USC Annenberg
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SLAB

CONNECTED CITIES AND INCLUSIVE GROWTH (CCIG)
Policy Brief # 1
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Home Broadband in Los Angeles County

1. Introduction

Broadband is widely recognized as a key input for local development in the 21st century. Where high-speed, affordable Internet services are available, communities can thrive. Where they are lacking, communities stagnate as innovative people and businesses locate elsewhere. Promoting equitable investments in broadband has therefore become a priority for cities around the world.

In 2014 the City of Los Angeles launched CityLinkLA, an initiative aimed at securing private investments in advanced communications networks. The goal of CityLinkLA is to "provide basic access to all for free or at a very low cost and gigabit (1 Gbps) or higher speed access at competitive rates". Similar initiatives are under way in many other cities in the US and globally. They share a common goal of creating economic opportunities and enhancing quality of life through broadband-related investments.

The Connected Cities and Inclusive Growth (CCIG) project is collaboration between the USC Annenberg Research Network for International Communication (ARNIC) and the USC Price Spatial Analysis Lab (SLAB). The project's main goal is to map broadband availability and adoption in Los Angeles (LA) County, and analyze the socio-economic determinants of the observed spatial distribution.

Ultimately, the project seeks to provide a comprehensive diagnosis and identify geographical disparities in broadband access that informs current policy initiatives and debates.

This policy brief focuses on the geographic distribution of broadband infrastructure in LA County. As such, it examines the availability of Internet access services across communities and explores its demographic determinants. It is based on two separate data sources. The first is the California Broadband Availability data collected yearly by the California Public Utilities Commission (CPUC), which contains information about Internet service availability (by provider, technology and speed) at the census block level.[1] The second is the American Community Survey (ACS), which provides a comprehensive demographic portrait of communities at the census tract level.[2]

By overlaying these datasets, our analysis provides a unique characterization of the state of broadband in Los Angeles at the most disaggregated geographical level available. It is important to note that the goal of the analysis is not to establish a causal relationship between Internet infrastructure and socioeconomic

[1] Data as of December 2015 (most current available).
[2] For precision, we use the ACS 5-year 2014 estimates rather than the most current (but more imprecise) ACS 1-year 2015 estimates.

factors. Rather, we seek to identify potential disparities in service availability and quality across communities, and suggest cost-effective policies to address them.

In particular, this policy brief addresses the following questions:

- Is there competitive provision of basic and high-speed Internet access services across communities in LA County?

- Are there broadband 'deserts' where basic or high-speed broadband is not available to local residents?

- Are advanced broadband services (such as fiber-to-the-home, or FTTH) that enable gigabit-level speeds being rolled-out throughout LA County?

- Are there observable demographic patterns to the spatial distribution of broadband infrastructure in LA County?

The current analysis is restricted to wireline (i.e., fixed) broadband services, and therefore excludes wireless broadband. This is in line with the 2016 FCC Broadband Progress Report, which concluded that fixed and wireless broadband are imperfect substitutes, and that "both service provide necessary components of advanced telecommunications capability".[3] The analysis focuses on consumer services, while noting (as does the 2016 FCC Broadband Progress Report) that many small businesses also subscribe to residential plans.

2. Broadband availability and service quality in LA County

Figure 1 maps the availability of fixed broadband services in LA County based on the CPUC's definition of served, underserved, and unserved areas. The map indicates that most areas in LA County are covered by services with advertised speeds of at least 6 Mbps download/1.5 Mbps upload. The exceptions generally correspond to very small communities in low-density areas which account for 0.14% of the county's population (or approximately 14,000 residents). Overall, a very small fraction of Angelenos live in broadband 'deserts' where residential services are not available.

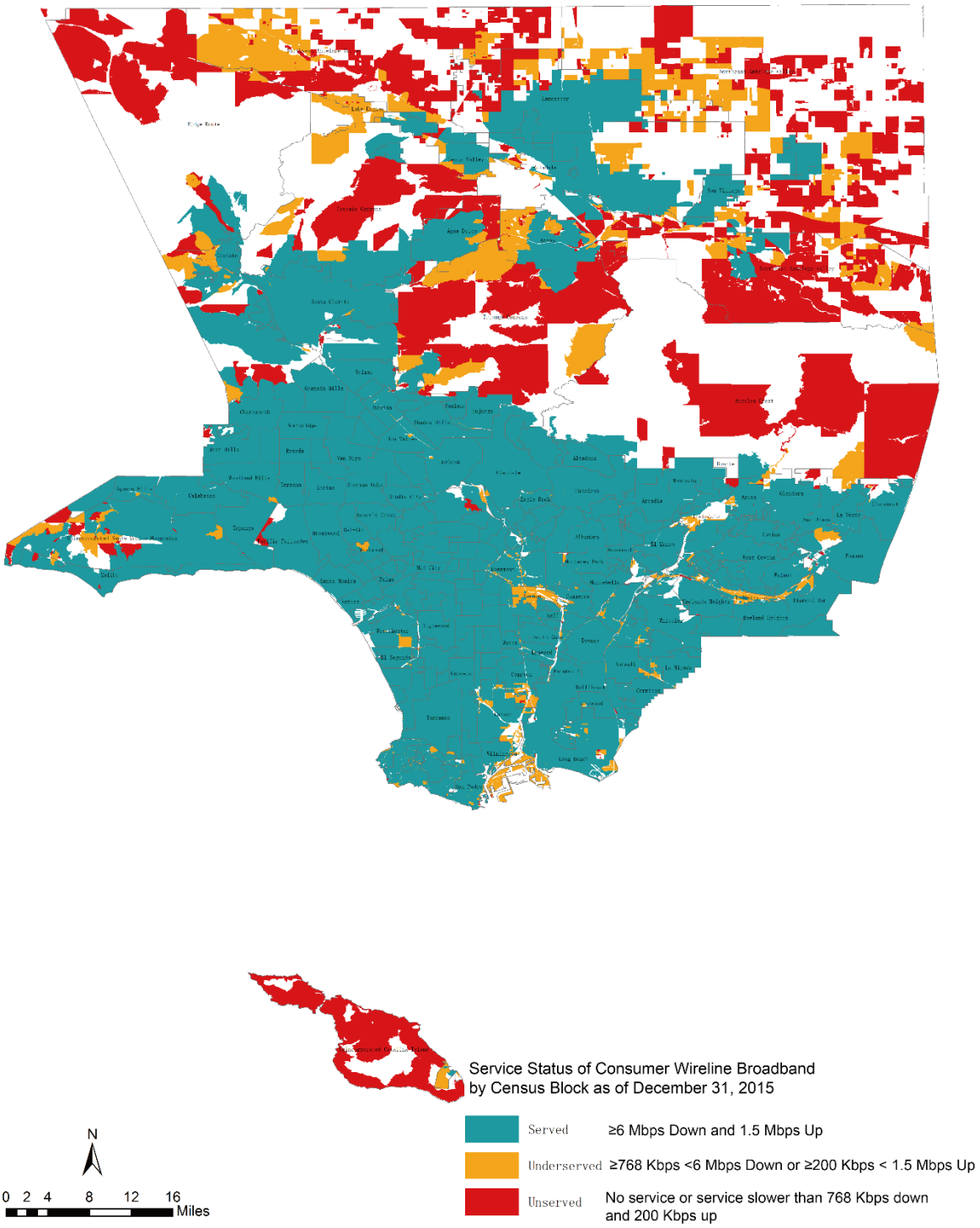
The FCC uses a higher threshold of 25 Mbps download/3 Mbps upload to define high-speed (as opposed to basic) broadband. Using this definition, the unserved population in LA County rises to 0.44%, or about 43,000 residents.

Whereas deficits in broadband infrastructure in these communities need to be addressed, overall LA County compares well with similar counties in the US. According to FCC data the average percentage of residents not served by high-speed broadband in the most densely populated counties (top quintile) nationwide is 6.3%.[4] If the comparison group is further restricted to counties in the top income quintile the average unserved population remains high at 5%. This is an order of magnitude above the unserved population in LA County.

[3] FCC (2016), *Broadband Progress Report*. GN Docket No. 15-191, pp. 7 (released January 29, 2016).

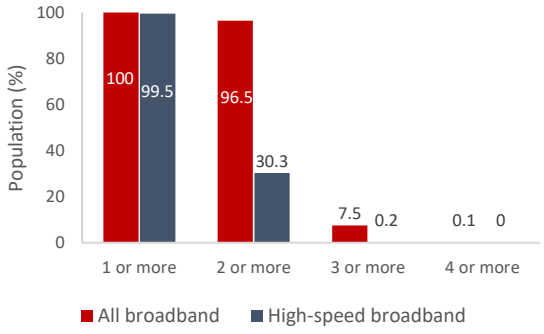
[4] FCC (2016), *Broadband Progress Report*. GN Docket No. 15-191, Appendix E (released January 29, 2016).

Figure 1: Fixed broadband service status by census block (December 2015)



On the other hand, residents in LA County can typically choose from a very limited set of fixed broadband providers (also referred to as Internet Service Providers, or ISPs). The lack of competition in the residential access market is illustrated in Figure 2. While most households (96.5%) can choose from at least two basic broadband providers, competition falls dramatically thereafter, with only 7.5% of households having a choice of three or more ISPs. There is even less competition in high-speed broadband. As shown, more than two-thirds of Angelenos live in areas served by a single provider of residential Internet connectivity offering speeds that meet the FCC's definition of 'broadband' service (25 Mbps download/3 Mbps upload speeds).

Figure 2: Population (%) by number of fixed broadband providers

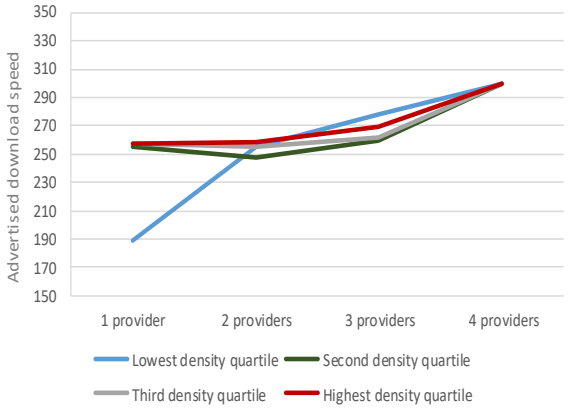


Source: CPUC.

The benefits of competition in the provision of broadband services are apparent. As an example, Figure 3 graphs the maximum advertised download speeds as a function of the total number of providers by census block. The figure strongly suggests a positive correlation between competition and advertised speeds. Further regression analysis reveals that, on average, every additional provider increases the advertised speed in a census block by about 22 Mbps (see Table A-1 in Technical Appendix).

The figure also suggests that the relation between competition and service quality is in part mediated by population density. In particular, it reveals that promoting market entry is particularly important in low-density areas. In these communities, each additional provider increases service quality by an average of 52 Mbps (see Table A-2 in Technical Appendix).

Figure 3: Maximum advertised download speed (in Mbps) by number of providers



Source: CPUC.

Figures 4 and 5 further illustrate the competition deficit in the Los Angeles broadband market. Figure 4 maps the number of basic broadband providers by census block. The figure reveals a clear pattern of duopoly competition that extends to most communities in LA County. In turn, Figure 5 shows a spatial pattern of near monopoly provision of high-speed broadband that comprises about 70% of LA County residents.

Unsurprisingly, many of the communities where competition is more intense are located in the wealthier coastal communities and in the San Fernando Valley. However, many are located in the less affluent region that extends from Long Beach to the San Gabriel Valley. The interplay between infrastructure investments and community demographics is explored further in Section 3.

Figure 4: Number of basic broadband providers by census block (December 2015)

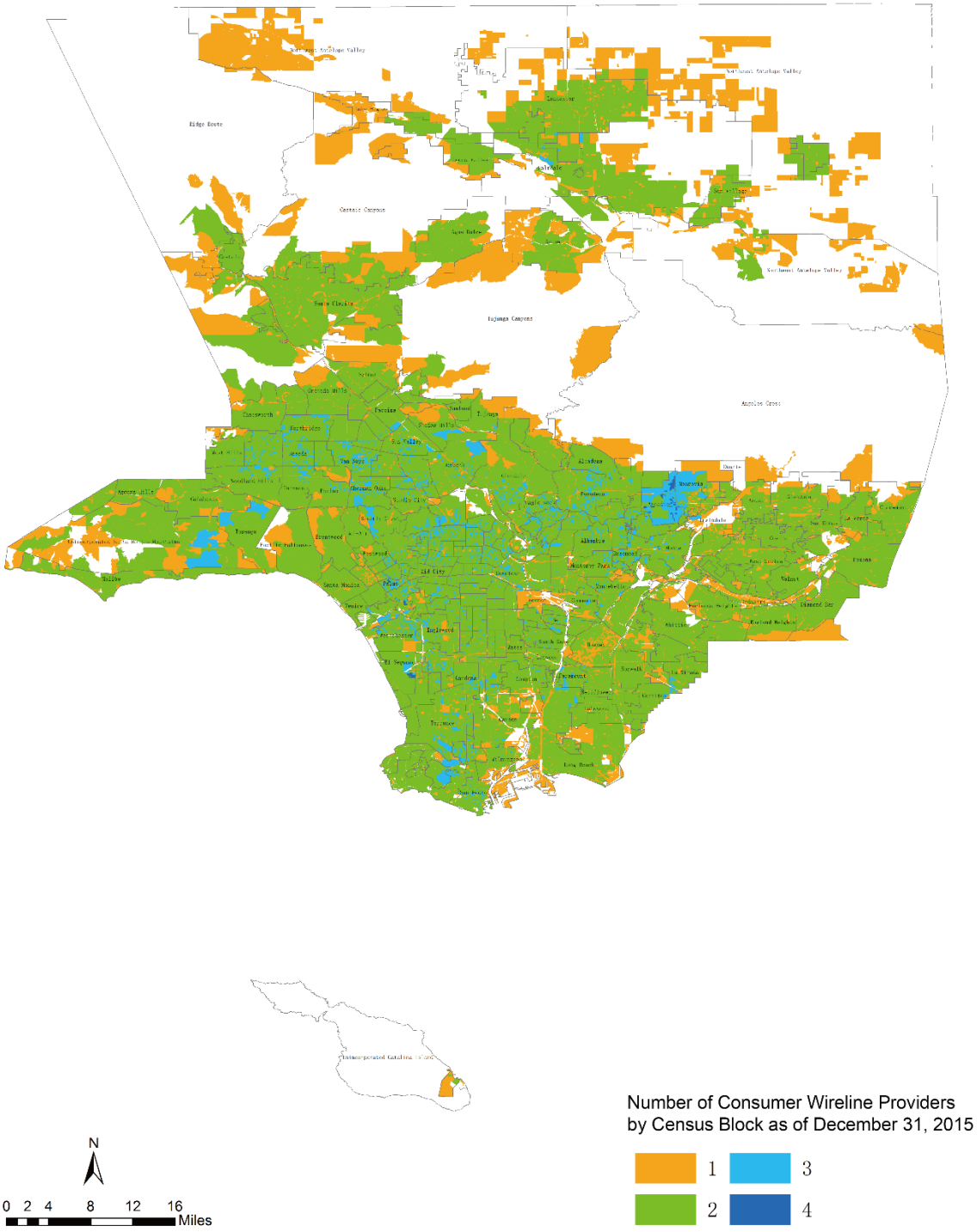
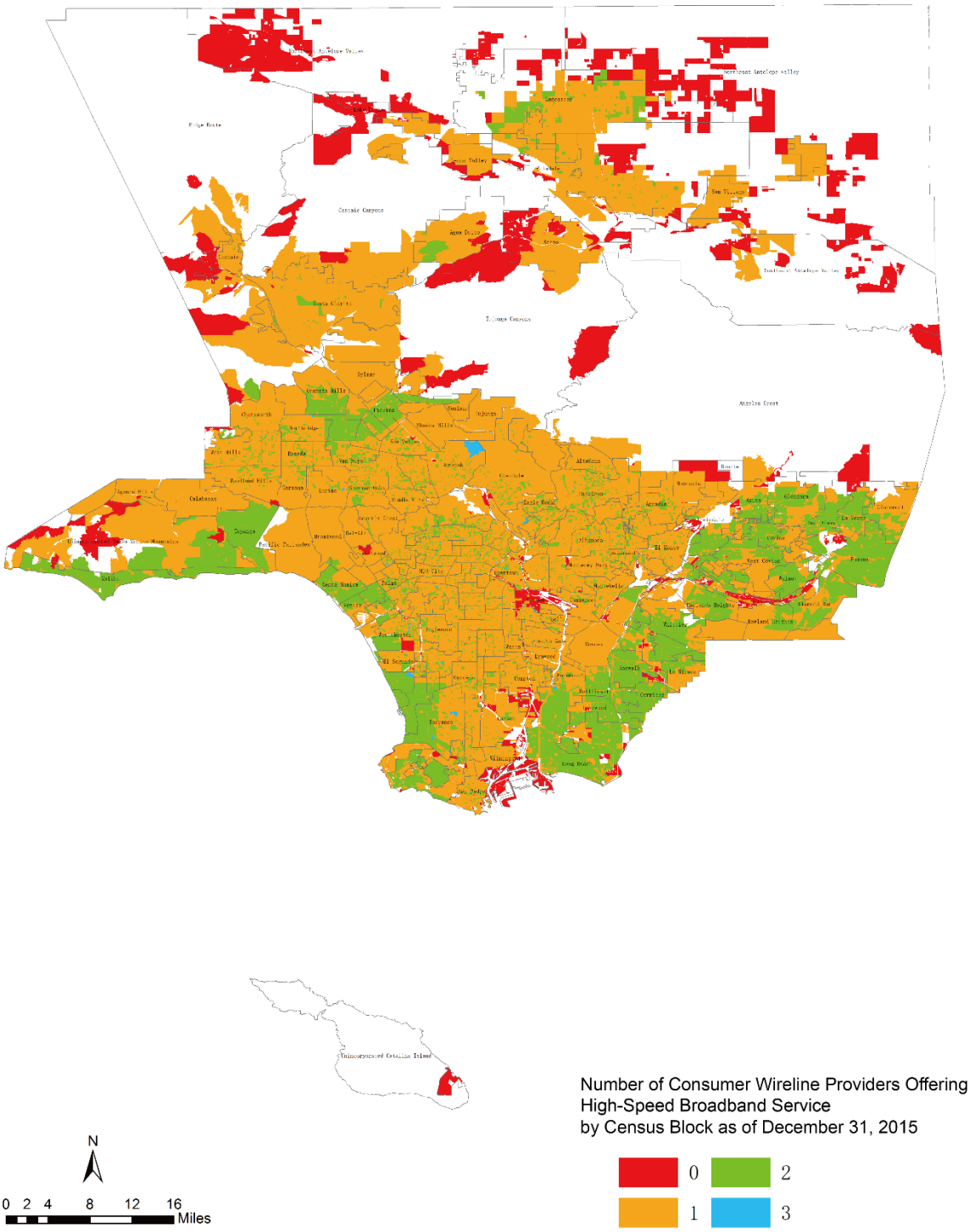


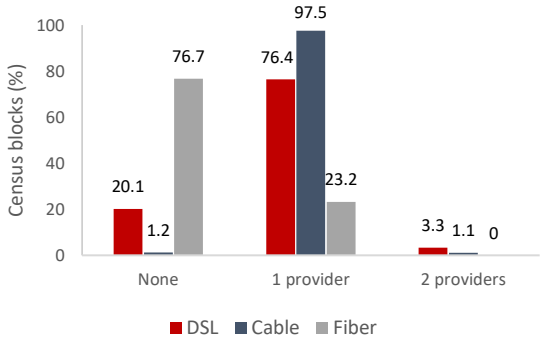
Figure 5: Number of high-speed broadband providers by census block (December 2015)



The competitive landscape in LA County reflects two underlying trends in US broadband markets. The first is the generalization of duopoly competition between the leading last-mile technologies: DSL (which uses existing landline telephone wires to deliver broadband) and cable-Internet services. The second major trend is ongoing industry consolidation in the telecom and cable-TV markets.

Figure 6 illustrates these trends. As shown, there is little geographical overlap between providers using similar last-mile technologies. Only about 3% of census blocks in LA County are served by more than one DSL provider, whereas only about 1% is served by more than one cable-Internet provider. As a result, the majority of households have a choice between a single DSL provider and a single cable provider.

Figure 6: Percentage of census blocks served by number of providers and technology



Source: CPUC.

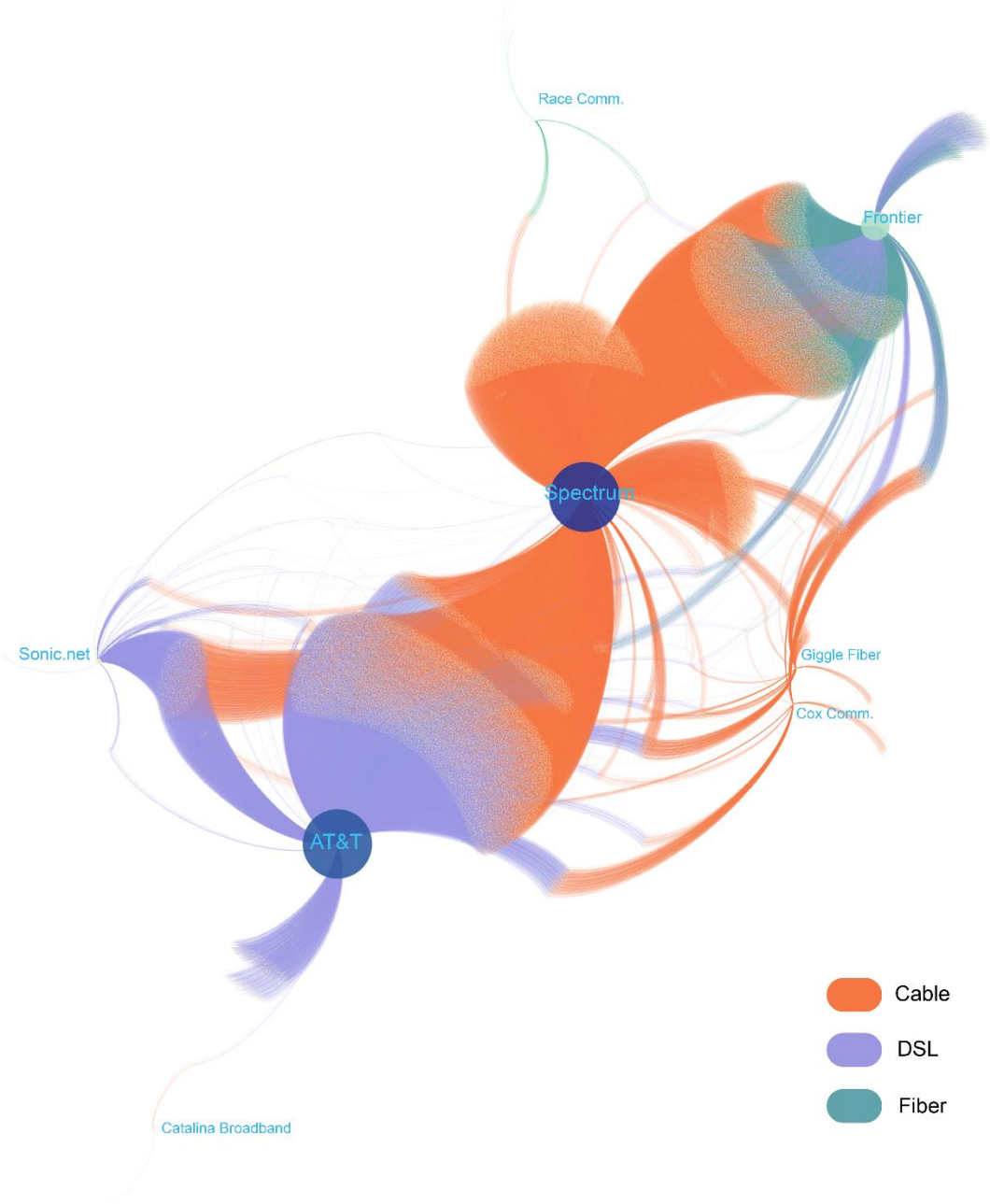
The limited extent of competition in the residential broadband market can be visualized in Figure 7. In this network graph, each node represents a census block that is served by one or more ISPs. Links denote the provision of service to that block by respective ISPs, with the link colored according to the last-mile technology used to service each block. The size of each provider's bubble is proportional to the number of blocks served.

The figure helps visualize the trends in the Los Angeles broadband market identified above. First, only a small fraction of blocks is served by competitors using similar last-mile technologies (whether DSL or cable). Second, industry consolidation has resulted in a landscape characterized by a dominant cable provider (Spectrum) and two DSL providers (AT&T and Frontier) servicing different areas.

The steady decline in competition in the US residential broadband market has been noted in studies by numerous scholars and several government agencies, including the FCC and the Department of Commerce.[5] Interestingly, the decline in the Los Angeles area predates the most recent wave of industry consolidation. For example, in May 2016 Charter Communications completed its acquisition of Time Warner Cable, leading to creation of Spectrum. However, this merger had a trivial impact in the competitive availability of broadband, for less than 1% of LA County residents lived in areas serviced by both operators previous to the completion of the merger.

[5] See in particular: FCC (2016), *Broadband Progress Report*. GN Docket No. 15-191; US Department of Commerce (2014), *Competition Among US Broadband Service Providers*, OCE Issue Brief #01-14; Crawford, S. (2011), The Communications Crisis in America, *Harvard Law & Policy Review* 245.

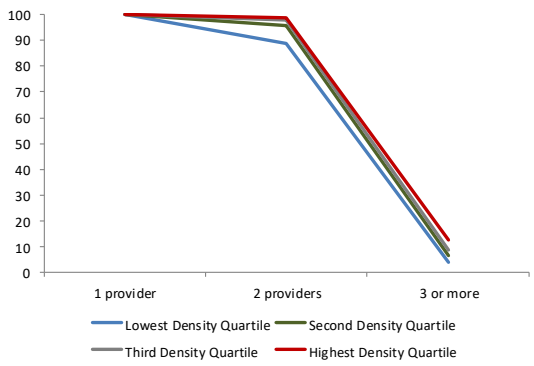
Figure 7: Network graph of fixed broadband competition in LA County (December 2015)



3. *How community demographics affect broadband infrastructure deployment*

Population density is a key determinant of broadband deployment, for it affects the average cost involved in servicing households. Unsurprisingly, our findings show that residents of more densely populated communities have more broadband choices. The effect is nonetheless surprisingly small in magnitude. Figure 8 plots the percentage of the population with access to one, two, and three or more basic broadband providers, with each line representing different quartiles of population density. As shown, the lines are tightly clustered, suggesting that, contrary to our expectations, population density is not strongly correlated with broadband availability.

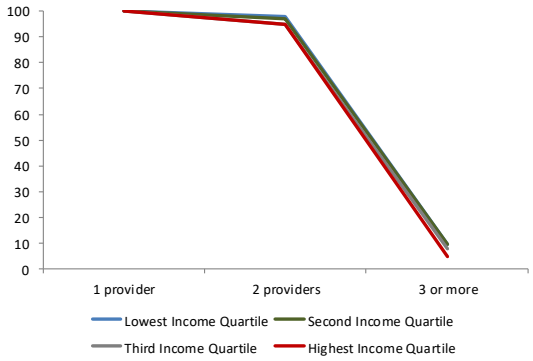
Figure 8: Population (in %) served by basic broadband providers by population density



Source: CPUC and ACS.

The evidence further indicates that the correlation between income and broadband availability is also weaker than expected. Figure 9 replicates the analysis above for different quartiles of household income. Again, the tightly clustered lines suggest that income has a small effect on competition in basic broadband services. In fact, competition appears to be slightly weaker in high-income areas, possibly reflecting the fact that many wealthy households in LA County are located in mountainous, low-density areas.

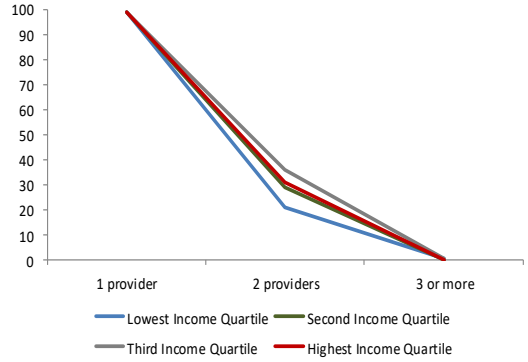
Figure 9: Population (in %) served by basic broadband providers by household income



Source: CPUC and ACS.

However, when the analysis is restricted to high-speed broadband, the correlation between household income and broadband choice becomes apparent, as shown in Figure 10. This suggests that ISPs, while present in many low-income communities with legacy infrastructure, are less likely to make the necessary upgrades to offer higher-quality services in these areas.[6]

Figure 10: Population (in %) served by high-speed broadband providers by household income



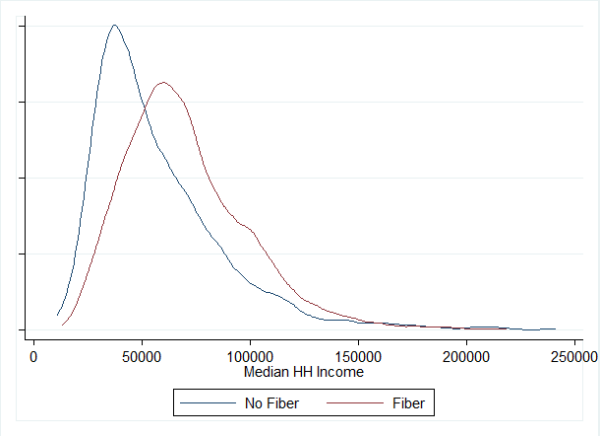
Source: CPUC and ACS.

Finally, our findings suggest that fiber infrastructure capable of delivering gigabit-level services is not being rolled out uniformly throughout LA County. Unsurprisingly, the evidence shows that fiber investments are

[6] These results are confirmed by regression models (Table A-3) in the Technical Annex.

more likely in wealthier communities, as shown in Figure 11. Regression analysis confirms that this finding is robust to the inclusion of cost-related factors such as population density and other community demographics.[7]

Figure 11: Median household income by fiber-based service availability



Source: CPUC and ACS.

4. Conclusion

Los Angeles County is home to some of the most innovative people and businesses in the world. Throughout the decades, this has driven job growth and attracted talent to the region. However, as the history of Los Angeles' postwar economic development proved, innovation needs a nurturing environment that helps transform ideas into economic opportunities and better quality of life.

The availability of quality broadband services at affordable prices is among the key prerequisites for these transformations to take place in the coming decades. Our findings nonetheless suggest that the existing broadband infrastructure in LA County does not meet these requirements.

Weak competition appears to be deterring the roll-out of next-generation network infrastructure, particularly in areas where, due to affordability and other barriers, expected demand is low. All else equal, weak competition is associated with higher prices and lower incentives for product quality upgrading. This not only raises costs for knowledge-based businesses but also perpetuates social and economic inequities across communities.

While broadband policies are largely set at the federal and state levels, there is still ample room for initiatives at the municipal level to address the challenges identified in our analysis. For example, cities control key properties and operations that affect the civil engineering cost of broadband deployment, which represent up to 80% of total deployment costs. In the city of Los Angeles, the Department of Water and Power (LADWP) owns an 820-mile fiber network with significant spare capacity.[8] These and other assets can be leveraged to jump-start the necessary investments to create a world-class broadband infrastructure throughout LA County.

[7] See Table A-4 in the Technical Annex.

[8] See CityLinkLA Request for Participants, issued June 23, 2015.

Technical Appendix

TABLE A-1: Broadband competition and download speeds, all blocks

DV: Advertised download speed (OLS)	
Number of providers	21.65***
	[0.933]
Controls:	
Population density	0.00001***
	[0.00002]
Constant	208.14***
	[1.867]
Observations	73,353

Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A-2: Broadband competition and download speeds (OLS), low-density blocks

DV: Advertised download speed (OLS)	
Number of providers	52.17***
	[1.734]
Controls:	
Population Density	0.00311***
	[0.00036]
Constant	138.27***
	[3.264]
Observations	18,339

Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A-3: High-speed broadband competition and community demographics

DV: Pop. (%) served by 2+ high-speed ISPs (OLS)	
Median HH income (log)	4.491***
	[0.717]
Population density	5.928***
	[0.202]
Hispanic HH (%)	-0.008
	[0.004]
White HH (%)	-0.001
	[0.002]
HH education (% HS or less)	-0.011
	[0.026]
Constant	-5.100
	[8.982]
Observations	2,310

Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A-4: fiber availability and community demographics

DV: Fiber service availability (logit)	
Median HH income (log)	1.479***
	[0.192]
Population density	0.008
	[0.050]
Hispanic HH (%)	0.027***
	[0.017]
White HH (%)	-0.012
	[0.011]
HH education (% HS or less)	-0.022***
	[0.026]
Constant	-17.422***
	[2.405]
Observations	2,310

Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

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About ARNIC

The Annenberg Research Network on International Communication (ARNIC) studies the emergence of new communication infrastructures, examines the attendant transformation of government policies and communication patterns, and analyzes the social and economic consequences. The project is multi-disciplinary – including communication, sociology, economics, and political science approaches – and follows an international comparative perspective spanning North America, Latin America, Asia, Africa, the Middle East, the Pacific, Western and Eastern Europe.

About SLAB

SLAB, the Spatial Analysis Lab at USC Price, aims to advance the visualization of the social sciences for public service through research, public engagement, and teaching. Our research experiments with developing alternative cartographies and exploring their potential roles in society, endeavoring to create knowledge and narratives that support an increasingly inclusive city. Aligned with Price's commitment to social justice and equity, the various activities of SLAB focus on bringing creativity and a humanistic attention to marginalized peoples and places.

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