Hudson Institute

The Economic Impact of Rural Broadband

Hanns Kuttner
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Publishers Note

This report has been revised since its original publication to correct calculation errors in Tables 1 and 2. This revised edition corrects those tables and the text reflects the corrected values in those tables.

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The Foundation for Rural Service (FRS) is a 501(c)(3) nonprofit organization based in Arlington, Va., that seeks to sustain and enhance quality of life in America by advancing an understanding of rural issues. Established by NTCA–The Rural Broadband Association in 1994, the vision of FRS is to harness the power of the rural communications industry to enrich lives in America. FRS supports rural telecommunications companies, communities and policymakers with educational information, products and programs to increase their community development and involvement.

The FRS mission emphasizes the benefits of rural telecommunications for the nation as a whole because FRS believes that America is a stronger and more unified nation when all of its communities have access to affordable, quality communications services. For FRS, the success of rural America is therefore not just a rural issue but a national imperative.

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Executive Summary

- Rural broadband companies contributed $24.1 billion to the economies of the states in which they operated in 2015. Of this, $17.2 billion was through their own operations and $6.9 billion was through the follow-on impact of their operations. The total represents the amount added to the Gross Domestic Product by this set of firms.

- While the industry produces a range of telecommunications services in rural areas, the economic activity accrues both to the rural areas served and to urban areas as well.

    - ❖ More of this benefit goes to urban than rural areas. Only $8.2 billion, or 34 percent of the $24.1 billion final economic demand generated by rural telecom companies accrues to rural areas; the other 66 percent or $15.9 billion accrues to the benefit of urban areas.

- The rural broadband industry supported 69,595 jobs in 2015, both through its own employment and the employment that its purchases of goods and services generated.

    - ❖ Jobs supported by economic activity created by rural broadband companies are shared between rural and urban areas. Forty-six percent are in rural areas; 54 percent are in urban areas. A combination of higher wages in the broadband industry and the specialized nature of the inputs used by the industry, inputs that are more likely to be found in urban than rural areas, drives this result.

- Rural broadband supported over $100 billion in e-commerce in 2015.

    - ❖ The largest share was in manufacturing, where a majority of transactions now involve electronic data exchange over broadband networks.

    - ❖ Nearly $10 billion involved retail sales; if broadband had the same reach in rural areas as it does in urban areas, sales would have been at least $1 billion higher.

Introduction

This study estimates the direct and indirect economic effects of the rural telecommunications, or broadband, industry on Gross Domestic Product (GDP). It then examines the economic impact of rural broadband on other industries. Rural broadband services are a necessary input in an economy where the ability to complete a transaction electronically has become indispensable. The economic impact would be greater if broadband was more widespread and as available in rural areas as it is in urban areas. Another economic impact is economic activity foregone because telecommunications capability in some rural areas is below that in urban areas.

This study quantifies the amount that the rural telecommunications industry contributes to final consumption as measured by GDP, both directly and indirectly.[1] The rural telecommunications industry as addressed in this report is composed of all those firms that meet the statutory definition of a rural telephone company.[2] (See Box 1.)

The direct effect represents the goods and services that rural telecommunications providers use to provide telecommunications services. The largest single input is wages paid to workers who perform a wide variety of specialized functions; they include linemen and other technicians who work to keep the network always "on," those who interact with customers, and those who carry out administrative functions such as billing, human resources, and executive direction. The industry requires a variety of capital inputs. These include network elements that are visible such as poles and wires as well as elements that are not as easily seen such as underground conduit and switches that connect customers to the broadband network. In addition to these specialized inputs, firms in the industry purchase fleet vehicles and general purpose office equipment such as personal computers. The indirect effect captures the impact made by those workers spending their wages; it also captures the value from vendors paying their workers and adding to the inputs they turn into the goods and services sold to rural telecommunications carriers. When sales to final consumers go up or down, GDP goes up or down by the sum of the direct and indirect effect.

The rural telecommunications industry also has an impact on the economy as an input that becomes part of the value of goods and services produced by other industries. In counting the sales to final consumers tallied in the GDP, the output of the rural telecommunications industry is an intermediate good used to create the final goods produced by other industries.

When the use of telecommunications services is an intermediate good, the amount paid for these services become part of other industries' final sales. These intermediate sales have an impact on

[1] Gross Domestic Product (GDP) sums up the economic effects of all industries. GDP is the value of all final goods and services produced in the economy over a period of time. An intermediate good becomes a final good or service when it reaches the ultimate consumer. A food manufacturer's purchase of grain involves an intermediate good; a grocery store's sale of cereal to someone who will eat it is a final sale.
[2] 47 U.S.C. §153(r)(37), added by the Telecommunications Act of 1996.

Box 1: The rural broadband industry

Rural telecommunications carriers came into existence when telecommunications meant voice communication over wire lines. In that era, Americans had universal access to voice telephony through a combination of carriers that operated only in rural areas and carriers based in urban areas that also served rural areas. Today, that industry is becoming the rural broadband industry, an industry which provides the "pipes" through which many services, including voice telephone, flow. The firms are also becoming more diverse as they offer not only broadband but also services that use broadband.

According to the definition of a rural telephone company in the Telecommunications Act of 1996, a carrier is deemed a rural telephone company based on either geographic features of its service area or its size. The geographic component has four measures that lead to an area being classified as rural. One measure uses a population test. The test defines areas that are urban; anyplace not covered by the urban definition is rural. Urban areas are where there are 10,000 or more people in an incorporated place (such as a village or city) or are areas which were included in an urbanized area by the Bureau of the Census prior to August 10, 1993. Another measure follows the number of telephone lines; carriers that provide fewer than 50,000 access lines, serve areas that have fewer than 100,000 access lines, or that have less than 15 percent of access lines in areas with more than 50,000 people qualify as rural telephone companies.

There are many approaches to defining rural used by federal government agencies based on such factors as total population and commuting patterns. Commuting patterns figure in the Office of Management and Budget's metropolitan statistical areas (MSAs) that seek to define economically integrated areas and follow county lines. Using the MSA/non-MSA line as the line between urban and rural, 19.3 percent of Americans live in rural America. Many live in areas that are extensions of a non-rural broadband carrier's urban service area. The FCC's definition puts some rural telephone companies in areas that by other agencies' definitions, such as the MSA, are urban (the rural broadband company profiled in Box 3 is an example).

The FCC's definition focuses on the characteristics that make an area more costly to serve; the most important of these is how densely packed potential customers are. The FCC definition also leads to a more granular line between urban and rural, going below the county-line level. More detailed lines and a multi-pronged test of what makes an area rural puts a smaller share of the country in the area served by rural broadband carriers than the MSA-based definition. About 7.6 percent of the US population lives in areas served by rural broadband carriers.

In addition to geography, the industry definition must choose what services to include. As technology has advanced, the scope of telecommunications services has broadened. Most recently, broadband has become a "pipe" through which many services can flow: voice telephony, through both wired and wireless connections; cable television service; and all the uses of the Internet: email, video, and now a wide variety of software applications or "apps."

In moving beyond voice telephony, rural telephone companies have expanded beyond the set of services centered on voice telephony that they provided in the pre-broadband era. "Rural telephone company" has become a term that describes the firms' historical roots but one which describes a declining source of their revenues.

The scope of this report includes all the rural telephone companies and the economic impact of all the services they provide, both the regulated service that has been their historical focus and newer services they offer.

the economy overall, outside the rural broadband industry's contribution to GDP. In the framework of this report, the Internet's contribution to the economy requires the services that the telecommunications industry provides. The cost of Internet services is one of the inputs used by

those firms to create the goods and services they sell. Internet-based sales would not occur without services provided by the telecommunications industry.

Within the telecommunications industry, rural telecommunications firms provide the connections that make possible purchases by rural consumers and sales by rural producers. These services that enable economic activity are an economic impact of the rural broadband industry. Again, they are not part of the GDP-based measure of rural broadband's economic impact because other firms, such as retailers and Internet content providers, make the sale to the final consumer. Nonetheless, where final sales could not be made without services provided by rural telecommunications firms, there is an economic effect. A full accounting of the industry's economic effect must take these amounts into account to create a full understanding of the economic effect of the rural telecommunications industry.

The Transition to Broadband

This report builds on a Hudson Institute study produced in 2011 that first measured the economic impact of the rural telecommunications sector as of 2009. Since then, regulated telephone service has declined as a share of the industry's output and broadband has grown. With the transition to broadband, firms in this sector have increased the scope of services they offer.[3]

Many consumers first experienced this transition in the Internet boom of the 1990s through Internet service providers accessed by dial-up connections to the telephone network. Like many technology transitions, the transition to broadband has also opened new possibilities. For rural telephone companies, this process involves a transition from dial tone telephone service that provides access to the public switched telephone network to broadband that provides access to the Internet as the product that defines the industry.

Thus far, new possibilities include offering access to services that require the capacity broadband offers such as distance education, telemedicine, remote monitoring systems aided by live-stream video systems using cameras as well as entertainment such as video content and multi-player interactive gaming. The data for 2015 in this report reflects an industry that is further along the transition from telephone to broadband and draws a growing share of its revenue from services other than voice telephone. It also reflects the growth of "e-commerce" that relies on broadband to provide the data transmission that is fundamental to e-commerce.[4]

The core product: from voice telephone to data transfer. Before this transition began, "telecommunications" was synonymous with "telephone service." A copper wire network defined the era. This network allowed connections to be made through the public switched telephone network to someone next door or around the world. Voice telephony was the industry's primary service. At the end of the transition, voice telephony will be only one of the services available from

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[3] Broadband has its roots in what began with a network sponsored by the federal government in the 1960s. Other networks emerged, and the federal government withdrew from much of its role in the 1990s (National Science Foundation, "Fact Sheet: A Brief History of NSF and the Internet," https://www.nsf.gov/news/news_summ.jsp?cntn_id=103050.)

[4] The broader scope of services sold by firms in the industry is reflected in the relationship between expenses related to regulated telephone service and the total size of the firm. Total firm size defines the direct economic impact presented in this study. The Hudson 2011 study used data from a sample of Kansas firms. Total expenses were 1.30 times as large as regulated expenses. This report uses data from a larger and more geographically diverse group of firms. In the more recent sample total expenses were 1.98 times the size of regulated expenses.

the rural broadband industry. Signals that travel over glass fiber for some or all of their journey from point to point characterize the new network just as copper wire characterized the old.

These new telecommunications networks support digital data transfer. The amount of data moved across networks has grown from 100 Gigabytes a day in 1992 to 100 a second in 2002 to 16,144 a second in 2014. Some of the uses behind this data have become familiar. Email and resources and services that can be accessed by using browser software to reach a web site are examples. Video currently plays the greatest role in increasing the volume of data. One technology supplier has suggested that machine-to-machine connections may be the source of the greatest increase in the next five years.[5] Homes are one point of origin for machine-to-machine connections. Internet-enabled appliances, heating and cooling systems, and home security and surveillance systems can support new concepts of home automation. In healthcare, machine-to-machine connections can alert healthcare providers of adverse events such as spikes in blood pressure or failure to take medications if dispensers are not opened. All these uses point to more and more demand for data and more and more demand for capacity to move that data. Increased expectations about how much and how fast data can move increase the gap between places with access to broadband and those without.

Universal service. The public policy commitment to universal service began when telecommunications was synonymous with transmitting voice from place to place. The concept of universal telecommunications service in the United States took form in the early 20th century.[6] Universal service, meaning service available in sparsely populated areas at prices similar to those charged in more densely populated areas, was promoted through various means.[7]

In the Telecommunications Act of 1996 Congress codified universal service as a commitment that "quality services ... be available at just, reasonable, and affordable rates"; that "[a]ccess to advanced telecommunications and information services should be provided in all regions of the Nation"; and, that "[c]onsumers in all regions of the Nation ... should have access to telecommunications and information services ... that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to rates charged for similar services in urban areas."[8] In its 2011 *USF/ICC Transformation Order*, the Federal Communications Commission (FCC) said broadband has become the "universal service" that fulfills the statutory intent.[9] The market response reflected consumer demand and the cost

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[5] Cisco Systems, 2015, "The Zettabyte Era: Trends and Analysis," http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/VNI_Hyperconnectivity_WP.pdf

[6] "Universal service" was part of a slogan adopted by the then-named American Telephone and Telegraphy Company (AT&T) that implied AT&T would be the universal provider. The commitment itself is often referred to as the Kingsbury Commitment after a letter from AT&T official Nathan Kingsbury in which AT&T made a commitment to the Justice Department to open up access to the network that linked Bell System companies to competing telephone companies. (Letter from Nathan Kingsbury, Vice President, American Telephone and Telegraphy Company to the Attorney General, December 13, 1913, http://vcxc.org/documents/KC1.pdf.) This commitment provided access to carriers but did not assure that carriers would serve all of the country; this aspect of "universal service" would take decades to achieve.

[7] For example, in 1970 the FCC adopted the Ozark Plan, giving a greater allocation of costs from local plant—wires and switching equipment—to interstate service, allowing more costs to be shared with those in urban areas calling rural telephone company subscribers. Peter Temin and Louis Galambos, *The Fall of the Bell System: A Study in Prices and Politics* (New York: Cambridge University Press, 1987, 54.

[8] 47 U.S.C. §254(b).

[9] *Connect America Fund et al.*, WC Docket No. 10-90 et al., Report and Order et al., 26 FCC Rcd 17663 (2011) (*USF/ICC Transformation Order*)

of providing service, bringing service to areas where potential customers were closer together and thus per-customer costs lower. How much capital it takes to serve a customer determines where market-disciplined providers meet that demand.[10] The result has been broadband networks that do not yet reach as far as the copper wire network brought telephone service. Completing the transition to broadband has become the universal service goal.

America has large variations in population density. On average, there are 87.4 Americans per square mile. At the state level, New Jersey is the most densely populated state, with 1195.5 residents per square mile. It is 1,000 times more densely populated than Alaska, the least densely populated state, with 1.2 residents per square mile, and 200 times as densely populated as Wyoming, the second least densely populated state, with 5.8 residents per square mile.[11] Distance between customers accounts for a substantial portion of the cost of providing telephone service. A carrier with a longer average distance between customers must spend more on facilities, particularly miles of fiber and related costs of deployment, than a carrier with a shorter average distance between customers. The fundamental fact faced by rural broadband carriers is service territories where potential customers are further apart than they are in urban America.

In the era which created universal access to voice telephony, universal service relied on support from prices set by federal and state regulators. The terms on which rural telephone companies provided access to and from the national network created financial conditions which made it feasible to deploy networks even in areas with the fewest customers per mile. Firms serving rural areas could invest capital to bring wires down rural roads and install in crossroads hamlets the complex equipment required to switch connections to and from the national network. The prices used in these arrangements mitigated the higher costs that stemmed from larger distances between customers for rural companies.

As the telecommunications sector began a process of deregulation after the settlement of the government's anti-trust litigation against AT&T in 1982, a new approach to assuring the national commitment to access in all regions of the country and reasonably comparable service in both urban and rural areas took form. The Universal Service Fund became a fiscal mechanism to aggregate funds from all users of telecommunications services. One of its purposes has been to make it possible for carriers to serve areas characterized by low population density.

More recently, the FCC has begun to implement a new set of financial arrangements intended to make broadband rather than voice telephony the service that should be universally available. In its 2011 *USF/ICC Transformation Order*, the FCC embraced a new approach to universal service. Four types of support for higher costs became subject to a $4.5 billion per year budget.

The FCC's new concept of universal service meaning access to broadband rather than voice communication reflects revenue trends in how consumers use telecommunications services.

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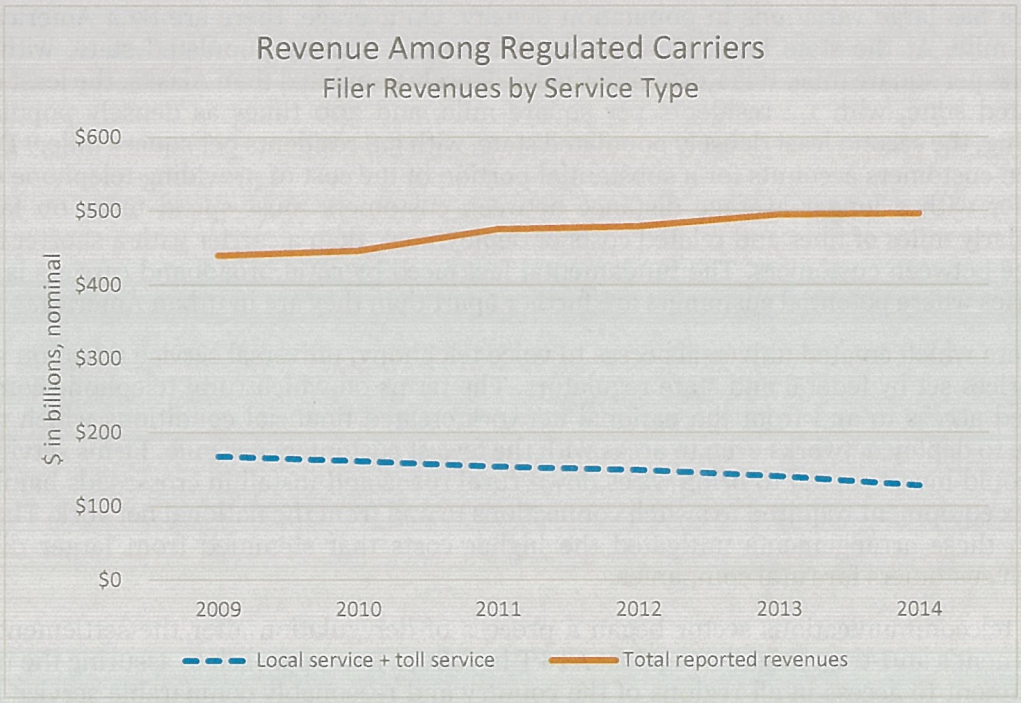
[10] Glass fiber supports the highest speeds. An analysis of the costs in several hundred projects to deploy fiber to the customer's premises in areas served by rural broadband companies found the cost, in 2010 dollars, was $4,430 per location served plus $12,911 per route mile. These costs reflect average costs in projects carried forward to the engineering phase; an overall average would likely be higher as it would include projects where early estimates were so high that the project was not carried forward to the engineering phase. ("Nebraska Rural Independent Companies' Capital Expenditure Study. Predicting the Cost of Fiber to the Premise. January 2011," http://www.bbpmag.com/docs2011/vantage%20Point%20model%20background.pdf.)

[11] U.S. Census Bureau, "Resident Population Data," http://2010census/data/apportionment-dens-text.php. Washington, DC has a higher population density than New Jersey: 9856.5 residents per square mile.

Changes in consumer behavior have resulted in voice telephony representing a declining share of the industry's revenues.

Figure 1.



Source: Table 1.1, "Filer Revenue by Service Type: 2004-2014," in Federal-State Joint Board on Universal Service, *Universal Service Monitoring Report: CC Docket No. 96-45. (Data Received Through September 2015),* Washington, DC: Federal-State Joint Board on Universal Service, 2015.

Figure 1 shows that across both rural and urban carriers regulated by the FCC, total revenue increased between 2009 and 2014, but the share attributable to telephone service declined over that period. The divergent directions of the two trends reflects the growing role of broadband and the relative decline of voice telephony over wireline networks in the basket of telecommunications services Americans consume.

The Transition to Broadband in Rural America

How fast is fast enough? The point at which service is fast enough to be considered "broadband" has proven to be an elusive concept. At the time of the 2011 *USF/ICC Transformation Order*, the FCC said that 4 megabits per second (Mbps) downstream and 1 Mbps ("4/1") upstream would define the statutory term "advanced telecommunications capability" described as "high-speed, switched telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video telecommunications…." In arriving at the 4/1 standard, the FCC noted that streaming video service required between 1 and 5 Mbps. Also, consumers demanded

service that allowed them to do multiple things simultaneously; for example, one household member reading email while another watched a video. At the time, it seemed that the 4/1 standard would allow for this.

However, consumer expectations rapidly increased. In its 2015 Broadband Progress Report, the FCC again looked at what was available in the marketplace, the speed requirements required by common applications, and what level of service consumers chose when provided options. The FCC then drew the line to at least 25 Mbps download and at least 3 Mbps upload.[12] Among those living in urban areas, 99 percent of Americans live in areas that by the FCC's measure had access to fixed broadband speeds of 10/1 or better.[13] It would be hard to argue that service in rural America was "comparable" to urban America if the FCC aimed only for 4/1 service.

Many Americans who live in the area served by rural broadband providers now have access to service that meets or exceeds both the 10/1 and the more recent 25/3 standard. An uncertain number do not. (See Box 2.)

Box 2: What speed is available where?

How much of America does not yet have access to broadband? An accurate answer to that question would require a roster of every possible point of service in the United States and reports from every carrier listing the maximum speed they offer at every area in their service territory.

Available data systems do not acquire data at the level of detail required to provide a definitive, accurate answer. Instead, they provide an approximation. The FCC requires carriers to report what level of service they offer at the Census block level. Blocks, block groups, and tracts are Census geographic units, with blocks nested in block groups and block groups nested in tracts. Tracts are subdivisions of counties or similar units. Most tracts fall in the range of 1,200 to 8,000 people. Blocks are the smallest unit of geography at which the Census Bureau aggregates data. The Census Bureau establishes boundaries for blocks. All of the landmass of the United States, Puerto Rico, and the Island Areas has been allocated to blocks. For the 2010 Census, the Census Bureau delineated the United States into 73,057 tracts, and these tracts into 217,740 block groups, and the block groups into 11,078,297 blocks.

Other geographic lines may cross Census tract and block lines. Census tracts and blocks do not align with Zip code boundaries or utility service areas. The FCC asks carriers to draw service area maps and suggests software that would help translate these maps into locations of Census blocks.

In the data reported to the FCC, if a carrier provides service above a particular speed anywhere in the Census block, that block gets counted as an area where that speed is available, whether one or all households in the Census block live could obtain service at that speed level. Thus a count of how many Americans have broadband with a particular speed available based on data reported to the FCC is an upper bound estimate of the actual number.

[12] Federal Communications Commission, "2015 Broadband Progress Report and Notice of Inquiry on Immediate Action to Accelerate Deployment," https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-10A1.pdf

[13] 99 percent was an upper bound on the number who had availability. See Box 2 for a discussion of how data reporting practices lead to reporting of an upper bound rather than an actual number.

Direct and Indirect Economic Effects of the Rural Broadband Industry

Rural broadband providers directly added $17.2 billion to the U.S. economy, as measured by GDP, in 2015 (See Table 1). These direct effects sum up the operation of the industry over one year. The direct effect supported further rounds of spending, a process that reflects the degree to which those purchases become further consumption or instead become savings, taxes, or imports. These further rounds are the indirect effects, $6.9 billion in 2015. Thus the industry's total 2015 effect was $24.1 billion. Appendix B explains data and methods for this assessment.

Table 1. Economic Impact of Rural Telecommunications, 2015

	Direct Impact ($, millions)	Additional Impact ($, millions)	Total Impact ($, millions)	Employment (number of jobs)
Alabama	241.7	87.0	328.8	1,014
Alaska	329.8	109.6	439.3	1,027
Arizona	258.4	100.2	358.7	1,085
Arkansas	479.9	148.4	628.3	1,511
California	363.8	213.1	576.9	1,617
Colorado	196.2	104.0	300.3	840
Connecticut	0.0	0.0	0.0	0
Delaware	0.0	0.0	0.0	0
District of Columbia	0.0	0.0	0.0	0
Florida	1,241.9	538.4	1,780.3	5,955
Georgia	720.8	369.0	1,089.8	3,212
Hawaii	44.2	17.3	61.5	175
Idaho	232.8	62.8	295.6	903
Illinois	313.3	153.1	466.4	1,318
Indiana	335.7	109.6	445.3	1,251
Iowa	429.0	95.9	525.0	1,431
Kansas	468.5	171.5	640.1	1,283
Kentucky	312.3	102.1	414.4	1,239
Louisiana	287.5	107.5	395.0	1,273
Maine	114.2	35.6	149.8	453
Maryland	6.9	3.3	10.3	28
Massachusetts	2.4	1.1	3.5	8
Michigan	234.5	85.4	319.9	960
Minnesota	659.4	251.8	911.3	2,527
Mississippi	132.0	35.9	167.9	492
Missouri	527.5	235.0	762.4	1,917
Montana	258.2	75.9	334.1	1,056

Nebraska	205.3	54.3	259.6	678
Nevada	87.1	28.3	115.4	327
New Hampshire	40.6	15.3	55.9	150
New Jersey	103.7	52.7	156.4	376
New Mexico	187.9	68.0	255.9	845
New York	443.8	206.4	650.1	1,419
North Carolina	1,246.6	477.3	1,723.9	5,240
North Dakota	228.0	48.4	276.4	616
Ohio	453.7	181.1	634.8	1,863
Oklahoma	421.3	177.4	598.7	1,970
Oregon	259.6	93.1	352.7	1,030
Pennsylvania	795.4	374.6	1,170.0	3,233
Rhode Island	0.0	0.0	0.0	0
South Carolina	618.0	230.3	848.3	2,725
South Dakota	236.1	50.2	286.3	734
Tennessee	532.5	247.4	779.9	2,606
Texas	1,336.6	719.9	2,056.5	6,388
Utah	109.7	48.8	158.4	591
Vermont	67.1	20.8	87.9	239
Virginia	402.7	196.2	599.0	1,453
Washington	310.2	136.2	446.3	1,130
West Virginia	155.2	45.5	200.7	518
Wisconsin	689.2	219.9	909.2	2,625
Wyoming	82.1	19.4	101.5	262
Total	17,203.3	6,925.4	24,128.7	69,595

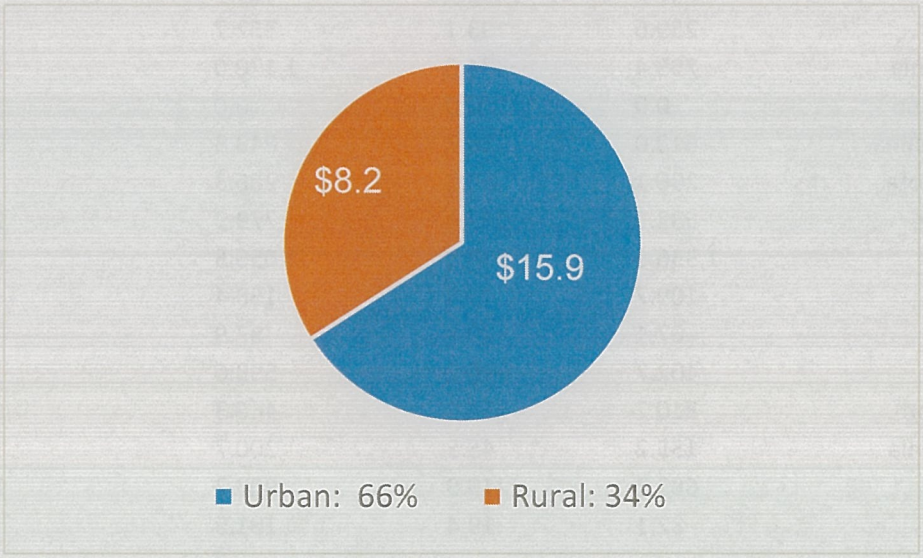
Source: Hudson Institute modeling using data from "Universal Service Fund Data: NECA Study Results," https://www.fcc.gov/general/universal-service-fund-data-neca-study-results, an unpublished Bureau of Economic Analysis table containing Regional Input-Output Modeling System (RIMS II) data, and an unpublished Bureau of Labor Statistics table containing data from the Quarterly Census of Employment and Wages

The economic activity created demand that supported 69,595 jobs spread throughout the economy. While some are jobs held by people employed by the rural broadband firms, more are jobs that rely on the goods and services purchased by telecom companies and their employees. Suppliers to the telecom sector range from electrical utilities and contractors that print and mail bills, suppliers that play a role in the ongoing operation of a broadband service provider, to the companies who provide the specialized engineering services required to layout a broadband network and companies that provide components in those projects that come into play when a company decides to make large capital investments to create or upgrade broadband networks.

An examination of where these dollars go shows that more end up in urban areas than rural. Slightly more than one-third of final economic demand generated by rural telecom companies accrues to rural areas; the remaining share benefits urban areas (Figure 2). This reflects the

relative strengths of rural and urban economies and how they interact. Production of agricultural commodities overwhelmingly takes place in rural areas and the largest share of capital goods comes from urban areas. A job may be on the payroll of a rural broadband provider but much of the goods and services those workers buy come from outside the area. Broadband is a relatively capital intensive sector, and the capital goods overwhelmingly come from outside the area rural broadband providers serve.

Figure 2: Economic Impact of Rural Broadband, 2015: Urban v. Rural Economies



Source: Hudson Institute modeling using data from "Universal Service Fund Data: NECA Study Results," https://www.fcc.gov/general/universal-service-fund-data-neca-study-results, an unpublished Bureau of Economic Analysis table containing Regional Input-Output Modeling System (RIMS II) data, and an unpublished Bureau of Labor Statistics table containing data from the Quarterly Census of Employment and Wages

In looking at patterns across states, there is variation in the degree of total impact from economic activity in the rural broadband industry (Table 2). This reflects the differences in the presence of firms that provide the goods and services in the rural broadband services in the state's economy. The impact of one dollar added to or subtracted from rural broadband providers is lowest in North Dakota and highest in California (Appendix B, Table B-1). In other words, a company in North Dakota purchasing electronic switches for its broadband network is more likely to buy from an out-of-state company than is a company operating in California.

Table 2. Economic Impact, by State, and Urban/Rural Location (Dollars, in Millions)

	Rural	Urban	Total
Alabama	105.9	222.9	328.8
Alaska	196.4	242.9	439.3
Arizona	69.0	289.7	358.7
Arkansas	384.3	244.0	628.3
California	81.2	495.7	576.9
Colorado	68.2	232.1	300.3
Connecticut	0.0	0.0	0.0
Delaware	0.0	0.0	0.0
District of Columbia	0.0	0.0	0.0
Florida	308.2	1,472.1	1,780.3
Georgia	307.0	782.9	1,089.8
Hawaii	21.2	40.2	61.5
Idaho	132.8	162.8	295.6
Illinois	92.9	373.5	466.4
Indiana	211.0	234.3	445.3
Iowa	288.0	237.0	525.0
Kansas	446.1	194.0	640.1
Kentucky	272.9	141.5	414.4
Louisiana	111.6	283.5	395.0
Maine	63.6	86.2	149.8
Maryland	2.2	8.0	10.3
Massachusetts	0.6	2.9	3.5
Michigan	82.3	237.6	319.9
Minnesota	279.1	632.2	911.3
Mississippi	99.9	68.0	167.9
Missouri	327.1	435.3	762.4
Montana	220.0	114.2	334.1
Nebraska	109.6	149.9	259.6
Nevada	28.0	87.4	115.4
New Hampshire	39.3	16.5	55.9
New Jersey	25.5	130.9	156.4
New Mexico	103.2	152.7	255.9
New York	103.6	546.6	650.1
North Carolina	509.7	1,214.3	1,723.9
North Dakota	243.5	32.9	276.4

Ohio	164.9	469.9	634.8
Oklahoma	224.1	374.7	598.7
Oregon	69.1	283.6	352.7
Pennsylvania	326.5	843.5	1,170.0
Rhode Island	0.0	0.0	0.0
South Carolina	317.1	531.2	848.3
South Dakota	158.5	127.8	286.3
Tennessee	272.1	507.8	779.9
Texas	402.4	1,654.1	2,056.5
Utah	37.9	120.6	158.4
Vermont	56.9	31.0	87.9
Virginia	184.3	414.6	599.0
Washington	103.9	342.4	446.3
West Virginia	144.8	55.8	200.7
Wisconsin	334.5	574.6	909.2
Wyoming	71.9	29.6	101.5
Total	8,202.8	15,925.9	24,128.7

Source: Hudson Institute modeling using data from "Universal Service Fund Data: NECA Study Results," https://www.fcc.gov/general/universal-service-fund-data-neca-study-results, an unpublished Bureau of Economic Analysis table containing Regional Input-Output Modeling System (RIMS II) data, and an unpublished Bureau of Labor Statistics table containing data from the Quarterly Census of Employment and Wages

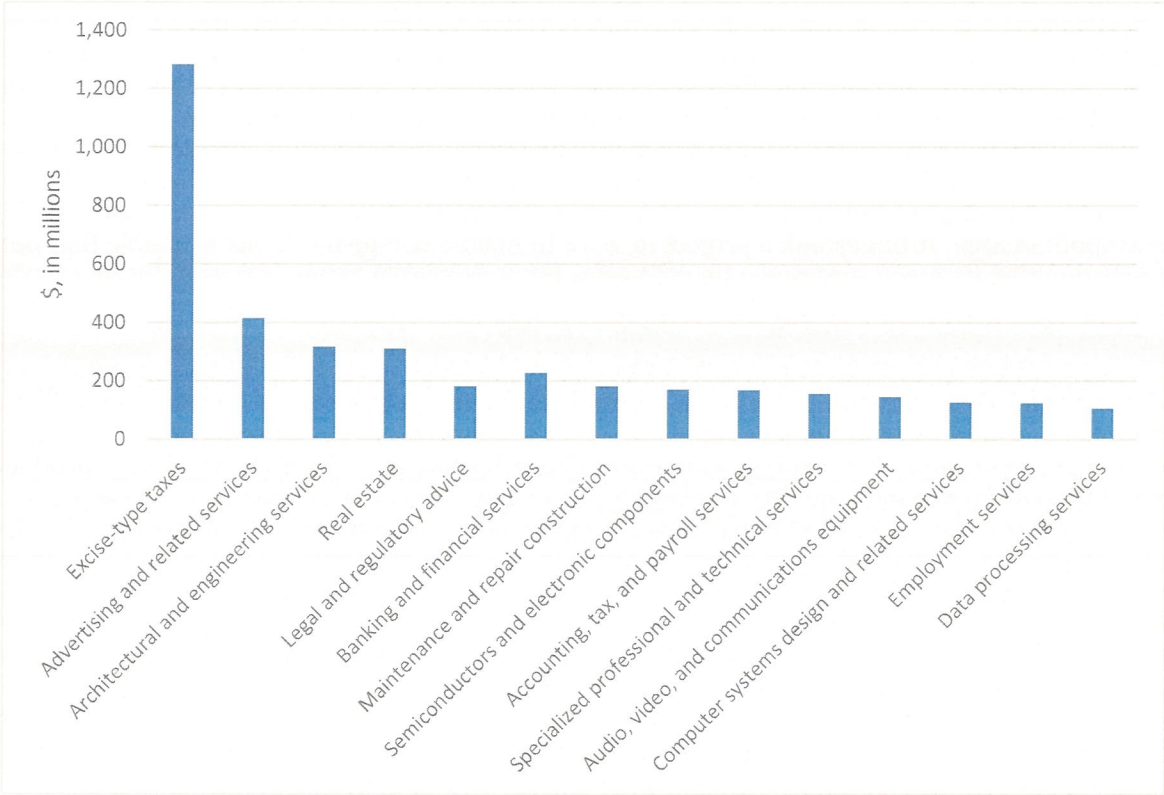
Inputs Used to Produce Rural Broadband Services

The geographic division of economic activity generated by rural broadband providers between urban and rural areas reflects the nature of the inputs used to create broadband services. The largest categories are capital consumption—using up part of the capital investment required to create broadband networks and compensation of labor, which represents about 21 percent of expenditures.

Many of the inputs purchased by rural broadband providers are more likely to come from urban areas than the rural areas these firms serve. Figure 3 shows the ten largest categories of inputs that come from outside the telecommunications sector.[14]

[14] This reflects the work of the Department of Commerce's Bureau of Economic Analysis to develop an understanding of what inputs are required to produce an industry's output. These input-output tables provide a recipe for the economy: $1 of output costs so many cents of engineering services, equipment, etc.

Figure 3: Inputs Used by Rural Broadband Providers, 2015



Source: Hudson Institute modeling using Bureau of Economic Analysis, *2002 Standard Make and Use Tables at the Detailed Level,* Washington, DC, 2008.

The largest "purchase" required to produce telecommunications services is the taxes that telecommunications sellers collect and remit to governments. The other categories of inputs are goods and services more likely to be produced outside the provider's service area, either the state's urban areas or out-of-state. Many are specialized professional services (those of engineers, architects, lawyers, accountants, and bankers) that concentrate in urban areas, where overall demand is higher, where the necessary economies of scale are likely to be met, and where positive externalities from concentration of an industry ("Silicon Valley" is an example) bring like firms together.

Examples of Goods and Services Purchased

Rural broadband companies often must turn to markets outside their own service areas to obtain the goods and services they use as inputs for the products they provide. Broadband networks are capital intensive. A look at recent projects suggests that rural carriers increasingly turn to urban-based suppliers for goods and services necessary to complete their home-area capital investment programs. Emery Telephone, doing business as Emery Telecom, is a rural broadband firm based in Orangeville, UT, and serves an area on the other side of the Wasatch Range from Salt Lake City and the bulk of Utah's population. This carrier carried out a capital investment project in 2013

whose costs totaled more than one-quarter of its total expenses that year. The largest outside contractor for the project was an electric supply company in Salt Lake City that supplied cabling and electrical supplies. A firm from Ogden, UT, north of Salt Lake City, did cable and fiber installation.[15] Perry-Spender Rural Telephone Cooperative, which does business as PSC, serves an area in southern Indiana between Evansville and Louisville, KY. It undertook a capital investment project of the sort that involves cabling, conduit, cabinet, and hardware such as repeaters. The largest-dollar contract in 2013 went to a firm that does utility construction outside its service area but still in rural Indiana; the second largest went to a firm in Columbus, OH, that specializes in fiber optic splicing.[16] Colton Telephone Company serves 928 lines at the edge of the Portland, OR, metropolitan area. It undertook a project in 2014 to make fiber-to-the-home available that both nearly doubled its assets and made its debt grow by more than a factor of five. To carry out this project, Colton turned to a utility construction company closer to Portland and secured the services of an engineering firm from near Salt Lake City.[17]

Many categories of services come from sellers that target a statewide or national market. For example, consultants who prepare regulatory filings required of telecommunications providers tend to concentrate in state capitals and around Washington, DC. The high technology products required to deliver broadband services largely come from distant urban markets. The experience of Dickey Rural Networks (DRN) provides an opportunity to see those flows in action. DRN has its headquarters in Ellendale (population: 1,300) the county seat of Dickey County, near the North Dakota-South Dakota border. Founded in 1950, this rural coop entered the 21st century with an aging network that required more and more resources to maintain. DRN decided to build a fiber access infrastructure. By 2011 DRN had constructed a network that combined gigabit passive optical network and point-to-point gigabit Ethernet (GE). Current service offerings peak at 100 Mbps, but DRN has plans to offer 500 Mbps service. The range of services offered expanded to include voice, video, high speed data, in-home networking and video surveillance. To create this network, DRN purchased equipment and services from a vendor in California.[18]

The Role of Rural Broadband in Other Sectors of the Economy

The economic activity considered thus far in this report has been the level of current economic activity supported by rural broadband providers through the purchases of goods and services they produce. This does not cover the full range of their economic impact. That full range involves a wide variety of activities that have changed or become more efficient through one particular broadband product, access to the Internet. They include impacts on how people search for jobs, how they learn, and how they use the health care system. In all these domains, connections to broadband access and use have been found. These impacts are in addition to broadband's impact as an input to production processes across the economy. For many industries, telecommunications is a necessary input. Thinking about what the economy would be like without telecommunications requires thinking about the economy of the early 20th century and before. Without telecommunications, economic transactions would have to be face-to-face or via another service

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[15] Emery Telephone, "Form 990. Return of Organization Exempt from Income Tax, 2013," http://www.guidestar.org/FinDocuments/2013/870/217/2013-870217682-0b054f6a-9O.pdf

[16] Perry-Spender Rural Telephone Cooperative, "Form 990. Return of Organization Exempt from Income Tax, 2014."
http://www.guidestar.org/FinDocuments/2013/350/921/2013-350921201-0a949db3-9O.pdf

[17] Colton Telephone Company, "Form 990. Return of Organization Exempt from Income Tax, 2014," http://www.guidestar.org/FinDocuments/2014/930/143/2014-930143500-0bccf2af-9O.pdf.

[18] "Calix Case Study. Creating a New Business Model through Network Transformation," www.calix.com/content/dam/calic/marketing-documents/public/Calix_DRN_case_study.pdf.

to which the government has made a universal service commitment, the postal service. Many parts of the economy rely on telecommunications to make transactions possible, or at least more efficient than they would be if buyers had to come together face-to-face. Telecommunications services get used throughout the economy. Thus, in some sense, almost all of the economy depends on telecommunications services. In some areas its value stems from how much more costly second-best technologies are. Face-to-face and paper sent by mail have higher marginal costs than phone, fax, or email. The second-best technologies also take more time, and time is costly. In other areas telecommunications is a necessary part of the service. Firms that provide call centers or Internet-based content could not exist without telecommunications.

The rise of the Internet has inspired efforts to count the dollar value of transactions that use this technology. These transactions can be traced and their dollar amount counted up as a measure of Internet-facilitated economic activity. In these economic transactions, access to the Internet allows buyers and sellers to meet up virtually. The Bureau of the Census tracks e-commerce in manufacturing, wholesale, service, and retail businesses. E-commerce includes online orders over the Internet, Extranet, EDI network, electronic mail, or other online system.

E-commerce was strongest in manufacturing, where 57.1 percent of all shipments involved e-commerce.[19] We estimate that rural broadband providers supported $100 billion of these sales through service to manufacturers in their service areas.

An example of manufacturing shipments involving e-commerce comes from Sioux Center, IA, a town with a population of 7,048, located halfway between Sioux City, IA, and the South Dakota state line. A window manufacturing company was looking to locate a 260,000 square foot plant that would employ 200 people. To be viable, the plant's location had to have the broadband capability that would allow the manufacturer to carry out data transfer with a network of distributors, as well as with the corporate headquarters 250 miles away. Premier Communications, a rural broadband provider, was able to provide data transfer at up to 1 gigabit per second (Gbps). Absent the broadband availability that the manufacturer wanted, Sioux Center would have been out of the running in a competition among more than 50 sites.[20]

Retail e-commerce has grown substantially, up 30 percent from $261 billion in 2013 to $340 billion in 2015. Without the access to the Internet provided by the rural broadband industry, $9.2 billion of these sales would not have taken place.[21]

As with manufacturing, rural broadband shapes economic geography. Rural consumers who turn to shopping online are already more likely to go beyond their own communities for such goods as food and clothing.[22] For consumers who seek greater variety than available in their immediate communities, online purchases require less time and effort than a journey to a more distant physical location.

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[19] U.S. Census Bureau, "E-Stats 2013: Measuring the Electronic Economy," last modified May 28, 2015, https://www.census.gov/econ/estats/.

[20] NTCA-The Rural Broadband Association, "Meet the 2014 Smart Rural Community Showcase Award Recipients."

[21] This estimate reflects (1) the share of Americans who live in the service territory of rural broadband companies and (2) income levels in rural areas overall. Details of data sources and assumptions appear in Appendix B, Methods Used in This Report.

[22] Sharron J. Lemmon, et al., "Online Shopping for Food and Fiber Products as a Form of Outshopping," *Clothing and Textiles Research Journal* 27, no. 1 (2007)27.

Broadband, at the speed defined as a minimum by the FCC, has not yet reached all of rural America. We estimate that Internet sales would be $1 billion higher if all Americans in rural America had access to broadband.[23] Some of this amount represents migration from one form of sale to another; for example, a sale that took place via a telephone call being replaced by one made via the Internet. Another portion of this amount would represent new sales as rural households embrace products such as video-on-demand delivered over broadband networks. Even where turning to the Internet simply replaces another way to make a sale, there is an economic benefit when the Internet is a lower cost technology. In these cases, the Internet provides yet another example of how the economy becomes more efficient when a capital investment substitutes for labor.

Broadband as a transformational input. As with many new technologies, users start off putting the new technology to work as a one-for-one substitute for the old. Email substituted for making telephone calls or sending a letter via the mail. Video-on-demand has substituted electronic delivery for going to a store or kiosk to pick up a DVD.

While email may already be pervasive, many substitutes have yet to reach their full potential. In the case of telehealth, broadband capability is one factor that has kept the full potential from being realized. Telehealth allows a health care provider to "see" a patient who is not physically present. A patient at a rural health clinic can be "seen" by a specialist at an academic health center in a large city via an image transmitted through broadband. A small hospital can rely on a radiologist who is several time zones away to read images during overnight hours. In both of these examples, the service could not have taken place without a broadband connection. In the kind of income accounting that underlies Table 1, showing direct and indirect impact of rural broadband, only the broadband component of the transaction is included. The medical service adds to the economy, but it does not appear in counting the economic impact of the broadband sector. These are examples of indirect effects that are not captured by measures that follow dollar flows to and from the telecommunications sector.

Telehealth has used technology to substitute for physical proximity in delivering a health care "visit." Telehealth has the potential to change the visit from an event to a process as an "Internet of things" grows to include devices such as home blood pressure monitors, scales, and drug storage boxes that can generate a message to a patient's electronic medical record to record blood pressure, weight, and when the drug storage box lid opened. A combination of information about blood pressure change, weight change, and drug box opening by a patient with congestive heart failure could produce a layer of responses: a text message reminder to take medications, a call from a case manager, a request to come and see the doctor. This interaction of patient and provider would give a new meaning to the term "health maintenance organization."

Looking forward, broadband's importance will grow through its ability to create new types of services such as social media. Facebook, Twitter and other forms of social media have created ways to bring people together that are vastly different from earlier methods of communication. As new technologies emerge, broadband's economic importance will grow.

[23] $1 billion represents a lower bound to the estimate. The size of missed opportunities depends on what share of rural Americans do not have access to broadband. Details of data sources and assumptions are in Appendix B, Methods Used in This Report.

Conclusion

The economic effects of the rural broadband industry reach throughout the economy. The rural broadband industry influences the size of the economy through employment and purchases of goods and services. This influence totaled $24.1 billion in 2015, both directly and indirectly through the follow-on impact of those direct purchases. The access that these firms provide to networks that reach around the world are a necessary input to all that makes up e-commerce. In this way rural broadband defines the economic geography of the United States, making it feasible for some economic activity to take place in some locations and infeasible in others. It also changes the economic geography of distance. With broadband the website of a seller across the country can be reached with less effort (and cost) than a physical store 75 miles away in a regional mall.

The impact of rural broadband on the size and location of economic activity can be quantified. In the long run, the economic impact of rural broadband will be more important for the role it plays in changing what the economy is. Information technology shows an amazing capability to create new services. It has also disrupted the role that location plays in the economy. Broadband networks have nearly erased the cost of moving information.[24] Broadband networks allow that disruptive role to happen. This disruption will reach as far as the broadband speed required to support these uses will allow.

Box 3: High speed Internet in rural America—an example from along the Kentucky/Tennessee border

North and east of Nashville lies the area served by North Central Telephone Cooperative (NCTC). Its main office is in Lafayette, TN, a town with a population of almost 4,500. After the 2000 Census the federal government determined Macon County to be part of the Nashville Metropolitan Statistical Area, a conclusion that reflects where more Macon County residents now work, but one that did not pull homes together anywhere as close as those in Nashville proper.

NCTC wanted to offer in its service area the kinds of services that were available in more densely populated areas. With help from the federal government's Broadband Initiatives Program, NCTC has built "fiber to the premise" for more than 75% of its service area, and the remainder is part of an ongoing construction project.[25]

NCTC offers several service levels. For areas with fiber, customers can choose speeds from 4 Mbps up to 1 Gigabit. Most of those still being served by copper can receive up to 20 Mbps. In addition to wired connections to its network, NCTC also offers nine WiFi hotspots.[26] These provide service in parks and public spaces such as the main square in the county seat town. Non-subscribers can buy blocks of WiFi time.

The range of services available from NCTC now extends far beyond dial tone telephone service. NCTC offers a variety of television packages, wireless routers to enable a household to access the Internet with computers and cellular phones, and video property surveillance. In addition to bringing television content from outside, NCTC also generates content such as a feature about why Shriners are visiting local elementary schools and coverage of school sports matches.[27] Other services, such as a data center, target business needs. This level of service has allowed NCTC to be recognized by NCTA – The Rural Broadband Association as both a Smart Rural Community and a Gig-Capable Provider.

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[24] Consumers frequently face no marginal cost. The additional cost to send one more email is zero.
[25] "Fiber Progress Map," http://www.nctc.com/about-nctc/fiber-progress-map/
[26] "Free WiFi for North Central High Speed Internet Customers," http://www.nctc.com/my-nctc-2/wifi/
[27] "NCTC-TV. Your Best Source for Local Stories about Local People," http://www.nctc.com/my-nctc-2/local-tv/

Appendix A: Universal Service Fund: Support for Service in Low Population Density Areas, for Low Income Users, Rural Health Providers, Schools and Libraries

After the Telecommunications Act of 1996 became law, the FCC developed four mechanisms to carry out the law's instructions to "preserve and advance universal service."[28] The Universal Service Fund (USF) receives funds from a contribution factor imposed on interstate telephone service. The contribution factor gets set quarterly; in the second quarter of 2016 it was 17.9 percent. Consumers may be familiar with seeing the contribution factor as part of their bill for regulated (wireline) service.

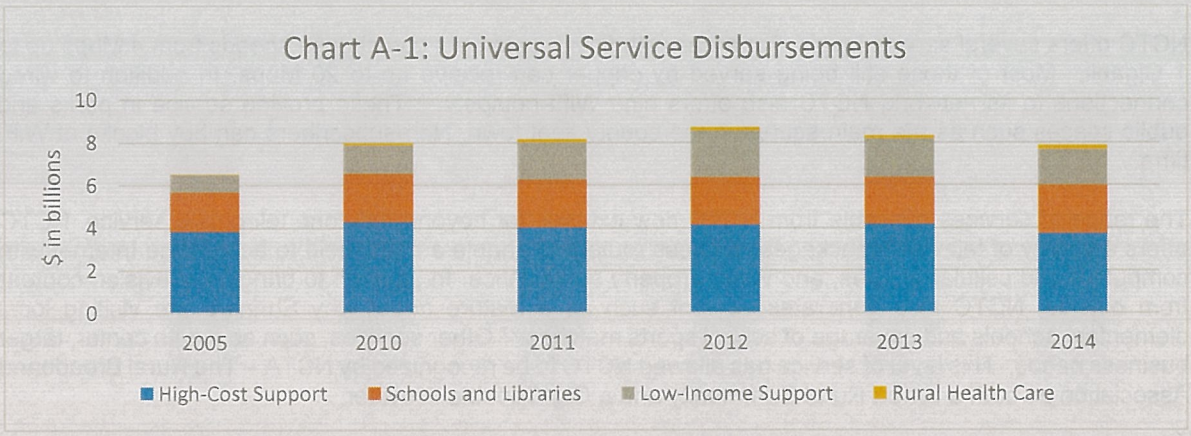
Three of the four mechanisms support service users:

Low income. Individuals who live in households with incomes under 135 percent of the poverty threshold for a family of their size and individuals who participate in social assistance programs can obtain assistance. One service, Lifeline, reduces the charge for basic telephone service. Another, Linkup, reduces the amount a new customer must pay to initiate service.

Rural health. The program supports comparable prices for service for rural health care providers. It also supports the Rural Health Care Pilot Program for state and regional telehealth networks.

Schools and libraries. This program, sometimes referred to as the "e-rate" program, helps schools and libraries pay for broadband, maintenance, and internal connections. Support ranges from 20 to 90 percent of costs, depending on what share of the population served is poor and whether the school or library serves a rural or urban area. In recent years, these payments supported service at more than 115,000 schools and libraries.

The fourth mechanism, ***the high cost fund***, supports the higher cost of bringing telecommunications services to less populated areas. Chart A-1 shows how the pattern of funds used for each of the four mechanisms has changed over time.



Source: Table 1.10, "Universal Service Fund Disbursements, 2001-2014" in Federal-State Joint Board on Universal Service, Universal Service Monitoring Report: CC Docket No. 96-45. (Data Received Through September 2015), Washington, DC: Federal-State Joint Board on Universal Service, 2015.

[28] 47 U.S.C. §254(b)(5).

High cost support. The USF has provided support to rural telecommunications providers that has allowed them to build networks that provide access to voice telephone service at prices that are similar to those paid by users in urban areas. In 2011, the FCC released the *USF/ICC Transformation Order* which laid out a path to change the USF from targeting voice telephony to broadband as the universal service. In this order, the FCC set out different paths for carriers serving rural areas regulated at the state level under rate-of-return rules and those that operated under a price cap or were rate-of-return affiliates of price cap carriers. The FCC has begun a process of reviewing how USF resources should be used to support universal access in areas served by carriers subject to rate-of-return regulation.

Appendix B: Methods Used in This Report

Data about telecommunications firms. The FCC makes available data collected by the National Exchange Carrier Association (NECA) used to calculate USF payments.[29] The data release covers carriers which receive amounts that relate to their current conditions. For those carriers whose payments have been frozen by the 2011 *USF/ICC Transformation Order*, we used data from their pre-freeze period, with the amounts converted to current (2015) dollars by the change in the producer price index.

The publicly available data reflects costs associated with regulated service. The economic impact of rural broadband providers reflects all of the services they provide. The range of services includes regulated and a wide variety of unregulated service including voice telephone, Internet access, cable television, data storage, computer support, and security systems. JSI is a consulting firm serving the telecommunications industry that compiles data from many rural broadband firms on a confidential basis. JSI provided grouped summary values about the relationship between expenses related to regulated service and overall service for 103 rural broadband firms. These values were then applied to the NECA data made available by the FCC to produce firm-level estimates of total expenses.

The JSI sample reflects a broader range of firms than used in Hudson's 2011 report. That report relied on a survey of Kansas rural broadband providers.[30] In addition to including a more diverse set of firms, the JSI data also captures firms further along the broadband transition, with more of them offering additional value-added services beyond network access.

Analyzing Economic Impacts. The analysis presented in this paper is based on income accounting. Income accounting provides a measure of the size of an economy. The most common income accounting measure is Gross Domestic Product (GDP). In this approach, value added is summed across all the producers in an economy to produce a measure of national output. Value added is the difference between output and intermediate inputs. Intermediate inputs include raw materials, services, and operating expenses of the producer.

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[29] https://transition.fcc.gov/wcb/iatd/neca.html "From 9/15, Submission of 2014 Study Results," DATA FILE: http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/Monitor/usf15af.zip

[30] Center for Economic Development and Business Research. *Kansas Rural Local Exchange Carriers: Assessing the Impact of the National Broadband Plan,* Wichita: Wichita State University, 2011.

The Bureau of Economic Analysis (BEA) in the Department of Commerce analyzes the input and output of producers across the economy to create a baseline understanding of what inputs are required to produce the observed level of output in each industry. The result is an input-output table that shows the requirements in each industry for goods and services produced in the rest of the economy. These relationships can be thought of as a recipe: to produce $1 worth of output in a particular industry requires so many cents of labor, so many cents of electrical equipment, etc.

These input-output relationships form the basis for a set of analyses of the US economy provided by the BEA. One analysis used in this report is a set of state-level analyses called the Regional Input-Output Modeling System, or RIMS. RIMS provides state-level analyses of the change in final demand that occurs for each dollar delivered by an industry. RIMS provides a way to assess the relationship between change in one industry and the state-level change in output, earnings, employment, and value added.

BEA provides RIMS multipliers for 406 sectors of the economy. The analysis in this section involves those for the telecommunications industry. Table B-1 shows these RIMS multipliers for the several states.

Table B-1. State Level Multipliers

	Output	Earnings	Employment
Alabama	1.3599	0.2311	5.2348
Alaska	1.3323	0.2171	3.9672
Arizona	1.3878	0.2465	5.1329
Arkansas	1.3092	0.2107	4.0789
California	1.5856	0.3024	4.7556
Colorado	1.5302	0.2846	4.7443
Connecticut	1.4512	0.2450	4.0284
Delaware	1.3423	0.1777	3.6943
District of Columbia	1.3666	0.0493	0.7919
Florida	1.4335	0.2596	5.6746
Georgia	1.5120	0.2759	4.9995
Hawaii	1.3914	0.2368	4.8249
Idaho	1.2698	0.2122	5.1816
Illinois	1.4888	0.2667	4.7941
Indiana	1.3264	0.2165	4.7654
Iowa	1.2236	0.1901	4.6234
Kansas	1.3661	0.1893	3.4000
Kentucky	1.3270	0.2076	5.0711
Louisiana	1.3740	0.2407	5.4673
Maine	1.3113	0.2317	5.1280
Maryland	1.4816	0.2502	4.6503
Massachusetts	1.4604	0.2497	4.0516
Michigan	1.3642	0.2421	5.0925

Minnesota	1.3819	0.2373	4.7036
Mississippi	1.2721	0.2019	4.9653
Missouri	1.4455	0.2154	4.2658
Montana	1.2941	0.2143	5.3638
Nebraska	1.2644	0.2033	4.4299
Nevada	1.3249	0.2219	4.8072
New Hampshire	1.3776	0.2239	4.5526
New Jersey	1.5082	0.2557	4.0779
New Mexico	1.3620	0.2312	5.6003
New York	1.4651	0.2375	3.7038
North Carolina	1.3829	0.2412	5.1561
North Dakota	1.2124	0.1775	3.7809
Ohio	1.3993	0.2374	4.9791
Oklahoma	1.4212	0.2456	5.5817
Oregon	1.3585	0.2269	4.9517
Pennsylvania	1.4710	0.2500	4.6871
Rhode Island	1.3767	0.1864	3.7499
South Carolina	1.3726	0.2303	5.4487
South Dakota	1.2125	0.1866	4.3510
Tennessee	1.4647	0.2580	5.6686
Texas	1.5386	0.2829	5.2695
Utah	1.4449	0.2661	6.3310
Vermont	1.3105	0.2120	4.6136
Virginia	1.4873	0.2410	4.1160
Washington	1.4390	0.2439	4.2934
West Virginia	1.2932	0.1978	4.3826
Wisconsin	1.3191	0.2224	4.8975
Wyoming	1.2367	0.1934	4.3809

Source: Unpublished Bureau of Economic Analysis table containing Regional Input-Output Modeling System (RIMS II) data from 2008.

The analysis of inputs used by rural telecommunications companies is based on another BEA analysis product and data provided to the FCC.

The BEA product is its benchmark input-output table showing direct requirements of the telecommunications industry (which has industry code 517 in the North American Industry Classification System). (The "Supplementary Make, Use, and Direct Requirement Tables" are available from the BEA web site, http://www.bea.gov/industry/io_benchmark.htm.)

Rural broadband's role in manufacturing. The Census Bureau found that $3.3 trillion in manufacturers' sales in 2013 involved e-commerce. An estimate of the share of these sales that rely on rural broadband carriers rests on two parameters. One is the share of manufacturing that

occurs in the area served by rural broadband firms, and the second is the relative value added by firms in these settings.

Manufacturing makes up a slightly smaller share of employment in rural areas that are less densely populated. In 2007, manufacturing accounted for 7 percent of employment in urban areas, 12 percent in relatively more densely populated rural areas, and 7 percent in rural areas with relatively less dense populations. These facts show that manufacturing makes up a relatively larger share of employment in small towns but a similar share of employment in urban and less-populated rural areas. (Other sectors are more important for what makes the relative shares of jobs different in urban and rural areas. Agriculture, fishing and forestry account for 1 percent of employment in urban areas and 12 percent in low-density rural areas. Service-sector jobs make up 44 percent of employment in urban areas and 30 percent in low density rural areas.)[31]

The mix of manufacturing types differs between urban and rural areas. An analysis of county-level data on the value added per hour of labor in manufacturing found that value added was highest in the core of large metropolitan areas, dropped in metropolitan-fringe areas, and was lowest in counties that were neither part of a metropolitan area nor adjacent to another metropolitan-area county. In these counties not adjacent to urban areas, value added per hour was 67.3 percent of the level in counties that were at the core of metropolitan areas.[32] This makes 67 percent of overall productivity the lower bound to the difference between manufacturing in areas served by rural broadband carriers and the economy overall.

Another way that urban and rural manufacturing differ is scale. This follows from the difference between urban and rural. Auto plants typify urban manufacturing, and makers of cars and trucks were the portion of the manufacturing sector with the largest share of sales involving e-commerce (as manufacturers typically sell to dealers, not consumers).

An estimate of the lower bound of the manufacturing sales that rely on services from rural broadband companies begins with the assumption that 7 percent of the country's population is in areas served by rural broadband providers and the location of manufacturers follows the same urban/rural pattern as the location of workers in manufacturing. This implies that $231 billion in manufacturing sales involved sales by manufacturers served by rural broadband firms. The fact that value added in the most rural manufacturing is 67 percent of that in the most urban areas would reduce this amount to $154.8 billion. Differences in e-commerce adoption by type of industry and by scale of firm could mean that manufacturers in rural areas are only two-thirds as likely to use e-commerce as elsewhere in the economy. At this level, manufacturing in areas served by rural broadband providers would be $103.7 billion. Thus $100 billion provides a reasonable estimate of the lower bound.

Retail sales. The estimate of the dollar amount of Internet retail sales using Internet access from rural broadband providers builds on two factors: first, what share of Americans rely on rural broadband providers to reach the Internet; and, second, the expenditure patterns of those consumers. The estimate begins with the assumption that 7.2 percent of consumers (see Box 1) rely on rural broadband carriers to access the Internet. With respect to consumers, there is the assumption that both urban and rural consumers are equally likely to make Internet purchases; the only relevant difference is income. Consumers in low-density rural areas had per capita

[31] Council of Economic Advisers, "Strengthening the Rural Economy – The Current State of Rural America," https://www.whitehouse.gov/administration/eop/cea/factsheets-reports/strengthening-the-rural-economy/the-current-state-of-rural-america.

[32] H. Patrick Gale, "Labor Productivity and Wages in Rural and Urban Manufacturing Plants," *Review of Regional Science* 28(1998):13-26.

incomes that were 54 percent of those in urban areas.[33] A final consideration is the availability of adequate speed to support retail purchases. The download speed required to support a satisfactory sales experience with an Internet seller is lower than that required to download video. Further, homes are not the only place to reach the Internet to make an online purchase. Consumers might also make purchases at other places where they have access, such as at work or at a community-anchor institution like a public library. Nonetheless, an estimate meant to provide a lower bound to the amount of retail sales through rural broadband providers requires a discount factor to reflect less availability of speeds such as 25 Mbps download/3 Mbps upload in rural areas, and this estimate adopts the assumption that 70 percent of households in areas served by rural broadband firms have access to this speed. Thus with $340 billion in Internet retail sales in 2015, 7.2 percent of consumers living in areas served by rural broadband providers, 70 percent of those having access to broadband at the 25 Mbps download/3 Mbps upload speed, and low-density rural per capita income 54 percent of urban incomes, $9.25 billion forms a lower bound estimate of the amount of Internet sales through rural broadband providers.

A related estimate is the dollar value of sales that do not take place because rural consumers lack access to adequate broadband. One approach would be that outlined in the previous paragraph, only without the assumption of rural consumers lacking access to service that meets the 25 Mbps download/3 Mbps standard. That amount would be nearly $4 billion. However, this would not be a lower bound to the estimate. A lower bound would require measures of how sensitive retail purchases are to higher speeds and the extent to which consumers who face slower speeds at home make Internet purchases at places such as work or libraries where they have access to higher-speed service. With the plausible range between $0 and $4 billion, we believe $1 billion is a defensible estimate of the lower bound of additional purchases that would be made via the Internet if all rural consumers had access to service that met the broadband standard.

[33] Council of Economic Advisers, "Strengthening the Rural Economy – The Current State of Rural America," https://www.whitehouse.gov/administration/eop/cea/factsheets-reports/strengthening-the-rural-economy/the-current-state-of-rural-america.

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