers to restart a show already in progress, without the use of any equipment other than the existing digital cable set-top box.[9] These features add significant value, which increases the demand and level of subscribership to these digital services and digital service bundles.

We are unaware of any public sources that provide the percentage of cable customers that subscribe to different bundles, e.g., analog video plus phone. Some cable companies disclose the percentage of customers subscribing to single-product, double-product, and triple-product bundles, but do not provide a further breakdown of subscribership by the exact type of bundle. This makes it difficult to estimate the impact on consumers of the decade-long transformation of the industry. For purposes of this analysis, however, we have been provided detailed data on the breakdown of the services provided by the three largest cable companies, Comcast, TWC, and Cox, which serve collectively about two-thirds of the total customer base nationwide. In *Figure 6* below, we present aggregate data on subscribership to different services over the past two years.

[8] http://www.timewarnercable.com/nynj/learn/hso/compareisps.html
[9] http://www.timewarnercable.com/nynj/learn/cable/startover.html

Figure 6

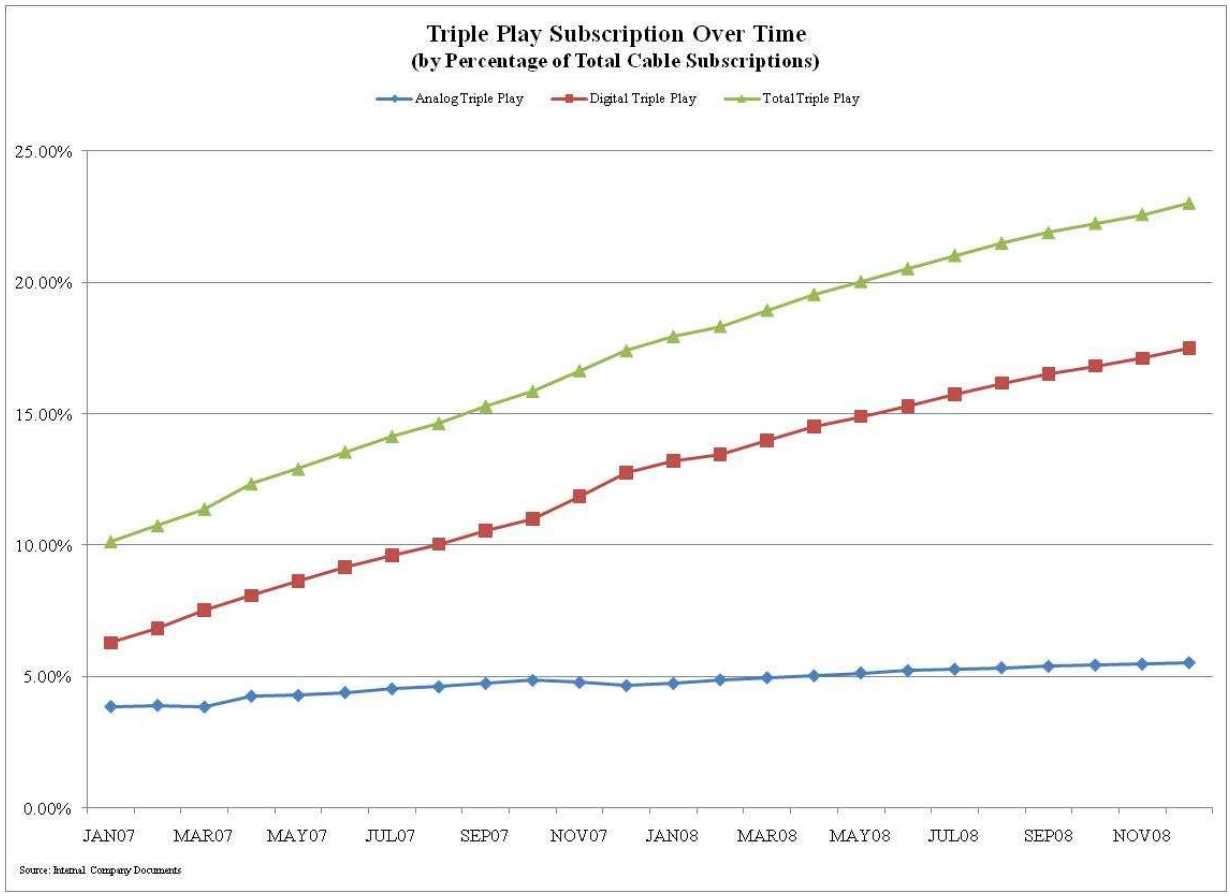
Percentage of Cable Customers to Different Cable Packages

Type of Package	Jan-07	Dec-08
Single Component Customers		
Analog Video Only	34.71%	21.04%
Digital Video Only	16.69%	16.42%
High-Speed Data	5.19%	5.47%
Cable Digital Phone Service	0.34%	0.46%
Total Single Component	**56.92%**	**43.39%**
Two- Product Bundle Customers		
Analog Video + High-Speed Data	16.71%	13.01%
Digital Video + High-Speed Data	13.92%	16.68%
Analog Video + Cable Digital Phone Service	1.08%	1.15%
Digital Video + Cable Digital Phone Service	0.68%	1.53%
Cable Digital Phone Service + High-Speed Data	0.54%	1.23%
Total Two- Product Bundle Customers	**32.94%**	**33.60%**
Three- Product Bundle Customers		
Analog Video + High-Speed Data + Cable Digital Phone Service	3.86%	5.52%
Digital Video + High-Speed Data + Cable Digital Phone Service	6.28%	17.49%
Total Three- Product Bundle Customers	**10.14%**	**23.01%**

Source: Internal Company Documents
Note: Totals above may not appear to compute due to rounding.

This data set, though covering a relatively short period of time, provides powerful insights into the trend of services subscribed to by cable customers. Customers are shifting at a rapid pace from single services to multiple services and from older technology to newer technology. We take note of two measures of this shift. The first is that subscriptions to analog video, either on a stand-alone basis or sold along with other components, have fallen rapidly in less than two years from 56% to 41% of the total subscriber base. The second is that subscriptions to the triple-play of digital video service, high-speed data service, and cable digital phone service have grown at a rapid pace during this time. The trend line for triple-play service is shown in *Figure 7* below.

Figure 7



The evidence presented here demonstrates a sea change in the nature of the relationship between the cable companies and their customers. The popularity of bundles means that any estimate of how changes in the cable industry (and the development of competition in the markets where the industry operates) affect consumer welfare can only be measured with a multi-dimensional yardstick.[10] It is no longer meaningful to compare the price of only a single component at two points in time. Conducting a more complex analysis requires the use of more sophisticated economic modeling tools than are typically used to assess the performance and competitiveness of the cable industry. We believe, however, that the use of these tools gives a more thorough and complete understanding of the well-being of the cable companies' customers.

The tools relied on here enable us to measure the change in consumer surplus, which is defined as the total value to consumers from consumption of a product net of the consumer expenditures on this product. Consumer surplus is the most widely used measure of consumer welfare, and the change in consumer surplus between two different points in time (or scenarios) is a reliable measure of how markets are performing. Such an analysis enables a much more informed judgment of whether the structural and behavioral changes in the market have benefited consumers, or alternatively, whether changes in regulatory policy are needed to redirect the course of the market.[11]

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[10] Consumer welfare refers to the individual benefits derived from the consumption of goods and services. See, *Glossary of Industrial Organization Economics and Competition Law,* complied by R. S. Khemani and D. M. Shapiro, commissioned by the Directorate for Financial, Fiscal and Enterprise Affairs, OECD, 1993.

[11] We use both the terms consumer welfare and consumer surplus in the rest of this report. Consumer welfare refers to the concept of consumer benefits; consumer surplus refers to the actual measurement of consumer welfare.

Bundling theory and measurement of benefits

Why Firms Bundle

Telecommunications companies are increasing the promotion and sale of bundled services. Cable companies, the subject of this report, bundle video, data, and voice service, and compete vigorously with the ILECs, which also bundle the same three services, along with a fourth service -- wireless -- in many cases. For example, Verizon is now promoting a bundle of three FiOS services for just $99.99 a month. The bundle includes "245 all-digital video and music channels, over 14,000 On Demand titles per month, with 1,200 titles in HD", Internet with speeds of 10 Mbps, and unlimited residential calling anywhere in the United States, with three popular calling features.[12] Verizon is even sweetening the pot with $150 cash back and a two-year price guarantee. Clearly, consumers are on the winning side of the rivalry between traditional cable companies and the ILECs.

The popularity of service bundles among providers can be explained by supply and demand factors. The marginal cost of providing an additional customer with any of the three services (voice, data, or video) is low because of the large economies of scale in deploying a wireline (or fiber-based) network. Moreover, once a customer has subscribed to one service, the marginal cost of providing that customer with a second and third service is even lower. This is true of the installation costs, since a technician can install all three services in one visit to the customer premise. It is also true for the ongoing costs of serving and billing a customer. This means that the network provider has a powerful incentive to attract as many customers as possible to as many services as possible, even those customers with relatively low willingness to pay for an individual service. Simply stated, a small positive profit margin from a new customer is better than no margin at all from a consumer who does not subscribe.

[12] Letter from Geoff Walls, Executive Director, Consumer Marketing, Verizon to Michael D. Pelcovits, received March 25, 2009.

Another widely noted factor is that bundled-service subscribers may be "stickier" than single-service subscribers. Considering the high cost of acquiring a new customer, the cable companies and the ILECs have a powerful incentive to sign up a customer for a bundle in order to reduce customer churn.

Consumers also benefit from bundling, although the impact of bundling on consumers will depend on many factors. It is beyond the scope of the paper to disaggregate the total change in consumer welfare over the last ten years into two separate components: the benefits from the introduction of new services versus the benefits from the act of bundling per se. This would require us to construct a hypothetical world where the cable companies (and ILECS) were not allowed to give any discounts on bundles of services, but were otherwise allowed to set their own prices. This is an interesting theoretical exercise, but not very practical, absent a compelling public policy reason to consider such sweeping regulatory intervention into the pricing practices of the traditional cable companies and their ILEC competitors.

Although it is difficult to attribute the precise benefits to consumers from bundling per se, we believe that bundling is very beneficial to cable subscribers. Bundling plays an important and valuable role and increases consumer welfare by increasing the level of subscribership to the different services offered by the cable companies (and the ILECs). This increase in output is unambiguously beneficial, because the marginal cost of these services is very low. So long as the marginal price of these services exceeds marginal cost, there will be an increase in consumer welfare as a result of the increase in subscribership. Simply put, bundling by cable companies is a good deal for subscribers, because it encourages many more of them to buy additional service that they value quite highly – but not highly enough to have bought at the stand-alone price.

Bundling increases subscribership by reducing heterogeneity in customer valuations. If some customers are willing to pay a lot for one product and others are willing to pay a lot for a different product, then bundling can be used to provide both types of customers with a

compelling offer to purchase both products. This point is most easily understood through an example of a theater company selling tickets to multiple productions.[13]

Figure 8
Bundling Illustration
Theater Patrons' Willingness to Pay

Patron Type	Play	
	Shakespeare	Shaw
I	40	20
II	20	40
III	45	10
IV	5	45

In this example, illustrated in *Figure 8* above, there are four types of customers differing in their willingness to pay for two plays -- one by William Shakespeare and the other by George Bernard Shaw. The goal of the theater company is to maximize profits and attract as many patrons as possible to the two productions.[14] If the theater company charges one price for each production to all of its customers, its optimal price is $40. Assuming only one patron of each type, this will generate $80 from each production for a total of $160, since only two patrons will attend each production (i.e., Patrons I and III to Shakespeare and Patrons II and IV to Shaw).

By bundling tickets to the two plays into a season subscription, the theater will increase attendance, revenue, and profits. The theater company's bundling practice benefits consumers significantly, by attracting more patrons to attend more plays than they would have if the bundle subscription option were not offered. By setting the bundled subscription price at $50 for the two productions, the theater will attract all four patrons to both productions, since all

[13] This example is adapted from Brandenburger and Krishna, Harvard Business School case study 9-191-177, "Bundling" (1990, cited by Barry Nalebuff, DTI Economics Paper No. 1, "Bundling Tying, and Portfolio Effects," February 2003.

[14] We assume for purpose of this example that the theater company incurs no marginal cost of filling empty seats in the theater. Although the calculation of profit maximizing prices would be different for a firm with positive marginal cost, the analysis would still demonstrate that bundled pricing would maximize profits and increase subscribership.

patron types have a combined willingness-to-pay for the two productions of at least $50. This will generate $200 ($50 times four subscriptions) in total revenue. The theater company will be more profitable and the plays will be better attended.

We can quantify the increase in consumer welfare as follows. Total consumer surplus increases from $10 under the single price regime to $25 under the bundling regime. Consumer surplus is the difference between willingness-to-pay and price. In the single price regime, patrons III and IV buy tickets for $5 less than their willingness-to-pay, which yields a total of $10 in consumer surplus. In the bundling regime, patrons I and II will each pay $10 less than their willingness-to-pay for the bundle, and patron III will pay $5 less than his willingness-to-pay. Patron IV will pay an amount exactly equal to his willingness-to-pay. Total consumer surplus will thus increase to $25 ($10+$10+$5).

This stylized example demonstrates how a single seller can use bundling to increase its sales and its profits, by matching prices more closely to the consumers' willingness-to-pay for its services. It further demonstrates how consumers and the seller can all benefit from that arrangement. This example does not explain all of the factors that affect the cable operators' or the ILECs' pricing practices. There are many dimensions to the prices of these companies' services that reflect costs and demand characteristics, including usage, video content, and bandwidth. It would not be privately beneficial or socially optimal to eliminate pricing variations that reflect these cost and demand factors.

Bundling and Competition

Product bundling is a very common practice in many competitive industries. For example, restaurants offer prix fixe meals at a discount relative to the sum of the price of the individual courses on the menu. Retail stores often hold sales that discount the price of a second item conditional on the customer buying the first item at full price. This constitutes a bundled price for the two items. In the vast majority of cases, these practices have no deleterious effect on competition, and have the potential to increase economic welfare.

The economics literature contains models that show how bundling can be used by a multiproduct monopolist to foreclose entry into one of the markets where it has a monopoly.[15] Conceptually, bundling could be used to reduce the profits available to a new entrant into one of the multiproduct monopolist's markets to such an extent that the potential entrant does not find it worthwhile to incur the sunk costs necessary to enter the new market. For example, Microsoft was found guilty of illegal tying behavior, in part because it bundled its web browser (Internet Explorer) for free with its operating system. This behavior was deemed to be illegal because it had the effect of preventing Netscape, which was the major web browser competitor to Microsoft, from challenging Microsoft's dominance in the operating systems market.[16] This was only possible because of the large barriers to entry into these markets and the absence of significant competition in Microsoft's core markets. These models, however, do not fit the circumstances of the retail markets served by cable companies. There is no issue of foreclosure, because cable's major competitors in these markets have already made significant investment in the market and serve a large share of the markets. Entry is a *fait accompli* in all markets served by the cable companies, and indeed in some markets, e.g., voice, the cable company is the new entrant.

It may be possible to gain insight into the role of bundling in markets served by the cable industry from the economics literature on multiproduct duopolies. Economists often derive and apply results from a model of pure duopoly to an industry with more than two firms, because of the excellent modeling properties of duopolies. According to these models, price competition is more intense and consumer welfare is often substantially larger when sellers are allowed to bundle, in contrast to a situation when they can commit to selling all products only on an individual basis. In fact, the reduction in consumer heterogeneity that benefits a monopoly seller, like the theater company, can reduce the duopoly firms' profits, because the rivals are unable to occupy market "niches," which could otherwise soften price competition. For example, if the ILEC is perceived to provide superior voice service while the cable provider is perceived to provide superior video service, price competition would be softer if the two services were sold separately than if they were bundled together.

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[15] For a survey of this literature, see: Lars A. Stole, Chapter 34, *Handbook of Industrial Organization, Volume 3,* edited by Mark Amstrong and Robert Porter, Elsevier, 2007.

[16] In the United States District Court for the District of Columbia, *Court's Findings of Fact*, United States of America vs. Microsoft Corporation, November 5, 1999.

If competing sellers do not benefit from bundling, why then do we see competition in bundling? Just as sellers of similar goods engage in price wars, each multiproduct seller may have a unilateral incentive to offer a bundle, regardless of whether its competitor follows suit. In other words, Firm A may be better off bundling its products regardless of whether Firm B bundles. Similarly, Firm B may be better off bundling its products regardless of whether Firm A bundles. If, however, bundling were impossible, both firms would be better off.[17] This is the classic 'Prisoners' Dilemma' found in the game theory literature, in which each of two accused individuals is given a choice between confessing his involvement with a crime and receiving a light penalty—and subsequently revealing the complicity of the other individual, who receives a heavy penalty—and remaining quiet. The two accused prisoners would be better off if neither confessed to the crime (both would go free or face lesser charges), but once they are put in separate rooms, each has a powerful incentive to confess to the crime. The payoff matrix in *Figure* 9 below shows the payoffs in terms of years in prison for each prisoner, contingent on his and his accused partner's choices.

Figure 9
Payoff Matrix for Prisoners' Dilemma Game

		Prisoner 2's strategies	
		Confess	Don't Confess
Prisoner 1's strategies	Confess	(5 years, 5 years)	(1 year, 10 years)
	Don't Confess	(10 years, 1 year)	(2 years, 2 years)

Note: Payoff prison terms are given as (Prisoner 1's term, Prisoner 2's term).

Comparing the prison terms for each alternative, each prisoner comes to the same conclusion: confessing is a best response to either action that his partner could possibly take, so he will certainly confess. There is no chance of reaching the best outcome for both (i.e., not confessing) unless the prisoners can mutually commit to not confessing before they enter into the separate interrogation rooms.[18]

[17] See Matutes and Regibeau (1992) and Reisinger (2003). Competition is intensified—and industry profits reduced—when consumers' willingness to pay for a given seller's bundle components is negatively correlated, as in the theater example above. Stole (2003) includes a more general survey of this literature.

[18] The nature of the mutual agreement to not confess may require an enforcement mechanism to penalize a prisoner that does not stick to the agreement.

Similarly, the multiproduct duopolists might encounter the following set of payoffs associated with their bundling or non-bundling pricing arrangements, as seen in the hypothetical example of *Figure 10*:

Figure 10
Payoff Matrix for Multiproduct Duopoly

		Firm B's strategies	
		Bundle	Don't Bundle
Firm A's strategies	Bundle	($5.00, $5.00)	($10.00, $0.50)
	Don't Bundle	($0.50, $10.00)	($7.00, $7.00)

Note: In this case, payoffs are given in terms of the firms' profits per customer.

As in the prisoners' dilemma example, a firm that chooses bundling while its rival chooses not to bundle earns greater profits than it would from following suit and not bundling, generally at the expense of the rival. Conversely, a non-bundling firm will lose profits if its rival decides to bundle. Hence, each multiproduct duopolist chooses to bundle, which is the 'dominant strategy'—so-called because this strategy is most profitable regardless of what its rival chooses.

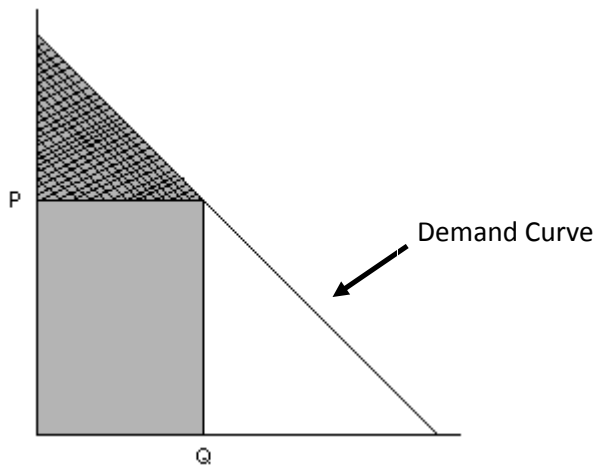
The outcome of this "game" is that total industry profits are lower ($10; $5 for each firm) than they would be if the firms could commit to not bundling ($14; $7 for each firm). The only way out of this "Prisoners' Dilemma" for the duopoly would be for an outside party – a misguided antitrust or regulatory authority – to impose a non-bundling requirement on the industry.

Measuring Consumer Benefits

The relationship of bundled pricing and consumer welfare has important implications for measuring consumer benefits -- which is a central objective of this study. Under "normal" conditions -- where a single product is sold by itself -- the surplus to consumers can be

measured by estimating the area under the demand curve. As shown in *Figure 11* below, if a quantity "Q" of a product is sold at a price "P," then “total consumer surplus” from consumption of the good is the entire shaded area between the demand curve and the price level. Consumer surplus, which is measured as total consumer benefits minus consumer expenditure, can be easily computed as the hashed triangular area under the demand curve. To estimate surplus, the economist’s task is "simply" to estimate the shape of the demand curve.

Figure 11



The corresponding demand curve for a bundle cannot be used in the same way to calculate consumer welfare. This is because the benefits we are seeking to measure are those for the components of the bundle -- not the bundle itself. And since the demand curve for the bundle can arise from a variety of demand curves for the components, we cannot simply add up the area under the demand curve for the bundled services. Rather, it is necessary to model the underlying consumer preferences for the components themselves.

Implementation and Results of the Modeling

We created a three-good model, which is detailed in the Appendix to this paper. To simplify our explanation of the model, however, we will begin with an explanation of a stylized two-good model. This model contains all of the key elements of the three-good model, and makes it easier to understand the effects of bundling on consumer welfare.

Description of the Two-Good Model

The modeling technique adapted for this paper is termed a spatial or locational model. It is commonly used to analyze consumer preferences for differentiated products. The model assumes that each consumer prefers certain products provided by one of the firms in the industry over other products, and that the preferences can be mapped to some key characteristic of the product. For example, all else being equal, a consumer will prefer to shop at a nearby store than to travel to a competing store. The consumer's willingness-to-pay more for the "better" product, i.e., the one from the closest store, will depend on how much he or she would have to travel and the cost of this travel. In our model, consumers are assumed to differ by their willingness to pay for the "higher quality" product, i.e., digital video or high-speed data. Further, we assume that preferences are uniformly and independently distributed across a single attribute for each product.

The utility of this model is that it can be used to estimate consumer welfare from different pricing scenarios. More importantly, the model enables a comparison of consumer welfare in the two periods: the pre-bundling world of 1998, and the post-bundling world of 2008. For this analysis, we assume that during the first period the only services available are analog cable and slow-speed data. In the second period, consumers can choose to purchase either of the two higher-quality products (i.e., digital video and high-speed data) or the bundle composed of both higher-quality products.

Populating the Two-Good Model

To estimate the impact of the changing cable industry on consumer welfare, we must select and compare two snapshots of the industry's customer base. We need to know prices of the service options available to the cable customers, the share of customers purchasing the different service options, and demand elasticities for digital video service and high-speed data service. Average prices and market shares were based on FCC published statistics and industry sources. As explained below, several adjustments were made to this data to fit the specifications of the models. For example, prices were adjusted for inflation and for the quality

of the video service. Demand elasticities were based on published studies of the demand for multi-channel video services and high-speed data service.

Prices for analog and digital video services were obtained from public sources and then adjusted for changes in the market between 1998 and 2008. First, we adjusted prices to account for inflation, by restating the prices for earlier years in 2008 dollars. In *Figure 10* below, the inflation adjustment yields constant dollar prices in the columns labeled "Real Analog" and "Real Digital" for each year between 1998 and 2008. This shows that in real terms the price of analog video service has increased from $37.29 to $49.65, while the price of digital video service has increased from $51.60 to $63.66.

Figure 12
MiCRA Model - Cable Prices with CPI and Viewing Hours Adjustments (per month)

Year	Analog Total Price	Digital Tier	Digital Total Price	CPI	Inflation rate multiple	Real Analog Price	Real Digital Price	Adjusted Viewing Hours	Real Price Per Viewing Hour	Real Analog Prices after VH adjustment in 2008$	Real Digital Prices after VH Adjustment 2008$
1998	$27.88	$10.70	$38.58	163.6	1.34	$37.29	$51.60	113.4	$0.329	$58.85	$73.16
1999	$28.94	$9.49	$38.43	168	1.30	$37.71	$50.08	116.4	$0.324	$58.01	$70.37
2000	$31.22	$8.42	$39.64	174	1.26	$39.33	$49.93	122.0	$0.322	$57.72	$68.33
2001	$33.75	$11.58	$45.33	178	1.23	$41.42	$55.63	129.6	$0.320	$57.22	$71.43
2002	$36.47	$10.12	$46.59	181.0	1.21	$44.09	$56.32	138.0	$0.320	$57.20	$69.43
2003	$38.95	$10.08	$49.03	185.2	1.18	$46.02	$57.93	147.7	$0.312	$55.78	$67.69
2004	$41.04	$10.72	$51.76	190	1.15	$47.29	$59.64	154.8	$0.306	$54.69	$67.04
2005	$43.04	$12.99	$56.03	199	1.10	$47.37	$61.67	163.7	$0.289	$51.79	$66.09
2006	$45.26	$13.83	$59.09	203	1.08	$48.81	$63.72	169.4	$0.288	$51.57	$66.49
2007	$47.27	$13.00	$60.27	208.5	1.05	$49.61	$63.25	174.0	$0.285	$51.03	$64.67
2008	$49.65	$14.01	$63.66	219	1.00	$49.65	$63.66	179.0	$0.277	$49.65	$63.66

Source: FCC *Statistical Report on Average Rates for Basic Service, Cable Programming Service, and Equipment; SNL Kagan.*

We also adjusted prices to reflect the change in the quality of the service over time. Cable video services of 2008 are superior to the services offered in 1998. For analog cable customers, the difference is due primarily to the increased desirability of cable network programming. Viewership of ad-supported cable programming has grown significantly over the last ten years mostly at the expense of broadcast television programming, and now exceeds the

combined viewership of all other television sources. The most recent data on ratings indicate that ad-supported cable programming's average nightly total ratings have posted a 10-ratings-points or better advantage over broadcast TV for the entire period spanning the previous 65 weeks.[19]

It is admittedly difficult to adjust for quality improvements, and it is beyond the scope of this paper to propose a new quality index. We have adopted a technique proposed by Professor Steven Wildman in earlier work done for the cable industry, where he adjusted prices for the change in hours spent viewing cable programming.[20] Professor Wildman takes the position that this adjustment for viewing hours will likely understate the actual change in the quality of the product. We have chosen, however, to adjust prices in direct proportion to the time spent viewing cable programming. This adjustment is shown in *Figure 12*, where we "inflate" pre-2008 prices to adjust for less viewing. The algorithm we adopt is to calculate the price per viewing hour in each year and then multiply the price by a constant number of viewing hours. We apply this adjustment to inflation-adjusted prices described earlier and generate a price series shown in *Figure 12* as "real analog prices 2008$ adjusted for viewing hours." We also estimate a similar price series for digital video service by adding the actual price for the digital tier to the adjusted analog prices.

Other inputs for the model were derived from a number of sources. The price for dial-up is based on estimates for dial-up service in 1998 (adjusted to 2008 prices) and for a weighted average of dial-up and DSL in 2008.[21] The prices for high-speed data service and the digital video/high-speed data services are based on observations of current cable company prices. Market shares are based on the information provided to us by the cable companies. Finally, elasticity estimates were selected based on our review of the economics literature.[22] *Figure 13* below presents a summary of the inputs used in the two-good model.

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[19] Cabletelevision Advertising Bureau, News Release, February 2, 2009.

[20] Steven S. Wildman, "Assessing Quality-Adjusted Changes in the Real Price of Basic Cable Service," September 10, 2003.

[21] The model limits consumers' choices to only two types of service for each component, e.g., high-speed data over cable or an "outside good." Therefore, we must estimate the price of the outside good based on the average of the prices of all of the alternatives to the newly-introduced services.

[22] The economics literature reports estimates of the demand elasticity for cable modem service ranging from -0.59 to -3.20. The more recent studies generate higher estimates, which should be

Figure 13
Summary of Inputs Used in Two-Good Model
(2008 Prices)

Inputs	1998	2008
Prices		
Analog Cable	$59	$50
Digital Cable	-	$64
Dial-up	$7	$10
High-Speed Data	-	$45
Bundle (Digital Video & High-Speed Data)	-	$99
Shares		
Analog Cable Only	-	23%
High Speed Data Only	-	20%
Digital Cable Only	-	18%
Bundle (Digital Video & High-Speed Data)	-	40%
Digital Video: Demand Elasticity	2.0	
High-Speed Data: Demand Elasticity	1.5	

- = not available

Results of the Two-Good Model

The model estimates the change in consumer welfare for each of four cohorts, which are defined by the services purchased in 2008. We then use the share of consumers in each

expected because cable modem service faces increased price competition from DSL and fiber optic broadband services. See: Austan Goolsbee, "The Value of Broadband and the Deadweight Loss of Taxing New Technology," Discussion paper, University of Chicago, 2006. P. Rappoport, D. Kridel, L. Taylor, "Residential Demand for Access to the Internet," Discussion paper, University of Chicago, 2003. R. Crandall, G. Sidak, and H. Singer, "The Empirical Case Against Asymmetric Regulation of Broadband Internet Access, *Berkeley Technology Law Journal 17(1),* 953-87, 2002. Recent estimates of the demand elasticity for different tiers of cable service range from -1.5 to -5.27. See, A. Goolsbee and A. Petrin, "Consumer Gains from Direct Broadcast Satellite and the Competition with Cable TV," *Econometrica*, 72(2), 351-81 (2004); T. Chipty, "Veritcal Integration, Market Foreclosure, and Consumer Welfare in the Cable Television Industry," *American Economic Review,* 91(3), 428-453 (2001); T. R. Beard, G. S. Ford, R.P. Saba, "Fragmented Duopoly: A Conceptual and Empirical Investigation," *Journal of Business,* 78 (2005); G. Crawford and Ali Yurukoglu, "The Welfare Effects of Bundling in Multi-Channel Television Markets," Working Paper (2008).

cohort – which were among the model's inputs described above – to estimate the average change in consumer welfare for the cable industry's customers. These estimates are reported in *Figure 14* below.

Figure 14
Two-Good Model: Average Change in Consumer Welfare Using Adjusted Real Prices

Cohort	Share of Customers	Per Customer Monthly Change in Consumer Surplus
#1: Analog Cable Service	22.7%	$6.00
#2: High-Speed Cable Service	19.7%	$17.22
#3: Digital Video Service	18.0%	$18.67
#4: Bundle of Digital Video/High-Speed Data	39.7%	$30.25
Average (weighted)	100.0%	$20.15

Although the methods used to generate results are complex, the logic is quite comprehensible. Consumer benefits for each cohort are a function of the prices in the two time periods, the size of the cohorts (i.e. market shares), and the demand elasticities. To take an example, the model's estimation of benefit to consumers from the introduction of high-speed data service is conceptually similar to what would be measured using a simple demand curve for the service (as shown in *Figure 11*). Consumer surplus, which is the triangular area under the demand curve, is determined by the price level, the level of output, and the slope of the demand curve (as captured by the demand elasticity). Our model uses simplifying assumptions about the shape of the underlying preference functions, but these are analogous to the assumptions that economists make about the shape of demand curves, e.g. linearity. The assumptions are needed and somewhat arbitrary, but this does not mean that the results are arbitrary, because they are narrowly circumscribed by the data observed in the market. As an additional test of the model's logic and power, we ran several simulations to test its sensitivity to the selection of various parameters, such as demand elasticity. We found that the results are not overly sensitive to these specifications.

The model's results for each Cohort are consistent with logic and common sense. Cohort #1 is composed of cable consumers who do not subscribe to either of the newly introduced products – high-speed data or digital video. The benefits are attributable solely to the decline in the real price of analog cable, adjusted for viewing hours. In fact, the monthly benefit for this cohort of $6.00 is less than the decline in the real price for analog cable (adjusted for viewing hours), as a consequence of the conservative nature of the model. Cohort #2 is comprised of cable subscribers to high-speed data service. This cohort experiences an increase in consumer surplus, resulting primarily from the introduction of high-speed data service. This service, which is priced at $45 per month, provides an increase in consumer surplus of $17.22 per month on average to these customers. A portion of this increase in consumer surplus is due to the increased value of analog cable. But the majority of the increase (in the range of $11.22) is due to the introduction of high-speed data service. Cohort #3 is comprised of cable subscribers to digital video service, whose members experience an increase in consumer surplus of $18.67. These benefits result entirely from the introduction of digital video service, since these consumers do not upgrade their data service. Finally, Cohort #4, which represents those customers that purchase the bundle of digital video and high-speed data, gains an average of $30.25 in consumer surplus.

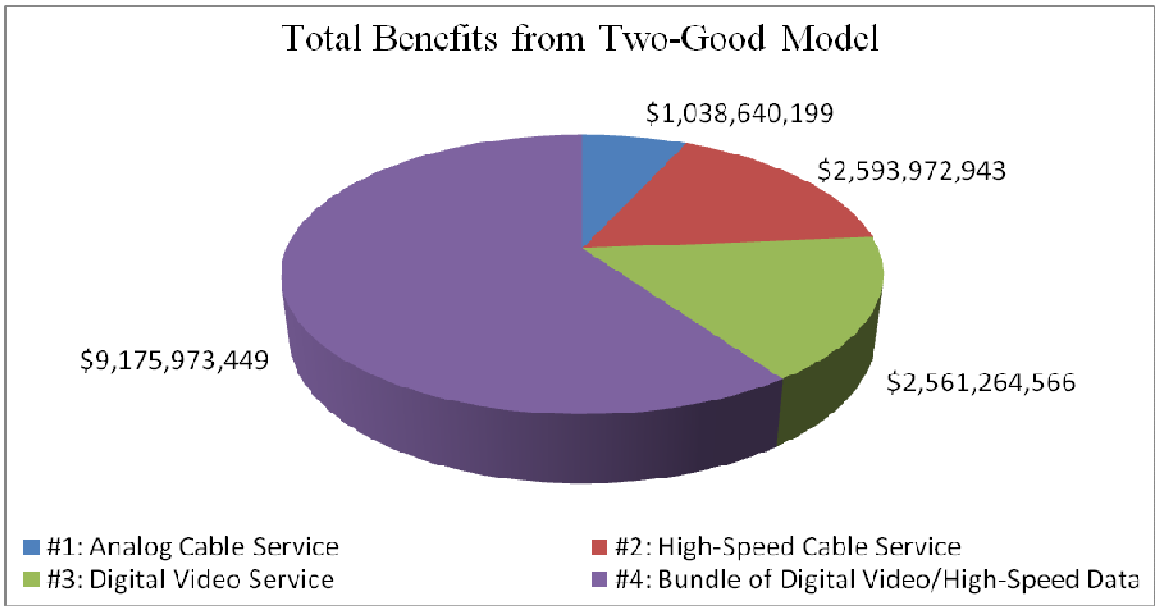
It is important to recognize that the average surplus to customers in Cohort #4, who are buying a bundle of digital cable and high-speed data ($30.25), is less than the sum of the average benefits for customers of the individual new services ($17.25 + $18.67 = $35.92). The reason is that some of the customers buying the bundle will not attach as much value to the two components as do the customers that buy only those components. This is picking up an effect similar to the Shakespeare and Shaw pricing experiment described above, as bundling encourages patrons to attend two plays rather than one, even though many customers' willingness-to-pay for their second-choice play is quite low. The parallel to the case of the cable customers is that customers will buy the bundle even though their willingness to pay for one of the two components is not very large. Nevertheless, those consumers still derive some net benefit from the bundle, compared to buying only one of the services.

The model measures the substantial benefits to consumers from the price changes and quality improvements in data and video services. The benefits from the changes in prices over the ten-year period are captured directly by the use of actual prices to calibrate the model. Although less obvious, the benefits from the quality improvements in data services over the last ten years are measured directly by the model. There is no need to include a separate quality-of-service variable for data services as there was for analog video services,[23] because the "demand curve" for high-speed data services reveals consumers' willingness-to-pay for today's quality of service relative to all the alternatives available in the marketplace, including slower DSL service, dial-up Internet access or no access at all. The area under the demand curve, which is used to compute consumer surplus, represents the entire benefit to consumers from consumption of the new high-speed data service.

The average per-subscriber monthly benefit from this ten-year transformation of the cable industry is $20.15, or $242 per year. Certainly some consumers have benefited more than others, but this is a natural occurrence in any market where different consumers have a different willingness-to-pay for new services. ***Across all cable subscribers the benefits from the two-good bundle add up to almost $15.4 billion annually.*** This is calculated as the product of the annual benefits times the number of cable subscribers. The benefit for each cohort of customers is displayed in *Figure 15* below.

[23] Since analog video service was available in both 1998 and 2008, and the quality of the service improved significantly during this period, it would not be correct to treat the "demand curve" for this service as constant and unchanging over time. Therefore, we could not measure the change in consumer surplus between 1998 and 2008 by comparing the triangles under the same demand curve without making explicit adjustments for quality.

Figure 15



We have also estimated a second scenario in which a partial adjustment is made for the increase in viewing hours; prices are adjusted to reflect just sixty percent of the increase in viewing hours. This is the same as assuming that analog prices have been unchanged in inflation-adjusted terms over the last ten years. This demonstrates that even if analog video consumers have experienced only a partial increase in quality (which is highly improbable), the overall effects of the transformation of the cable industry have been positive for consumers as a whole. The results from this scenario are shown in *Figure 16* below.

Figure 16
Two-Good Model: Average Change in Consumer Welfare
Using Partially Adjusted Real Prices

Cohort	Share of Customers	Per Customer Monthly Change in Consumer Surplus
#1: Analog Cable Service	22.7%	-$5.00
#2: High-Speed Cable Service	19.7%	$6.21
#3: Digital Video Service	18.0%	$7.67
#4: Bundle of Digital Video/High-Speed Data	39.7%	$19.35
Average (weighted)		$9.15

Results of the Three-Good Model

The three-good model adds voice service to the video and data services presented in the two-good model. In the base period, voice service is only available from the ILECs, so the cable customer is limited to purchasing one service -- analog cable. In the present period, cable companies offer their customers a digital voice service, either as a stand-alone service or as a component in a two-product or three-product bundle. Subscribers to cable digital voice service benefit from the lower price and larger feature set as compared to the ILECs' voice services offered ten years ago. As in the two-good case, the model compares consumer welfare in the base period with consumer welfare in the present period. The model is conceptually similar to the two-good model, although the underlying mathematics are much more complex. A complete description of the methodology is provided in the Appendix to this paper.

The three-good model requires many of the same inputs that were used for the two-good model, including base period shares and prices, as well as prices for the present-day period single-component and bundled services. Market shares, however, must be restated, to differentiate between subscribers to ILEC voice service and cable digital voice service. The

model also requires prices for stand-alone voice services and bundles that include voice service, along with the demand elasticity for cable voice services.[24] The inputs chosen for the model are shown in *Figure 17* below. Market shares were derived from company data summarized in *Figure 6*. It was necessary, however, to collapse certain categories of services and bundles to maintain a tractable model. For example, the market share of 18.48% for "High-Speed Data" includes single component customers that buy only high-speed data (5.47%), together with customers that buy high-speed data along with analog cable (13.01%). Further, all three-product customers are treated as if they are subscribing to digital video service, even though a small portion actually subscribe to analog video service. This reflects the trend in the market toward triple-play bundles that include digital video service.

Figure 17
Inputs to Three-Good Model

Type of Service or Bundle	Shares	Prices
Analog Video Only	21.04%	$50
Digital Video Only*	16.40%	$64
High-Speed Data	18.48%	$45
Cable Digital Phone Service	1.60%	$35
Digital Video + High-Speed Data	16.68%	$99
Digital Video + Cable Digital Phone Service	1.53%	$95
Cable Digital Phone Service + High-Speed Data	1.23%	$70
Digital Video + High-Speed Data + Cable Digital Phone Service	23.01%	$125
Cable Digital Phone - Demand Elasticity -2.00		

Source: Internal Company Documents, MiCRA modifications
*Digital video refers to a video service that includes analog and digital channels.

[24] The elasticity of demand for cable digital voice service, which is the firm demand elasticity rather than the market demand elasticity, is likely to be in the same range as the firm demand elasticities of the long distance companies in the 1990s. Estimates of the demand elasticity of long distance firms in the range of -1.33 to -6.50 are provided in: M. Pelcovits, "The WorldCom-Sprint Merger" in *The Antitrust Revolution: The Role of Economics*, 4th Edition, ed. J. Kwoka and L. White, Oxford University Press, 2003.

The results of the three-good model demonstrate significant consumer benefits from the cable industry's transformation and entry into data and voice markets.[25] As shown in *Figure 18* below, average monthly benefits for triple-play customers are $69.84. Average monthly benefits for all other customers are $21.94. Across all cable subscribers the average monthly benefit is $32.96.

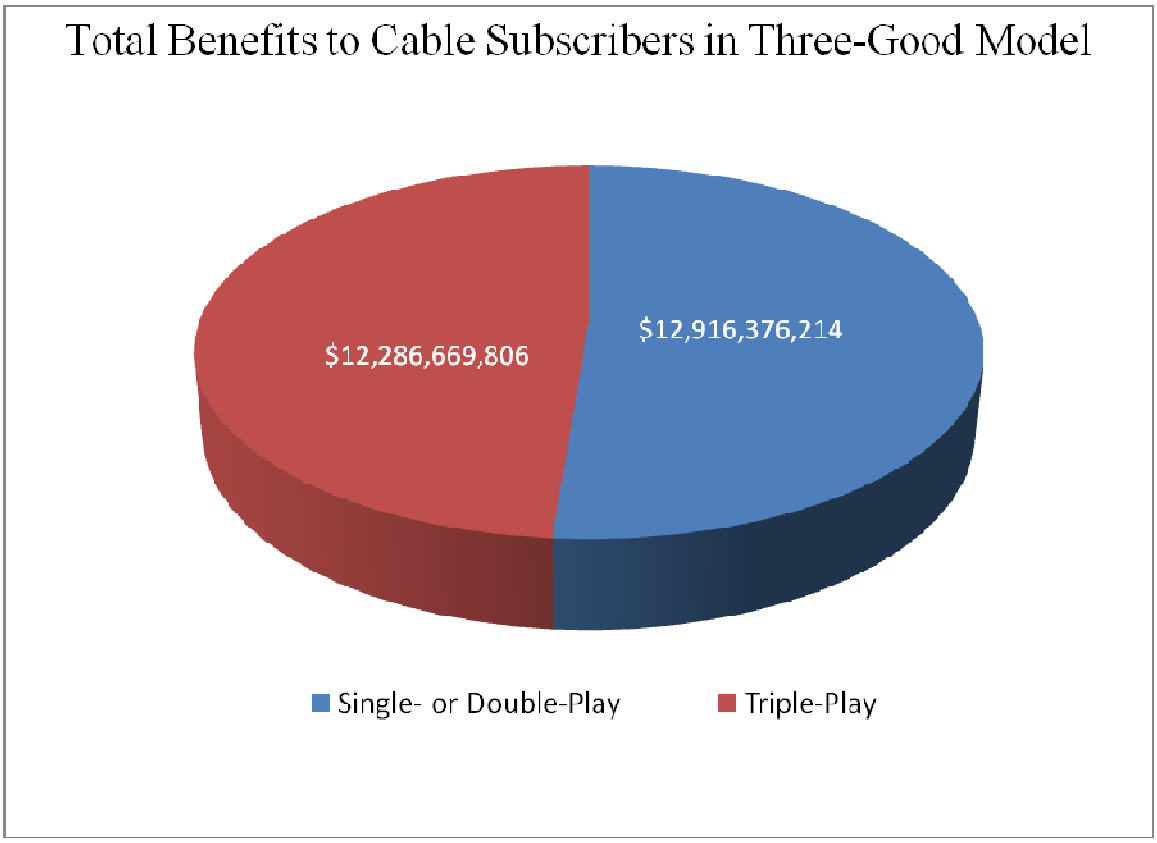
Figure 18
Three-Good Model: Average Change in Consumer Welfare Using Adjusted Real Prices

Cohort	Share of Customers	Per Customer Monthly Change in Consumer Surplus
Single- or Double-Play	77%	$21.94
Triple-Play	23%	$69.84
Average (weighted)		$32.96

On an annual basis the benefits to subscribers from the industry's transformation into a three-product provider equals approximately $25.2 billion. The benefits are about equally split between the single-play/double-play customers and the triple-play customers. Even though there are significantly fewer triple-play subscribers, the benefits are much larger for each of the subscribers than the single- or double-play subscribers.

[25] See the Appendix for a fuller discussion of the three-good model.

Figure 19



The average benefit estimated by this model for the single- and double-play subscribers ($21.94) is larger than the average benefit in the two-good model ($20.15). This may appear to be counterintuitive because very few of the double-play subscribers order cable digital voice service. Hence, any increase in benefits for these single- and double-play subscribers must be reflecting some other cause. Many factors affect the outcome of the two models and blur any comparison between the results for similar cohorts. However, one important reason for the increase in consumer surplus for the single- and double-play subscribers is that all cable subscribers will benefit from cable entry into the voice market, even those that continue to purchase voice service from the ILECs. Competition in voice markets has driven down market prices for ILEC subscribers as well as cable subscribers, and the model reflects the decline in voice service prices paid by all cable subscribers, not just those subscribing to the cable voice service.

Total Benefits to Consumers

The benefit to consumers resulting from the transformation of the cable industry is not limited to the cable companies' subscribers. Cable competition in the voice market benefits ILEC voice customers, even those that do not subscribe to cable service. In MiCRA's prior study of the effects of cable competition on voice markets, we estimated a monthly per-customer benefit of $12 from this competitive response.[26] As discussed above, the three-good model already includes these benefits for the cable companies' video and data customers who obtain voice service from the ILECs. In addition, the households with ILEC voice service but no cable service obtain similar benefits. There are approximately forty million households in this category; applying twelve dollars in monthly per-customer benefits to this population yields annual benefits of $5.8 billion.[27]

Of the 40 million households with ILEC voice service, approximately 27 million have DSL service.[28] These customers obtain significant benefits from their broadband service. Some studies, including one by Professor Austan Goolsbee, have estimated benefits (consumer surplus) on the order of $48 per month, which is much larger than the benefits estimated by our model.[29] Since cable high-speed data service spurred the ILECs' introduction and promotion of DSL service, it could be argued that all of these benefits should be attributed to the cable industry's broadband initiatives. A more conservative approach would be to attribute only a portion of the benefits to DSL customers to the cable industry. We have chosen to base our estimate of the effects of cable competition on DSL customers to be only 25% of the total

[26] *Consumer Benefits from Cable-Telco Competition,* Michael D. Pelcovits and Daniel E. Haar, November 2007, http://www.micradc.com/news/publications/pdfs/Updated_MiCRA_Report_FINAL.pdf.

[27] This estimate is derived by multiplying the number of households with wireline voice service (95 million) by the percentage of television households without service from a cable company (57%). Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, January-June 2008, National Center for Health Statistics. Available from: http://www.cdc.gov/nchs/nhis.htm. December 17, 2008. SNL Kagan, "Broadband Technology," Number 380, March 19, 2009.

[28] *High-Speed Services for Internet Access: Status as of December 31, 2007,* FCC, January 2009, Table 3.

[29] Austan Goolsbee, "*The Value of Broadband and the Deadweight Loss of Taxing New Technology.*"

estimated by Professor Goolsbee. This generates a per customer benefit of $12.00 per month from DSL, plus $12.00 per month from voice competition.

Figure 20 below presents an estimate of the total increase in consumer surplus from the cable industry's provision of the three services. Most of the benefit, $25.2 billion, can be ascribed to the cable companies' customers. Benefits to the ILECs' customers, however, should be included in the overall total and are conservatively estimated at another $9.7 billion. The total annual benefits therefore are $34.9 billion.

Figure 20
Total Consumer Welfare Gains from All Sources

Customer Group	Households (millions)	Monthly Per-customer	Total Annual Benefit
Cable Single- and Double-Play	49.1	21.94	$12,900,000,000
Cable Triple-Play	14.7	69.84	$12,300,000,000
ILEC Voice Only Customers	13.0	12.00	$1,900,000,000
ILEC DSL and Voice Customers	27.0	24.00	$7,800,000,000
Total			**$34,900,000,000**

Demographic Issues

The analysis conducted so far has focused on economy-wide consumer benefits; it does not disaggregate results according to characteristics of the consumers. The results of our analysis, which estimate large consumer benefits from the transformation of the cable industry, are pertinent to many policy issues. Nevertheless, this analysis does not shed light directly on how these benefits are distributed across different types of consumers. This is an issue that has attracted attention from many parties and government officials over the last several years.[30]

[30] See, for example, "Consumer Insights to America's Broadband Challenge," A Research Series from Connected Nation, Inc., October 13, 2008.

The FCC has tracked the availability of high-speed ("broadband") data services to households. Although its analysis has been subject to challenges, it does provide powerful evidence of a steady increase in availability of broadband data services over the past several years. The percentage of geographic areas (denominated by zip codes) with high-speed lines in service has increased from 60% in December 1999 to over 99% in December 2007.[31] Moreover, when the zip code data is grouped based on median household income, the trend in broadband data services coverage is even more impressive. Of the zip codes belonging to the decile with the lowest level of median household income, 91.8% are served by at least one high-speed data provider. This is a substantial increase from December 2001, when the penetration rate for this decile was only 62.7%.[32]

Availability of broadband data services, however, is not the same as subscription to those services. Hence, to analyze the impact of the cable industry on subscription patterns, we obtained subscribership data from several cable companies on a zip code basis. A limited data set was obtained for 2005 through January 2009, while a more comprehensive data set was available for 2007 and 2008.

We observed that a higher percentage of the cable companies' customers subscribed to high-speed data services in geographic areas (zip codes) with higher median income. This result was expected. However, the clear trend of customers in all income groups was a significant growth in subscribership to high-speed data service. As shown in *Figure 19* below, high-speed-data penetration has reached over 46% of households in zip codes with median income in the lowest 10% of the areas covered by these companies.

[31] FCC, High-Speed Report January 2009, Table 15.
[32] Id., Table 19.

Figure 21
Cable Demographics Aggregate Analysis
HSD Penetration

Decile	2007	2008
Median Income ranging between $5,787 and $27,595	38.81%	46.47%
Median Income ranging between $27,596 and $31,826	42.27%	49.98%
Median Income ranging between $31,827 and $35,378	46.12%	53.19%
Median Income ranging between $35,379 and $38,564	47.72%	55.33%
Median Income ranging between $38,566 and $41,877	51.20%	58.82%
Median Income ranging between $41,887 and $45,961	53.40%	60.97%
Median Income ranging between $45,965 and $50,961	55.71%	63.20%
Median Income ranging between $50,963 and $57,500	58.33%	65.48%
Median Income ranging between $57,510 and $68,252	62.82%	69.52%
Median Income ranging between $68,63 and $200,001	67.09%	73.12%

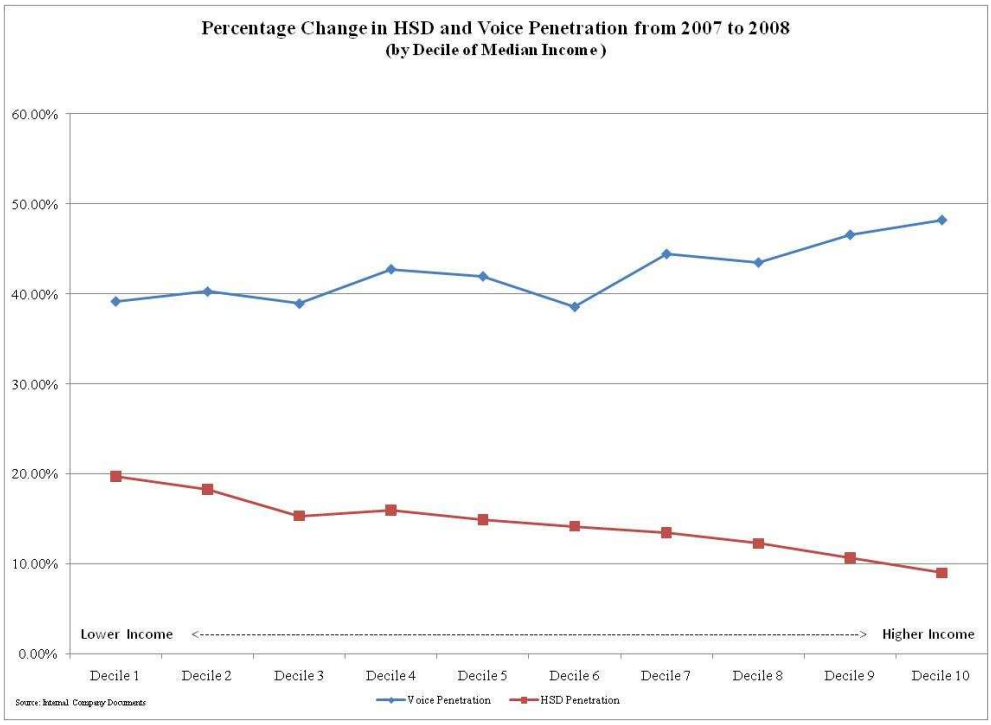
The penetration rate in the lowest income decile increased substantially from 39% only one year earlier. This represents a 20% increase in the penetration rate, compared to a 13% increase for the population as a whole. *Figure 20* displays the percentage increases in penetration according to deciles.

These results are consistent with the most recent estimates from the Pew Internet survey, which showed strong broadband growth from 2008 to 2009 for the two groups of low-income Americans.[33] The Pew survey shows broadband adoption increasing from 25% to 35% among households with income under $20,000 per year and also increasing from 42% to 53% among households with income between $20,000 and $30,000 per year. Our estimate of a 46% adoption rate for the ten percent of geographic areas with the lowest median income lies in

[33] Pew Internet & American Life Project, "Home Broadband Adoption 2009," June 2009, available on line at: http://pewinternet.org/Reports/2009/10-Home-Broadband-Adoption-2009.aspx. The report did not pick up the increase in broadband adoption among the lowest income households until 2009, and indeed found that it declined between 2007 and 2008. It appears that the earlier Pew Results, which come from a survey in April and May 2008, miss an upsurge in subscription occurring later in 2008. The decline in broadband adoption observed between the March 2007 survey result and the April/May 2008 survey result appears to be an anomaly relative to the overall trend in the market.

between the results of the Pew survey for the two lowest income groups in the Pew study. This is a logical result because the range of median household income for the lowest decile in our sample straddles the two lowest income groups in the Pew survey. One would expect that broadband penetration for this decile should lie somewhere between the levels estimated for these groups in the Pew survey. In any case, we would not expect our results to be identical to the Pew survey, because our results are based on median household income in a zip code, and this yields a blend across all households within that zip code. Moreover, our results are based on actual subscription data, rather than responses to a survey. Therefore, the two approaches are complementary, and provide substantial evidence demonstrating that investments in broadband network technology by the cable industry have benefited Americans of all income classes.

Figure 22



Cable customers' subscription to cable digital voice service is distributed even more evenly across income groups. According to the most recent data, the range of voice penetration among cable video customers averaged 27% in 2008. Penetration rates across income

categories ranged from 21.4% to 28.9%, as shown in *Figure 23* below. This provides additional support for our conclusion that cable benefits are accruing to Americans of all income classes.

Figure 23
Cable Demographics Aggregate Analysis
Voice Penetration

Decile	2007	2008
Median Income ranging between $5,787 and $27,595	15.35%	21.36%
Median Income ranging between $27,596 and $31,826	16.48%	23.12%
Median Income ranging between $31,827 and $35,378	16.94%	23.53%
Median Income ranging between $35,379 and $38,564	17.53%	25.03%
Median Income ranging between $38,566 and $41,877	18.34%	26.04%
Median Income ranging between $41,887 and $45,961	19.79%	27.43%
Median Income ranging between $45,965 and $50,961	19.18%	27.71%
Median Income ranging between $50,963 and $57,500	19.57%	28.08%
Median Income ranging between $57,510 and $68,252	19.74%	28.93%
Median Income ranging between $68,263 and $200,001	19.44%	28.80%

Policy Conclusions

In response to the first question posed in the introduction, consumers as a whole have unequivocally benefited from the transformation of the cable industry over the past ten years and its investment and entry into voice and high-speed data markets. The benefits can be attributed to the cable industry's massive investments in deployment of advanced communications infrastructure, which enables provision of new digital video, data, and voice services. Consumers have signaled their approval by subscribing to these new services in ever-increasing numbers. At present, 60% of cable customers subscribe to broadband Internet service, 26% subscribe to voice service, and the trend is toward increased subscriptions to both advanced services. The triple-play of digital video, data, and voice service is attracting a larger share of cable customers with every passing month. These consumption patterns provide

powerful evidence that consumers are benefiting enormously from the development of the cable industry over the last ten years. We estimate annual direct and indirect benefits resulting from the transformation of the cable industry to be $35 billion.

Our estimate of $35 billion in consumer benefits also answers our second question regarding the effect of bundling on consumers. Bundling has increased penetration of cable's new digital services and benefited consumers and the industry. Consumers benefit from the advantageous lower prices for the bundles. The industry benefits from its ability to exploit economies of scale and scope in the provision of digital services to the home.

The third question posed was whether the benefits from offering new services and new service bundles are shared across all demographic groups. It is well-recognized that broadband data service penetration has been much lower for the lowest income households. When broadband data service was first deployed, penetration rates were highly skewed toward upper income households. Recently, however, penetration rates for lower income households have increased substantially, reaching close to 50% in the geographic areas (zip codes) with the lowest median household incomes. This demonstrates that the cable industry's investments in digital technology are benefiting Americans of all demographic classes.

The fourth question posed was whether subscribers to analog video service have been harmed by the transformation of the cable industry. Our best estimate is that they have not been harmed, because the increase in real prices has been offset by an increase in the value of cable network programming. Even if we do not adjust fully for this increase in viewing, the cost to this ever shrinking pool of analog customers is very low – in the range of five dollars per month. In any case, it is inevitable that as any industry is transformed some consumers will benefit more than others, and some may not benefit at all. In the case of the cable industry, almost all consumers are direct and substantial beneficiaries. Moreover, as a result of the competition from the cable industry, other companies' consumers also benefit. In light of the economy-wide effects of an advanced communications infrastructure, it is likely that the benefits to the country as a whole from cable's investment in new technology are much larger than our estimate of $35 billion annually.

APPENDIX A: Triple-Play Offers of Three Largest Cable Companies

Service	Comcast	Cox	Time Warner Company
Triple-Play Bundle	HD Starter Triple Play	Cox Better Bundle	All the Best Triple Play
Promotional Price per Month	$114.99[1]	$85.98[2]	$129.95[3]
Post-Promotion Price per Month	$129.99	$115.98	$140.95
Bundle Components			
Video			
Digital Channels	100	150+	300
HD Channels	50	48+	100
Data			
Download (Mbps)	12	12	10
Upload (Mbps)	2	1	512 kbps
Voice			
Local	Unlimited	Unlimited	Unlimited
Long Distance	Unlimited	$0.12/min in-state and $0.15/min state-to-state	Unlimited
Calling Features	12	9	7

[1]12-Month Promotional Rate

[2]6-Month Promotional Rate

[3]24-Month Promotional Rate

APPENDIX B: Model Description

This appendix presents a detailed description of the two- and three-good models and how they were implemented for the purpose of this welfare analysis. Part 1 describes the theory behind both models, while Part 2 describes the calibration and estimation procedures used in order to 'fit' the models to the available data.

Part 1: Theory

Both the two- and three-good models are versions of the same spatial differentiation model of consumer preferences. The approach here is to describe the two-good formulation in great detail, and then explain how it has been modified to accommodate a third good.

Assume that consumers may choose between two differentiated products, A1 and A2, sold by two different firms, and that for simplicity only à la carte sales are possible. (We will subsequently introduce the possibility of bundles involving other goods.) Given a population of *m* consumers, assume that a consumer of type *i* will choose between A1 and A2 and has the following willingness-to-pay for one unit of a good A*j*, *j* = 1, 2:

$$U_i^{Aj}\left(x^i, p_{Aj}\right) = v\left(p_{Aj}\right) - t\left(l_{Aj} - x^i\right)^2 = v_{Aj} - p_{Aj} - t\left(l_{Aj} - x^i\right)^2 \quad \text{if } p_{Aj} < v_{Aj} - t\left(l_{Aj} - x^i\right)^2, \text{ zero else,} \tag{0.1}$$

where p_{Aj} is the retail price of A*j* and l_{Aj} is A*j*'s 'location' on the unit interval, $l_{Aj} \in [0,1]$. Here, $v\left(p_{Aj}\right) = v_{Aj} - p_{Aj}$ is the consumer's surplus associated with A*j* gross of 'transportation costs,' which is captured by the term $t\left(l_{Aj} - x^i\right)^2$. We assume that this consumer characteristic, which leads consumers to have different levels of overall willingness-to-pay for each good, is distributed throughout the consumer population as a continuous uniform random variable, where

$$\Pr\left(x^i < x\right) = \begin{cases} 0 \text{ for } x < 0; \\ z \text{ for } x \in [0,1]; \\ 1 \text{ for } x > 1. \end{cases} \tag{0.2}$$

Here the similarity of A1 and A2 depends on their distance in spatial terms, given by $d_A = l_{A2} - l_{A1}$, and the transportation cost parameter *t*. As either *d* or *t* shrinks to zero, A1 and

A2 become increasingly similar to one another. For the purposes of this exercise, we have assumed that $l_{A1} = 1 - l_{A2} = 0$, so that $d_A = 1$[34]. A consumer will therefore choose A1 over A2 only if $U_i^{A1}\left(x^i, p_{A1}\right) > U_i^{A2}\left(x^i, p_{A2}\right)$, or if

$$(0.3) \qquad x^i < \tilde{x} = \frac{1}{2} + \frac{\left(\Delta v_A + p_{A2} - p_{A1}\right)}{2t}.$$

Here $\Delta v_A = v_{A1} - v_{A2}$ is the difference between consumers' willingness to pay for A1 and A2 gross of price and transportation costs, which is common to all consumers. If Δv_A is positive (negative), all consumers consider A1 to be a better (worse) value, even at the same price and transport cost. Because each consumer with $x^i < \tilde{x}$ will choose A1 over A2, the seller of A1 faces a demand curve under independent pricing given by

$$(0.4) \qquad D_{A1}\left(p_{A1}, p_{A2}\right) = \frac{1}{2} + \frac{\left(\Delta v_A + p_{A2} - p_{A1}\right)}{2t}.$$

The seller of product A2 then faces a demand curve $D_{A2}\left(p_{A1}, p_{A2}\right) = 1 - D_{A1}\left(p_{A1}, p_{A2}\right)$.

However, suppose that in addition to product A, consumers also value a second good (good B). Similar to good A, consumers value each 'version' of good B, B1 and B2, according to

$$(0.5) \qquad \begin{aligned} &U_i^{Bj}\left(y^i, p_{Bj}\right) = v\left(p_{Bj}\right) - s\left(l_{Bj} - y^i\right)^2 = v_{Bj} - p_{Bj} - s\left(l_{Bj} - y^i\right)^2 \\ &\qquad \text{if } p_{Bj} < v_{Bj} - s\left(l_{Bj} - y^i\right)^2, \text{ zero else,} \end{aligned}$$

Here, the transport cost parameter is *s* instead of *t*, allowing for differing degrees of substitutability for markets A and B. Let $l_{B1} = 1 - l_{B2} = 0$ and y^i to be uniformly distributed over the unit interval as in the product A case. Assume further that x^i and y^i are independent random variables, so that consumers' willingness to pay for A1 or A2 is independent of their willingness to pay for B1 or B2.

$$\Pr\left(x^i < x,\ y^i < y\right) = \begin{cases} 0 \text{ for } x < 0 \text{ or } y < 0; \\ xy \text{ for } (x, y) \in [0,1]; \\ x \text{ for } y > 1,\ x \in [0,1]; \\ y \text{ for } x > 1,\ y \in [0,1]; \\ 1 \text{ for } x > 1 \text{ and } y > 1. \end{cases}$$

[34] As we explain in Part 2, we have allowed the data to effectively tell us the value of each transportation cost parameter.

Assume that a common seller provides both A1 and B1, so that this seller may offer bundled sales of A1 and B1 as well as à la carte sales, while other service providers offer only independently priced products. In this case, the demand curves faced by each service provider are less straightforward than in (0.3). Figure A.1 shows the shares of consumers that choose each of four possible A-B product combinations as functions of a menu of prices, including the price of a A1-B1 bundle (consisting of one unit each of A1 and B1), the à la carte prices of each available product p_{A1}, p_{A2}, p_{B1} and p_{B2}. Additionally, we allow for the possibility that consumers receive extra utility from consuming a bundle of A1 and B1, so that

$$U_i^{bund}\left(x^i, y^i, \hat{p}\right) = v_{A1} + v_{B1} + v_{bund} - \hat{p} - t\left(x^i\right)^2 - s\left(y^i\right)^2, \tag{0.6}$$

where v_{bund} is this extra 'bundle' utility. Bundle consumers are therefore only those who value the bundle more than any other combination of two goods—A1 and B2, A2 and B1, or A2 and B2—at the going retail prices. For example, in order for a consumer to purchase the bundle instead of A1 and B2, we must have

$$\begin{aligned} U_i^{bund}\left(x^i, y^i, \hat{p}\right) > U_i^{A1B2}\left(x^i, y^i, p_{A1}, p_{B2}\right) = v_{A1} + v_{B2} - p_{A1} - p_{B2} \\ - t\left(x^i\right)^2 - s\left(1 - y^i\right)^2, \end{aligned} \tag{0.7}$$

which occurs when

$$y^i < \tilde{y}\left(\hat{p}, p_{A1}, p_{B2}\right) = \frac{1}{2} + \frac{\left(\Delta v_B + v_{bund} + p_{A1} + p_{B2} - \hat{p}\right)}{2s}. \tag{0.8}$$

Similar constraints result from comparing the bundle with each of the other two product combinations. (Figure A.1 illustrates the full set of compatibility constraints for each product combination graphically.) In fact, the set of bundle consumers is described by the following set of inequalities, along with (0.8):

$$\begin{aligned} x^i &< \tilde{x}\left(\hat{p}, p_{A2}, p_{B1}\right) = \frac{1}{2} + \frac{\left(\Delta v_A + v_{bund} + p_{A2} + p_{B1} - \hat{p}\right)}{2t}, \\ x^i &< \frac{1}{2} + \frac{\left(\Delta v_A + \Delta v_B + v_{bund} + p_{A2} + p_{B2} - \hat{p}\right)}{2t} - \frac{s}{t} \cdot y^i \end{aligned} \tag{0.9}$$

This set of inequalities defines a bundle demand function given by

$$
\begin{aligned}
D_{bund}\left(\hat{p},p_{A1},p_{A2},p_{B1},p_{B2}\right) &= \tilde{x}\left(\hat{p},p_{A2},p_{B1}\right)\cdot\tilde{y}\left(\hat{p},p_{A1},p_{B2}\right) \\
&\quad -\frac{1}{2}\cdot\left(\tilde{x}\left(\hat{p},p_{A2},p_{B1}\right)-\hat{x}\left(p_{A1},p_{A2}\right)\right)\cdot\left(\tilde{y}\left(\hat{p},p_{A1},p_{B2}\right)-\hat{y}\left(p_{B1},p_{B2}\right)\right)
\end{aligned} \tag{0.10}
$$

Similarly, incentive compatibility constraints for consumers of A1 and B2 are given by

$$
\begin{aligned}
x^i &< \hat{x}\left(p_{A1},p_{A2}\right)=\frac{1}{2}+\frac{\left(\Delta v_A+p_{A2}-p_{A1}\right)}{2t}, \\
y^i &> \tilde{y}\left(\hat{p},p_{A1},p_{B2}\right)=\frac{1}{2}+\frac{\left(\Delta v_B+v_{bund}+p_{A1}+p_{B2}-\hat{p}\right)}{2s}.
\end{aligned} \tag{0.11}
$$

Incentive compatibility constraints for consumers of A2 and B1 include:

$$
\begin{aligned}
x^i &> \tilde{x}\left(\hat{p},p_{A2},p_{B1}\right)=\frac{1}{2}+\frac{\left(\Delta v_A+v_{bund}+p_{A2}+p_{B1}-\hat{p}\right)}{2t}, \\
y^i &< \hat{y}\left(p_{B1},p_{B2}\right)=\frac{1}{2}+\frac{\left(\Delta v_B+p_{B2}-p_{B1}\right)}{2s}.
\end{aligned} \tag{0.12}
$$

Finally, consumers of A2 and B2 are only those with $\left(x^i,y^i\right)$ such that

$$
\begin{aligned}
x^i &> \hat{x}\left(p_{A1},p_{A2}\right)=\frac{1}{2}+\frac{\left(\Delta v_A+p_{A2}-p_{A1}\right)}{2t}, \\
y^i &> \hat{y}\left(p_{B1},p_{B2}\right)=\frac{1}{2}+\frac{\left(\Delta v_B+p_{B2}-p_{B1}\right)}{2s}, \text{ and} \\
x^i &> \frac{1}{2}+\frac{\left(\Delta v_A+\Delta v_B+v_{bund}+p_{A2}+p_{B2}-\hat{p}\right)}{2t}-\frac{s}{t}\cdot y^i.
\end{aligned} \tag{0.13}
$$

This yields market shares for the A1-B2, A2-B1, and A2-B2 cohorts, respectively, given by

$$
\begin{aligned}
&D_{A1B2}\left(\hat{p},p_{A1},p_{A2},p_{B1}\right)=\hat{x}\left(p_{A1},p_{A2}\right)\cdot\left(1-\tilde{y}\left(\hat{p},p_{A1},p_{B2}\right)\right), \\
&D_{A2B1}\left(\hat{p},p_{A2},p_{B1},p_{B2}\right)=\hat{y}\left(p_{B1},p_{B2}\right)\cdot\left(1-\tilde{x}\left(\hat{p},p_{A2},p_{B1}\right)\right), \text{ and} \\
&D_{A2B2}\left(\hat{p},p_{A1},p_{A2},p_{B1},p_{B2}\right)=\left(1-\hat{y}\left(p_{B1},p_{B2}\right)\right)\cdot\left(1-\hat{x}\left(p_{A1},p_{A2}\right)\right)- \\
&\qquad -\frac{1}{2}\cdot\left(\tilde{x}\left(\hat{p},p_{A2},p_{B1}\right)-\hat{x}\left(p_{A1},p_{A2}\right)\right)\cdot\left(\tilde{y}\left(\hat{p},p_{A1},p_{B2}\right)-\hat{y}\left(p_{B1},p_{B2}\right)\right).
\end{aligned} \tag{0.14}
$$

Figure A.1 shows the cohort regions (set of consumers that fall into each category) in a box of unit area. In order to isolate the actual change in consumers' surplus associated with the introduction of the first two goods (here, we assume without loss of generality that A1 and B1 are newly introduced goods), we assume that only A2 and B2 are available for purchase prior to their introduction. We also assume that all consumers bought A2 and B2 prior to the introduction of A1 and B1. Hence, a basic source of surplus gain—even if the prices of A2 and B2

do not drop with the introduction of competing products—is that either A1, B1, or both goods are a better 'match' for some consumers than are A2 and B2[35]. Hence, the change in surplus for a consumer that chooses to buy a bundle of A1 and B1 earns the following change in surplus with the introduction of A1 and B1 (and allowing p to represent the vector of menu prices $\left(\dot{p}_{A2}, \dot{p}_{B2}, \hat{p},\ p_{A1}, p_{B1}, p_{A2}, p_{B2}\right)$:

$$\Delta U_{bund}\left(x^i, y^i, \mathrm{p}\right) = \Delta v_A + \Delta v_B + \dot{p}_{A2} + \dot{p}_{B2} - \hat{p} + t\left(1-2x^i\right) + s\left(1-2y^i\right); \tag{0.15}$$

Here, we denote the prices of A2 and B2 in the previous period as $\dot{p}_{A2}$ and $\dot{p}_{B2}$. Similarly, a consumer who now buys A1 and B2 earns the following surplus due to the introduction of A1 and B1:

$$\Delta U_{A1B2}\left(x^i, \mathrm{p}\right) = \Delta v_A + \dot{p}_{A2} + \dot{p}_{B2} - p_{A1} - p_{B2} + t\left(1-2x^i\right); \tag{0.16}$$

For the remaining two cohorts—consumers who buy A2 and B1 or A2 and B2 in the present period—the changes in consumers' surplus are given by

$$\begin{aligned} &\Delta U_{A2B1}\left(y^i, \mathrm{p}\right) = \Delta v_B + \dot{p}_{A2} + \dot{p}_{B2} - p_{A2} - p_{B1} + s\left(1-2y^i\right); \text{ and} \\ &\Delta U_{A2B2}\left(\mathrm{p}\right) = \dot{p}_{A2} + \dot{p}_{B2} - p_{A2} - p_{B2} \end{aligned} \tag{0.17}$$

(Intuitively, the change in surplus for consumers who continue to buy A2 and B2 despite the availability of new products can only come from a change in the prices of A2 and B2, as the second statement of (0.17) suggests.) Given (0.15) through (0.17), we can now derive the total change in consumers' surplus from the initial period—in which only A2 and B2 are available—and the present period, in which consumers have a choice amongst all four goods à la carte as well as a bundle of A1 and B1. For example, for bundle consumers, the change in surplus is given by the integral of (0.15) over the set of x^i and y^i for which the bundle is chosen:

$$\Delta CS_{bund}\left(\mathrm{p}\right) = \iint_{D_{bund}(\mathrm{p})} \Delta U_{bund}\left(x^i, y^i, \mathrm{p}\right)\, \partial x^i \partial y^i \tag{0.18}$$

[35] One may imagine that A1 and B1 are of higher quality than the competing products—so that consumers that are willing to pay more for quality are made better off by their availability—or, more conservatively, that A1 and B1 are simply a better 'horizontal' match for some consumers. For example, the opening of a new Ethiopian restaurant in an area where only French restaurants previously operated holds great benefits for a consumer population that values variety in dining-out. Regardless of which situation is more descriptive of the industry in question, the model is able to accommodate; for example if the $\Delta v_A = v_{A1} - v_{A2}$ parameter is calibrated to be greater than zero, consumers are willing to pay more on average for A1 than for A2—suggesting that A1 may be of higher quality to most people than is A2.

Similarly, the total change in surplus for the A1-B2, A2-B1 and A2-B2 consumers are given by, respectively,

$$
\begin{aligned}
&\Delta CS_{A1B2}(\mathrm{p}) = \iint_{D_{A1B2}(\mathrm{p})} \Delta U_{A1B2}(x^i, \mathrm{p})\, \partial x^i \partial y^i; \\
(0.19) \qquad &\Delta CS_{A2B1}(\mathrm{p}) = \iint_{D_{A2B1}(\mathrm{p})} \Delta U_{A2B1}(y^i, \mathrm{p})\, \partial x^i \partial y^i; \text{ and} \\
&\Delta CS_{A2B2}(\mathrm{p}) = \iint_{D_{A2B2}(\mathrm{p})} \Delta U_{A2B2}(\mathrm{p})\, \partial x^i \partial y^i = \Delta U_{A2B2}(\mathrm{p}) \cdot D_{A2B2}(\mathrm{p}).
\end{aligned}
$$

The total benefit to consumers associated with the introduction of the two new goods is then given by the sum of these terms.

Introducing a third good into the model amounts to allowing consumers to have positive willingness-to-pay for a third class of products (product C*j*, *j* = 1, 2) in addition to those already described. We have assumed that consumers' preferences for the third good are very similar to their preferences for the first two; consumers' willingness-to-pay for one unit of product C*j* is given by

$$
\begin{aligned}
(0.20) \qquad & U_i^{cj}(z^i, p_{cj}) = v(p_{cj}) - r(l_{cj} - z^i)^2 = v_{cj} - p_{cj} - r(l_{cj} - z^i)^2 \\
& \text{if } p_{cj} < v_{cj} - r(l_{cj} - z^i)^2, \text{ zero else,}
\end{aligned}
$$

Again, we have allowed for the possibility that the transportation cost parameter *r* in market C potentially differs from the transportation cost parameters in either markets A or B. Also in a natural extension of the two-good theoretical model, we assume that the consumer-specific random variables (x^i, y^i, z^i) are independent and jointly uniformly distributed:

$$
(0.21) \qquad \Pr(x^i < x,\ y^i < y) = \begin{cases} 0 \text{ for } x < 0 \text{ or } y < 0; \\ xy \text{ for } (x,y) \in [0,1]; \\ x \text{ for } y > 1,\ x \in [0,1]; \\ y \text{ for } x > 1,\ y \in [0,1]; \\ 1 \text{ for } x > 1 \text{ and } y > 1 \end{cases}
$$

As in the two-good case, finding the 'predicted' cohort shares—the shares of consumers who would buy a bundle made up A1, B1 and C1 (i.e., the 'triple-play bundle') at a price $\hat{p}$; those who would buy a two-good bundle made up of A1 and B1 in addition to C2; and so on for each possible combination of product purchase combinations—amounts to identifying sets of incentive compatibility constraints for each cohort and finding the sets of x^i, y^i and z^i that

conform to those constraints. However, the incentive compatibility constraints multiply in number with the introduction of a third good; the 'cohort' shares are more complicated functions of product (and various bundle) prices, if the seller of A1, B1 and C1 offers every type of bundle as well as all three products at à la carte prices.

As in the two-good case, we have allowed for the possibility that individual consumers get some extra surplus (or lose a bit of surplus, if negative) from purchasing a bundle of a particular type. Hence, consumers who buy the triple-play receive surplus given by

$$U_i^{bund}\left(x^i, y^i, \hat{p}\right) = v_{A1} + v_{B1} + v_{C1} + v_{bund} - \hat{p} - t\left(x^i\right)^2 - s\left(y^i\right)^2 - r\left(z^i\right)^2. \tag{0.22}$$

Consumers of the double-play bundles composed of A1 and B1, B1 and C1, and A1 and C1, respectively, receive surplus given by, respectively[36],

$$\begin{aligned} &U_i^{AB}\left(x^i, y^i, \mathrm{p}\right) = v_{A1} + v_{B1} + v_{C2} + v_{AB} - \hat{p}_{AB} - p_{C2} - t\left(x^i\right)^2 - s\left(y^i\right)^2 - r\left(1 - z^i\right)^2; \\ &U_i^{BC}\left(x^i, y^i, \mathrm{p}\right) = v_{A2} + v_{B1} + v_{C1} + v_{BC} - \hat{p}_{BC} - p_{A2} - t\left(1 - x^i\right)^2 - s\left(y^i\right)^2 - r\left(z^i\right)^2; \text{ and} \\ &U_i^{AC}\left(x^i, y^i, \mathrm{p}\right) = v_{A1} + v_{B2} + v_{C2} + v_{AC} - \hat{p}_{AC} - p_{B2} - t\left(x^i\right)^2 - s\left(1 - y^i\right)^2 - r\left(z^i\right)^2. \end{aligned} \tag{0.23}$$

(Note that each of the four possible bundles has an extra 'surplus parameter' associated with it that may be nonzero in value.) Finally, à la carte consumers receive surplus given by

$$\begin{aligned} &U_i^{AB}\left(x^i, y^i, \mathrm{p}\right) = v_{A1} + v_{B2} + v_{C2} - p_{A1} - p_{B2} - p_{C2} - t\left(x^i\right)^2 - s\left(1 - y^i\right)^2 - r\left(1 - z^i\right)^2; \\ &U_i^{BC}\left(x^i, y^i, \mathrm{p}\right) = v_{A2} + v_{B1} + v_{C2} - p_{A2} - p_{B1} - p_{C2} - t\left(1 - x^i\right)^2 - s\left(y^i\right)^2 - r\left(1 - z^i\right)^2; \\ &U_i^{AC}\left(x^i, y^i, \mathrm{p}\right) = v_{A2} + v_{B2} + v_{C1} - p_{A2} - p_{B2} - p_{C1} - t\left(1 - x^i\right)^2 - s\left(1 - y^i\right)^2 - r\left(z^i\right)^2; \text{ and} \\ &U_i^{none}\left(x^i, y^i, \mathrm{p}\right) = v_{A2} + v_{B2} + v_{C2} - p_{A2} - p_{B2} - p_{C2} - t\left(1 - x^i\right)^2 - s\left(1 - y^i\right)^2 - r\left(1 - z^i\right)^2. \end{aligned} \tag{0.24}$$

(The final cohort here purchases only products that were available in the previous period—and no products from the seller of A1, B1 and C1—and is therefore denoted by the subscript 'none'.)

For example, consider the consumers who would buy the 'triple-play' bundle (made up of one unit each of A1, B1, and C1). Because there are eight possible purchasing patterns here,

[36] Note that a consumer of the double-play bundle made up of A1 and B1 must buy C2 instead of C1 at the à la carte price by assumption. One simplifying assumption of this model is that the seller of A1, B1 and C1 has priced its individual products and bundles so that no consumer finds it in his best interests to buy multiple goods from that product line on an à la carte basis; the consumer in this example will be better off buying the triple-play.

we have seven incentive compatibility constraints in play. A consumer of type $\left(x^i, y^i, z^i\right)$ will choose the three-good bundle at a price $\hat{p}$ instead of buying a double-play bundle of A1 and B1 at price $\hat{p}_{AB}$ along with C2 only if

$$(0.25)\qquad \begin{aligned} &U_i^{bund}\left(x^i, y^i, z^i, \mathrm{p}\right) > U_i^{AB}\left(x^i, y^i, z^i, \mathrm{p}\right) \text{ or equivalently if} \\ &z^i < \frac{1}{2} + \frac{\left(\Delta v_C + v_{bund} - v_{AB} + \hat{p}_{AB} + p_{C2} - \hat{p}\right)}{2r}. \end{aligned}$$

Let the set of all purchasing possibilities be given by

$$(0.26)\qquad K = \left\{bund,\ \text{AB, BC, AC, A1, B1, C1, } none\right\}.$$

By employing this procedure for each of the other six purchasing possibilities, we can again derive the cohort share for the triple-play bundle:

$$(0.27)\qquad D_{bund}\left(\mathrm{p}\right) = \iiint_{A_{bund}(\mathrm{p})} \partial x^i \partial y^i \partial z^i,$$

where $A_{bund}\left(\mathrm{p}\right) = \left\{\left(x^i, y^i, z^i\right): U_{bund}\left(x^i, y^i, z^i, \mathrm{p}\right) > U_k\left(x^i, y^i, z^i, \mathrm{p}\right) \forall k \neq bund \in K\right\}$. Employing this procedure for each of the eight cohorts yields a very similar expression for each:

$$(0.28)\qquad D_j\left(\mathrm{p}\right) = \iiint_{A_j(\mathrm{p})} \partial x^i \partial y^i \partial z^i,$$

where $A_j\left(\mathrm{p}\right) = \left\{\left(x^i, y^i, z^i\right): U_j\left(x^i, y^i, z^i, \mathrm{p}\right) > U_k\left(x^i, y^i, z^i, \mathrm{p}\right) \forall k \neq j \in K\right\}$. Figure A.2 illustrates the bundle cohort shares in three-dimensional space; each of the critical values, such as $\tilde{x}$, $\tilde{y}$, and $\tilde{z}$, are functions of the menu of prices, so that the shares increase or contract with changes in the bundle and à la carte prices of each product or bundle.

Again, as we did in the two-good case, we have assumed that only A2, B2, and C2 were available before A1, B1, and C1 were introduced, and that all consumers purchased A2, B2, and C2 at that time. Hence, the change in consumers' surplus for a person of type $\left(x^i, y^i, z^i\right)$ who presently buys the 'triple-play' bundle gains an amount of surplus given by

$$(0.29)\qquad \begin{aligned} &U_{bund}\left(x^i, y^i, z^i, \mathrm{p}\right) - U_{none}\left(x^i, y^i, z^i, \dot{\mathrm{p}}\right) = \Delta U_{bund}\left(x^i, y^i, z^i, \mathrm{p}, \dot{\mathrm{p}}\right) \\ &\quad \Delta v_A + \Delta v_B + \Delta v_C + v_{bund} + \dot{p}_{A2} + \dot{p}_{B2} + \dot{p}_{C2} - \hat{p} + t\left(1 - 2x^i\right) + s\left(1 - 2y^i\right) + r\left(1 - 2z^i\right) \end{aligned}$$

Similar calculations yield the change in surplus for each of the other seven cohorts (The vector of prices $\dot{\mathrm{p}} = \left(\dot{p}_{A2}, \dot{p}_{B2}, \dot{p}_{C2}\right)$ contains the prices of A2, B2, and C2 when these were the only goods available for purchase in this market):

$$U_{AB}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{AB}\left(x^i,y^i,\mathrm{p},\dot{\mathrm{p}}\right)$$
$$\Delta v_A+\Delta v_B+v_{AB}+\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-\hat{p}_{AB}-p_{C2}+t\left(1-2x^i\right)+s\left(1-2y^i\right);$$
$$U_{BC}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{BC}\left(y^i,z^i,\mathrm{p},\dot{\mathrm{p}}\right)$$
$$\Delta v_B+\Delta v_C+v_{BC}+\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-\hat{p}_{BC}-p_{A2}+s\left(1-2y^i\right)+r\left(1-2z^i\right);$$
$$U_{AC}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{AC}\left(x^i,z^i,\mathrm{p},\dot{\mathrm{p}}\right)$$
$$\Delta v_A+\Delta v_c+v_{AC}+\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-\hat{p}_{AC}-p_{B2}+t\left(1-2x^i\right)+r\left(1-2z^i\right);$$

(0.30)
$$U_{A1}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{A!}\left(x^i,\mathrm{p},\dot{\mathrm{p}}\right)$$
$$\Delta v_A+\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-p_{A1}-p_{B2}-p_{C2}+t\left(1-2x^i\right);$$
$$U_{B1}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{B1}\left(y^i,\mathrm{p},\dot{\mathrm{p}}\right)$$
$$\Delta v_B+\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-p_{A2}-p_{B1}-p_{C2}+s\left(1-2y^i\right);$$
$$U_{C1}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{C1}\left(z^i,\mathrm{p},\dot{\mathrm{p}}\right)$$
$$\Delta v_C+\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-p_{A2}-p_{B2}-p_{C1}+r\left(1-2z^i\right);\text{ and}$$
$$U_{none}\left(x^i,y^i,z^i,\mathrm{p}\right)-U_{none}\left(x^i,y^i,z^i,\dot{\mathrm{p}}\right)=\Delta U_{none}\left(\mathrm{p},\dot{\mathrm{p}}\right)=\dot{p}_{A2}+\dot{p}_{B2}+\dot{p}_{C2}-p_{A2}-p_{B2}-p_{C2}.$$

Using the notation from above, the total change in consumers' surplus as a result of the introduction of A1, B1 and C1 for the 'triple-play' cohort (those who buy A1, B1 and C1 in the present period) is given by

(0.31)
$$\Delta CS_{bund}\left(\mathrm{p},\dot{\mathrm{p}}\right)=\iiint_{A_{bund}(\mathrm{p})}\Delta U_{bund}\left(x^i,y^i,z^i,\mathrm{p},\dot{\mathrm{p}}\right)\partial x^i\partial y^i\partial z^i.$$

The total change in consumers' surplus can be similarly calculated:

(0.32)
$$\Delta CS_j\left(\mathrm{p},\dot{\mathrm{p}}\right)=\iiint_{A_j(\mathrm{p})}\Delta U_j\left(x^i,y^i,z^i,\mathrm{p},\dot{\mathrm{p}}\right)\partial x^i\partial y^i\partial z^i,$$

again, where $A_j\left(\mathrm{p}\right)=\left\{\left(x^i,y^i,z^i\right):U_j\left(x^i,y^i,z^i,\mathrm{p}\right)>U_k\left(x^i,y^i,z^i,\mathrm{p}\right)\forall k\neq j\in K\right\}$.

The sum of these individual cohort changes is then the total change in consumers' surplus in which we are ultimately interested:

(0.33)
$$\Delta CS_{total}\left(\mathrm{p},\dot{\mathrm{p}}\right)=\sum_{j\in K}\left(\iiint_{A_j(\mathrm{p})}\Delta U_j\left(x^i,y^i,z^i,\mathrm{p},\dot{\mathrm{p}}\right)\partial x^i\partial y^i\partial z^i\right)$$

To summarize, the goal of this theoretical exercise is to derive the change in consumers' surplus as a result of the introduction of either two or three new goods into two or three (potentially related) markets, accommodating the possibility that the single seller of these two or three new goods may employ a bundling arrangement in selling them. The following section will focus on how firm-provided data including market shares (by consumption cohort), price

schedules, and elasticities can be used to 'calibrate' this model—that is, to infer the values of the unknown parameters, including the transport cost and Δv parameters—and then use the inferred values to calculate consumers' surplus.

Part II: Model Fitting

Having derived the theoretical model that we will use to estimate the benefits associated with the introduction of new goods, we are next faced with the task of 'fitting' the model to the available data. This section will first describe the procedure used to actually calculate the benefits in the two-good case, then move on to the three-good case; the reader will see that we used somewhat different techniques to estimate key parameter values in each of these cases, owing to the added complexity of the three good bundling arrangement.

Two Goods

For this portion of the analysis, our newly introduced goods are digital cable television service and high-speed internet service, for which we have very recent price, cohort market share, and elasticity data, as well as price data for the alternatives to these goods that existed before their introduction. In the two-good case, we have five unknown parameters, each of which figures in the welfare analysis (see (0.18) through (0.19)): the two transportation cost parameters *t* and *s*, and the three Δv parameters Δv_A, Δv_B, and v_{bund}. Our strategy here is to allow the transportation cost parameters to be identified by our own-price elasticity data, while price and market shares identify the Δv parameters.

Given own-price elasticities for both digital cable video service and cable high-speed internet service[37], we are able to find unique values for each of the transportation cost parameters. The own-price elasticity for good A1 is given by

$$\varepsilon_{A1,pA1} = \frac{\%\Delta D_{A1}(\mathrm{p})}{\%\Delta p_{A1}} = \frac{\partial D_{A1}(\mathrm{p})}{\partial p_{A1}} \cdot \frac{p_{A1}}{D_{A1}(\mathrm{p})} \tag{0.34}$$

In the context of our theoretical model (recall the expression for good A1's market share from (0.4)), this expression becomes

[37] The own-price elasticities for each of these goods have commonly been measured only in an independent pricing context, which necessitates this approach, instead of a joint calibration or estimation procedure (with the other unknown parameters).

(0.35) $$\varepsilon_{A1,pA1} = -\frac{1}{2t} \cdot \frac{p_{A1}}{D_{A1}(\mathrm{p})}$$

Solving for the transport cost parameter *t*, we have[38]

(0.36) $$t\left(\varepsilon_{A1,pA1}\right) = \frac{p_{A1}}{D_{A1}(\mathrm{p})} \cdot \frac{1}{2\varepsilon_{A1,pA1}}$$

A very similar calculation for B1 yields a value for the transport cost parameter *s*:

(0.37) $$s\left(\varepsilon_{B1,pB1}\right) = \frac{p_{B1}}{D_{B1}(\mathrm{p})} \cdot \frac{1}{2\varepsilon_{B1,pB1}}$$

With the transport cost parameter values in hand, it is straightforward to obtain the Δv parameters using cohort market share and price data. The appropriate parameter values (uniquely) solve the following three equations, which set the predicted cohort shares equal to the empirically observed cohort shares:

Using these calibrated values for the Δv parameters along with the transportation cost parameters *t* and *s*, we are able to evaluate expressions (0.18) through (0.19). The resulting estimated changes in consumers' surplus for each cohort are shown in Figures 14 and 16.

Three Goods

The procedure for estimating the benefits to consumers associated with the introduction of three new goods might have been a simple extension of the above methodology, except that solving for the vector of Δv parameters in the three good case (here, this vector includes seven parameters: Δv_A, Δv_B, Δv_C, v_{AB}, v_{BC}, v_{AC} and v_{bund}) is very computationally intensive. Hence, we instead utilized a two-stage method of approximating these Δv parameters through maximum likelihood estimation, not unlike ordinary least squares regression. Our method for finding the transportation cost parameter values, *t*, *s,* and *r*, is identical to that used in the two-good case. Hence, this discussion will focus on the two-stage method employed in finding the vector of Δv parameters.

[38] One challenge of using elasticities estimated from an independent pricing context is that we also lack the prices and market shares associated with those elasticities. For the purpose of this exercise, we utilize the market share-weighted average of the prices of each good (cable high-speed internet as A1, for example, averaging bundled and à la carte sales) as the price p_{A1}, and total product market share as the market share $D_{A1}(\mathrm{p})$.

In the process of simplifying (and therefore, making tractable) the three-good model, we implemented a restriction on the relationship between cohort shares and the vector of Δv parameters: for each class of goods (markets A, B, and C), we assumed that the 'marginal' consumer between the triple-play bundle and respective double-play bundle (here denoted $\tilde{x}$, $\tilde{y}$, or $\tilde{z}$) and the 'marginal' consumer between the respective double-play and à la carte choices (here $\tilde{x}_{AB}, \tilde{x}_{AC}, \tilde{y}_{AB}, \tilde{y}_{BC}, \tilde{z}_{AC}$, or $\tilde{z}_{BC}$) are identical. Hence, we have assumed that $\tilde{x}_{AB} = \tilde{x}_{AC} = \tilde{x}$, $\tilde{y}_{AB} = \tilde{y}_{BC} = \tilde{y}$, and $\tilde{z}_{AC} = \tilde{z}_{BC} = \tilde{z}$. For example, $\tilde{x}$ is the set of consumers who are indifferent between the triple-play bundle and buying a double-play bundle consisting of B1 and C1, while buying A2 from a competitor, while $\tilde{x}_{AB}$ is the set of consumers who are indifferent between an A1-B1 double play (along with C2) and buying only B1 from the cable provider. The assumption $\tilde{x}_{AB} = \tilde{x}_{AC} = \tilde{x}$, for example, therefore amounts to allowing those consumers who are indifferent between eliminating A1 from any bundle—triple play or either double play that features A1—to be the same. The full set of assumptions amounts to saying that this 'marginal consumer rule' is true for all three goods—A1, B1 and C1.

This somewhat innocuous restriction simplifies the mathematical form of each cohort market share while imposing only a small cost on the degrees of freedom of the model; in fact, this restriction allows only one more than the number of 'free' variables within the system as in the two-good case[39]. Once two of the four original 'marginal' consumers are eliminated from each product market (leaving only $\tilde{x}$ and $\hat{x}$, for example, in market A), the problem simplifies considerably.

The first stage of the estimation procedure amounts to choosing values for the 'marginal' consumers in order to minimize the difference between the empirically observed cohort shares and those that would be predicted by calculating cohort shares from the theoretical model based on the assumptions outlined in the previous paragraph. The resulting maximum likelihood problem can be thought of as choosing six predicted 'marginal' consumers—two in each product market—using seven unique 'data points':

[39] Precisely, these three restrictions effectively eliminate all but one 'bundle valuation parameter', which include v_{AB}, v_{BC}, v_{AC} and v_{bund}, since they imply a unique relationship between each parameter and some linear combination of product prices. Additionally, the first two sets of restrictions ($\tilde{x}_{AB} = \tilde{x}_{AC} = \tilde{x}$ and $\tilde{y}_{AB} = \tilde{y}_{BC} = \tilde{y}$) imply the third ($\tilde{z}_{AC} = \tilde{z}_{BC} = \tilde{z}$).

$$
\begin{aligned}
D_{bund}\left(xtilda,\ ytilda,\ \ldots zhat\right) &= D_{bund} \\
D_{AB}\left(xtilda,\ ytilda,\ \ldots zhat\right) &= D_{AB} \\
&\vdots \\
D_{none}\left(xtilda,\ ytilda,\ \ldots zhat\right) &= D_{none}
\end{aligned}
\tag{0.38}
$$

These seven data points include one equation for each cohort, with each a function of all or most of the six unknown 'marginal' consumers, here denoted *xtilda, ytilda, ztilda, xhat, yhat,* and *zhat*. The estimation procedure therefore involves estimating one equation of the form

$$
D\left(xtilda,\ ytilda,\ \ldots zhat\right) = \hat{D}, \tag{0.39}
$$

with $\hat{D}$ the observed cohort share, six unknown 'parameters' and seven 'data points.' Table A.1 below shows the estimation results for the first stage, with the six marginal consumers being the best-fit values.

The second stage of the two-stage estimation procedure amounts to using these predicted 'marginal' consumers in order to estimate the Δv parameters themselves. Each of the 'marginal' consumers in the full model (see Figure A.2 for a visual illustration) is a function of a subset of the Δv parameters; for example,

$$
\tilde{x}_{AB}\left(\mathrm{p}\right) = \frac{1}{2} + \frac{\left(\Delta v_A + v_{AB} + p_{A2} + p_{B1} - \hat{p}_{AB}\right)}{2t\left(\varepsilon_{A1,pA1}\right)} = xtilda.
$$

Using the predicted values for each of these twelve marginal consumers (where, because of our simplifying assumptions employed in the first stage of the procedure, many are identical in value), we can estimate the value of each Δv parameter. Much like the first-stage of the estimation procedure, we have a (somewhat) over identified system, wherein our twelve predicted 'marginal' consumers are the 'data points' and the Δv parameters our unknowns to be estimated. This single 'equation' to be estimated takes the form

$$
\hat{m} = m\left(\Delta v_A, \Delta v_A, \Delta v_A, v_{AB}, v_{BC}, v_{AC}, v_{bund}, \mathrm{p}, \varepsilon\right), \tag{0.40}
$$

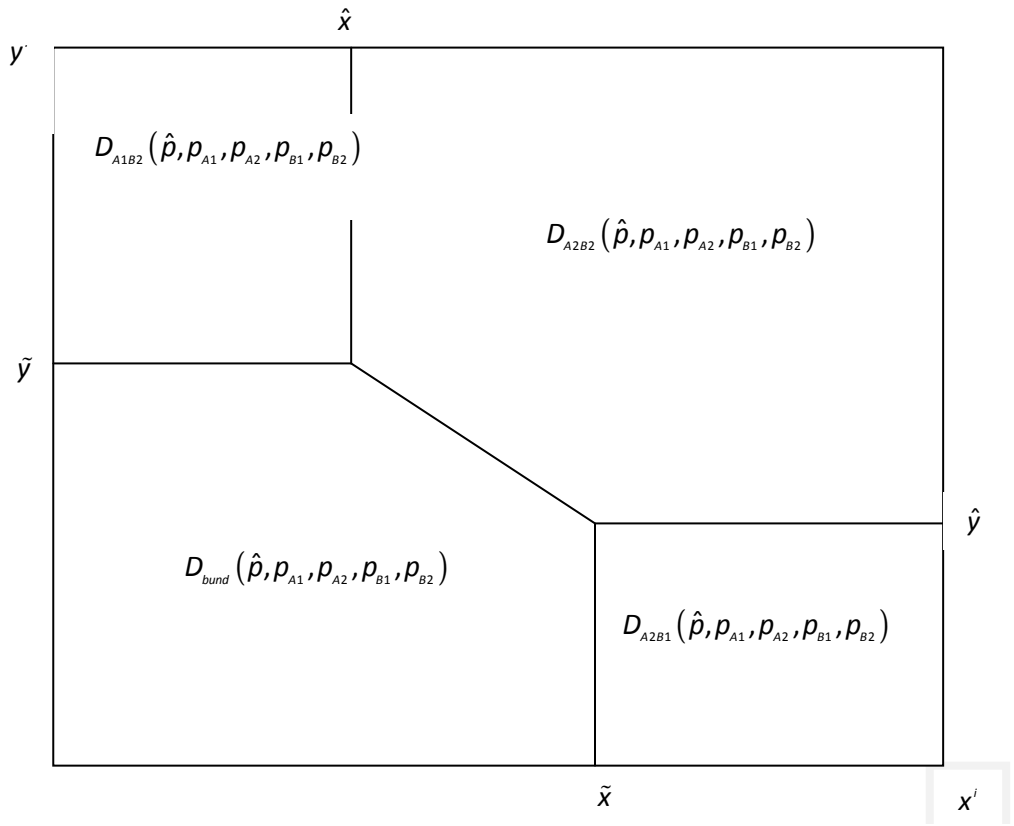
where $\hat{m}$ is the predicted 'marginal' consumer value from the first stage (*xtilda, ytilda,* etc.), and its theoretical value as a function of parameter values, menu prices, and elasticities.

The results of the second-stage estimation procedure are in Table A.2 below. Given these estimated parameter values, it is straightforward to 'plug (them) into' the welfare calculation of interest, seen in (0.31) through (0.33). In particular, we used the first-stage predicted values of each 'marginal' consumer (*xtilda, ytilda,* etc.) to form the bounds of

integration for each cohort expression, (0.31) through (0.32), while using the estimated Δv parameter values themselves in the ΔU_j expression itself[40].

[40] This is an improvement on the alternative, which involves using the estimated Δv parameter values throughout. On occasion the imprecision of the (second-stage) predicted 'marginal' consumer values place the bounds of integration outside of the unit interval, creating other problems for the welfare calculations.

Figure A.1: Illustration of Cohort Shares in Two-Good Case



This figure shows shares of customer cohorts in the two-good case: those who buy the two-good bundle (A1B1), one of the new goods à la carte (A1B2 or A2B1), and the old goods (A2B2) within a square of unit area. The negatively sloped line through the center of the square shows those consumers who are just indifferent between buying the bundle and buying neither A1 nor B1.

Figure A.2: Illustration of Cohort Shares in Three-Good Case

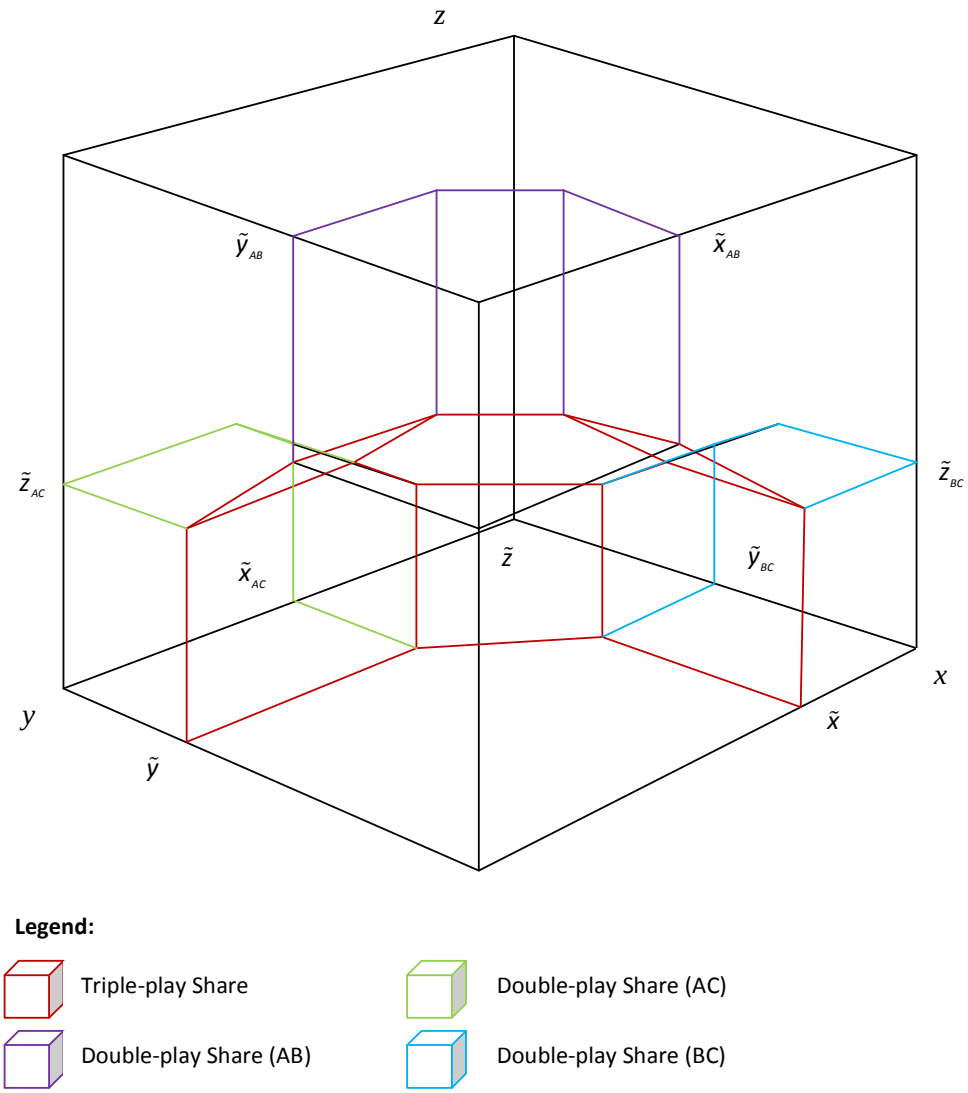


Table A.1: Three-Good Model First Stage Procedure ANOVA and Parameter Estimates

	Degrees of Freedom	Sum of Squares	Mean Square
Model	6	0.140451	0.0234084
Error	1	0.002075	0.002075
Uncorrected Total	7	0.142526	
Corrected Total	6	0.0534586	

Parameter	**Estimate**	**Asymptotic Standard Error**	**Confidence Interval (95%)**
xhat	0.0671529	0.0177546	0.158441, 0.292747
xtilda	0.798697	0.13351	0.897709, 2.4951
yhat	0.0599669	0.0176562	0.164377, 0.28431
ytilda	0.810195	0.134691	0.90121, 2.5216
zhat	0.0044628	0.0139933	0.173338, 0.182264
ztilda	0.504122	0.0756539	0.457152, 1.4654

Table A.2: Three-Good Model Second Stage Procedure ANOVA and Parameter Estimates

	Degrees of Freedom	Sum of Squares	Mean Square
Model	7	4.18239	0.597484
Error	5	0.0225733	0.00451467
Uncorrected Total	12	4.20496	
Corrected Total	11	3.80711	

Parameter	**Estimate**	**Asymptotic Standard Error**	**Confidence Interval (95%)**
Δv_A	17.0472	2.20655	11.3751, 22.7193
Δv_B	3.35366	2.46573	9.69202, 2.98471
Δv_B	2.44136	41.061	47.3367, −34.7853
v_{bund}	41.6939	4.18651	30.9322, 52.4557
v_{AB}	21.537	2.76235	14.4362, 28.6379
v_{AC}	18.93	2.75018	11.8604, 25.9996
v_{BC}	26.5422	2.94166	18.9805, 34.104

APPENDIX C: Authors' Biographies

Michael D. Pelcovits, Ph.D.

Michael Pelcovits is a principal with the consulting firm, Microeconomic Consulting and Research Associates (MiCRA). Dr. Pelcovits has thirty years' experience in regulation, intellectual property, and antitrust, with particular expertise in the telecommunications industry.

Dr. Pelcovits joined MiCRA in 2002, becoming one of the six principal economists of the firm. Since joining MiCRA, he has worked for corporate and government clients in the telecommunications and media industries. During the course of his tenure at MiCRA, Dr. Pelcovits has consulted for major U.S. and European telecommunications and cable corporations, the recording industry, and the Infocomm Development Authority of Singapore. He advised the government of Singapore on competition and interconnection policy issues relating to submarine cable landing stations and local private lines.
From 1988 to 2002, Dr. Pelcovits was employed by MCI Communications Corporation, and following its merger by WorldCom. He served as Vice President and Chief Economist of the corporation, where he was responsible for directing economic analysis of regulatory and antitrust matters before federal, state, foreign, and international government agencies, legislative bodies, and courts. Dr. Pelcovits served as MCI's representative during a consultative process with the Ministry of Telecommunications of Japan, which developed a costing model for interconnection pricing. He also presented MCI's case before the European Commission on mobile termination rates charged by the dominant carrier in the Netherlands, KPN.

Prior to his employment at MCI, Dr. Pelcovits was a founding principal of the consulting firm of Cornell, Pelcovits and Brenner. The firm specialized in telecommunications, broadcasting, transportation, and antitrust economics. Dr. Pelcovits served in two government agencies. From 1979 to 1981, he was a Senior Staff Economist at the FCC. From 1978 to 1979, he served with the Civil Aeronautics Board, Bureau of International Aviation.

During his career, Dr. Pelcovits has testified or appeared before thirty state regulatory commissions, the Federal Communications Commission, the Copyright Royalty Judges, the London Court of International Arbitration, the Office of Telecommunications (Oftel) of the UK government, the European Commission, the Ministry of Telecommunications of Japan, and the Civil Aeronautics Board. He has lectured widely at universities and government audience in the United States and overseas. He has published several articles on telecommunications regulation and international economics.

Dr. Pelcovits holds a B.A. from the University of Rochester (with highest distinction) and a Ph.D. from the Massachusetts Institute of Technology, where he was a National Science Foundation Fellow.

Abigail B. Ferguson, Ph.D.

Abigail Ferguson is an economist with the consulting firm, Microeconomic Consulting and Research Associates (MiCRA). She joined MiCRA in September 2008. Dr. Ferguson holds a B.A. from Davidson College and a Ph.D. from the University of Texas at Austin, earned in May 2009. Her dissertation features two theoretical essays on requirements tying and bundled rebates and how they should be treated by antitrust authorities.