Broadband’s Role in Agricultural Technologies & the Rural Economy

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Agenda

- What is “Broadband,” anyway?
  - Fixed vs. Mobile
  - The Rural – Urban Digital Divide
- Broadband Across the Midwest
- Academic research on rural broadband
- Current Federal / State Policy
What is “Broadband”, Anyway?

- Historically, anything > 200 kilobytes per second (kbps) in at least 1 direction was considered broadband
  - Dial-up modems provided ~56 kbps
  - Some datasets still use 200k threshold! (FCC’s Adoption Data)
- Current FCC Definition (2015+):
  - 25 MBPS down, 3 MBPS up
- Previous FCC thresholds:
  - 200 KBPS at least 1 direction (prior to 2008)
  - 786 KBPS down (2008)
  - 4 MBPS down, 1 MBPS up (2010)

ANY Technology (cable, fiber, wireless, satellite, etc.) that can meet this threshold is officially “broadband”
Fixed vs. Mobile

“Fixed” technology:
- Includes what most think of as “wired:” Cable, Digital Subscriber Line (DSL), Fiber
- Also includes: Fixed wireless and satellite

Mobile technology:
- Cellular networks (i.e. wireless)
- Generations of wireless networks & download speeds:
  - 3G (~3 MBPS)
  - 4G (~10 MBPS)
  - 4G LTE (~40 MBPS)
  - 5G is coming!* (~10GBPS+)

*Rural areas won’t be the first served (as usual)
Fixed vs. Mobile

- Are they complements? Or substitutes?

- FCC’s 2018 Broadband Report:
  - “…there are salient differences between the two technologies”
  - “…clear variations in consumer preferences / demands for fixed and mobile services”
  - “…we disagree with those that argue that mobile services are full substitutes for fixed service.”

- Dramatic shift towards mobile access since 2010

[Figure 1. Household Internet Connection Type by Year]

Source: Manlove and Whitacre, 2018
The Rural – Urban Digital Divide

- Rural areas lag behind in broadband availability

![Availability of 25 / 3 MBPS Broadband](chart)


Note: These statistics do not include satellite
The Rural – Urban Digital Divide

- The gap gets bigger as speeds increase

### Broadband Availability Across Speeds

<table>
<thead>
<tr>
<th>Speed</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 MB</td>
<td>100%</td>
<td>99%</td>
</tr>
<tr>
<td>10 MB</td>
<td>88%</td>
<td>99%</td>
</tr>
<tr>
<td>25 MB</td>
<td>81%</td>
<td>69%</td>
</tr>
<tr>
<td>100 MB</td>
<td>83%</td>
<td>41%</td>
</tr>
</tbody>
</table>

Source: Dec. 2016 FCC Form 477 Data

Note: These statistics do not initially include satellite.
The Rural – Urban Digital Divide

- Some claim rural is well-served by mobile...

Availability of 5 / 1 MBPS Mobile Broadband


Note that these statistics focus on population, not land area.
The Rural – Urban Digital Divide

- BUT, for higher mobile speeds – rural still lags behind

![Availability of 10 / 3 MBPS Mobile Broadband](chart)

How Much Speed Is Needed?

- **Precision Ag Technologies**
  - **Wireless Data Transfer (WDT):** 20KBPS
  - Prescriptions to equipment, from remote source
  - **Remote Display Access (RDA):** 1 MBPS
  - Remote diagnostics, cab display check-in

- **“Mainstream” Technologies**
  - Netflix: 3 MBPS
  - YouTube: 2MBPS
  - Videoconferencing: 4 MBPS
  - Telemedicine: 25 - 100 MBPS

Served reasonably well by 4G Mobile Networks
How Much Speed Is Needed?

Source: Hambly & Chowdury, 2018
The Rural – Urban Digital Divide

- There is also a rural – urban adoption gap


Source: Pew Internet Surveys, 2000-2016
Fixed Broadband Access in IL

Legend
2016
% Pop with 25 MB Fixed Access
- <25%
- 25-50%
- 50-75%
- >75%


Legend
2011
% Pop with 25MB Fixed Access
- <25%
- 25-50%
- 50-75%
- >75%

Source: FCC Form 477 Data, Dec. 2011
Broadband & Ag in IL

- Fixed Broadband Access in Dec. 2016 (FCC)
- Acres of Corn and Soybeans harvested in 2017 (NASS)
- Most counties with production have decent broadband coverage!
- Take a closer look at one of the heaviest production counties...
Iroquois County – Detailed Look

2016 Fixed Broadband Availability

- <4 MBPS
- 4-10 MBPS
- 10-25 MBPS
- 25-100 MBPS
- >100 MBPS
- Unserved

2011 Fixed Broadband Availability

Source: FCC Form 477 Data, Dec 2016

Source: FCC Form 477 Data, Dec 2011
What is Driving this Improvement?

- Significant **private** investment
- **Public** policy / investment has also played a role
  - Particularly for more remote areas

“From 1996-2016, the broadband industry has made capital investments totaling $1.6 trillion.”

Source: US Telecom, October 2017
A Broader Perspective...

Legend
Corn & Soybean Acres

% Pop with 25 MB Fixed Access
- <25%
- 25-50%
- 50-75%
- >75%

A Surprising Finding

**POSITIVE** relationship between acres in production and % of county population with 25MBPS broadband access
What About Cellular??

Mobile Wireless Competition Report (20th Annual)

September 27, 2017

Nationwide LTE Coverage - YE 2016

- The FCC says that cellular coverage is pretty good!
- Sept. 2017 report builds on data provided by each major carrier
- Some states look like they are fully covered!

Source: https://www.fcc.gov/reports-research/maps/nationwide-lte-coverage-ye-2016/
We can also look at each individual provider’s map.

This is LTE (fast) availability.

Source: AT&T Dec. 2016 4G LTE shapefiles; NASS 2017
Lower-level Cellular Data...

- We can also look at each individual provider’s map.
- This is LTE (fast) availability.

Source: Verizon Dec. 2016 4G LTE shapefile; NASS 2017
Lower-level Cellular Data...

- We can also look at each individual provider’s map
- This is LTE (fast) availability

T-Mobile

Federal Broadband Programs

- 2 Primary Federal Programs:
  1. FCC Universal Service Funds (FY18 caps)
     - E-rate (libraries, schools) ($2,600M)
     - HealthCare Connect Fund ($260M)
     - Lifeline ($9.25 monthly subsidy) ($1,200M)
     - Connect America Fund ($4,700M)
  2. USDA’s Rural Utility Service Grant / Loan Programs (FY18 caps)
     - “Community Connect” grants ($30M)
     - Broadband Loans ($6M)
     - Distance Learning / Telemedicine ($30M)

ARRA (2009): $7.2B in Broadband Funding

See also: Kruger, 2018 (https://fas.org/sgp/crs/misc/RL33816.pdf)
Kruger & Gilroy, 2016 (https://fas.org/sgp/crs/misc/RL30719.pdf)
NTIA’s Broadband USA Guide (2017)

- Details on each program listed
- Program purposes / eligible recipients

Broadband and Economic Growth

Broadband Infrastructure and Economic Growth*
Nina Czernich, Oliver Falck, Tobias Kretschmer, Ludger Woessmann

The broadband bonus: Estimating broadband Internet's economic value
Shane Greenstein \( a \), Mark J. Glick, Ryan C. McDavitt \( b \), \( 1 \)

Broadband and contributions to economic growth:
Lessons from the US experience
Lynne Holt \( a \), Mark Jamison \( a \)

Broadband and local growth
Jed Kolko \( f \)

The economic impact of broadband on growth: A simultaneous approach
Pantelis Koutroumpis \( e \)

Broadband's contribution to economic growth in rural areas:
Moving towards a causal relationship\(^*\)
Brian Whitacre \( a \), Roberto Gallardo \( b \), Sharon Strover \( c \)
\( a \) Department of Agricultural Economics, Oklahoma State University, Stillwater, OK 74075, USA
\( b \) Mississippi State University, USA
\( c \) University of Texas, USA

Does broadband speed really matter as a driver of economic growth? Investigating OECD countries
Ibrahim Kholiul Rohman \( 1 \), Erik Bohlin \( 1 \)

Broadband penetration and economic growth: Do policies matter?\(^*\)
Saibal Ghosh
Rural Broadband Research

- Kandilov and Renkow, 2010
- Zip-code level
- Positive impacts on employment, payroll, # of business establishments (ONLY for Pilot loan program)

We empirically evaluate whether participation in the U.S. Department of Agriculture's Broadband Loan Program, which began making loans in 2002, has had measurable positive impacts on zip code-level economic outcomes. Using difference in differences and propensity score matching program evaluation techniques, we find that loans made in 2002 and 2003 under the Pilot Broadband Loan Program have had a substantial positive impact on employment, annual payroll, and the number of business establishments in recipient communities. However, a more spatially disaggregated analysis reveals that the positive economic impacts of the pilot program are driven primarily by the outcomes in communities located closest to urban areas. Finally, we find no evidence that loans received as part of the current Broadband Loan Program had a measurable positive impact on recipient communities, possibly because enough time has elapsed for the impacts of the current Broadband Loan Program to have emerged.

<table>
<thead>
<tr>
<th>Variable</th>
<th>log(Employment)</th>
<th>log(Annual payroll)</th>
<th>log(Number of establishments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( BBLP_a )</td>
<td>0.002 (0.011)</td>
<td>0.017 (0.012)</td>
<td>0.010 (0.009)</td>
</tr>
<tr>
<td>( Pilot_BBLP_a )</td>
<td>0.050*** (0.020)</td>
<td>0.045** (0.018)</td>
<td>0.068*** (0.014)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.90</td>
<td>0.92</td>
<td>0.91</td>
</tr>
<tr>
<td>( n )</td>
<td>340,082</td>
<td>285,099</td>
<td>340,128</td>
</tr>
</tbody>
</table>
Rural Broadband Research

The Impact of Broadband on U.S. Agriculture: An Evaluation of the USDA Broadband Loan Program
Amy M.G. Kandilov, Ivan T. Kandilov, Xiangping Liu, Mitch Renkow

Published: 19 March 2017 Article history

Abstract
We evaluate the impact that the USDA’s low-cost broadband loan programs have on the U.S. agricultural sector. The broadband loan programs increase access to high-speed Internet in recipient communities, which can raise farm sales by increasing both farm output and prices received by producers. Further, high-speed Internet may drive down costs by providing information on cheaper inputs and better management practices, leading to an overall improvement in farm profits. Using U.S. county-level data on farm sales and expenditures in 2000 and 2007, we employ an inverse probability weighting technique to control for endogenous selection in an econometric model that also accounts for spatial dependence. We find that the two USDA broadband loan programs have had positive causal impacts on farm sales, expenditures, and profits in a subset of rural counties—those adjacent to metropolitan counties—but not in other types of counties.

- Kandilov et al., 2017
- County-level analysis, using farm sales / expenditure data from BEA
- Positive impacts on farm sales, expenditures, profits (for loan program)
- Also find positive impact on proportion of farms with Internet access
Rural Broadband Research

The broadband digital divide and the economic benefits of mobile broadband for rural areas

James E. Prieger*

Results 3 and 6, also novel in the digital divide literature, suggest that mobile broadband usage is filling in part of the rural availability and usage gaps in fixed broadband, and so it is clear that mobile broadband plays an increasingly important role in the broadband ecosystem. It is interesting to note that the FCC not requiring ownership of a computer in the household. The evidence suggests that as mobile and other forms of broadband diffuse in rural areas, they will stimulate local economic growth, although estimates vary concerning the magnitude of the causal impact. Thus, any policies affecting broadband diffusion – not just those currently pursued by the FCC – are highly important.

- Prieger, 2014
- Mobile access helps fill in gaps in fixed coverage in rural areas
- Significant potential for economic development associated with mobile broadband
Other work has found that adoption, not infrastructure, is more important for economic growth.

Broadband's contribution to economic growth in rural areas: Moving towards a causal relationship

Brian Whitacre\textsuperscript{a,*}, Roberto Gallardo\textsuperscript{b}, Sharon Strover\textsuperscript{c}


Does rural broadband impact jobs and income?
Evidence from spatial and first-differenced regressions

Brian Whitacre · Roberto Gallardo · Sharon Strover

- 2008-2011 data: Increases in BB adoption is associated with growth in income and jobs for non-metro counties. Increases in availability is not.
How Connected Are Our Farms?

Brian E. Whitacre, Tyler B. Mark, and Terry W. Griffin

JEL Classifications: Q12, R20
Keywords: Broadband, Connectivity, Precision Agriculture

We take an introductory look at the connectivity available on U.S. farms by examining the broadband availability for counties with high levels of crop production. These are also the areas where precision agriculture adoption rates would be the highest; they could be the most likely to employ telematics and participate in the usage of big data in decision making initially.

The statistics displayed in Table 1 demonstrate that, on aggregate, the counties with harvested acres seem to be better connected than the average non-metropolitan county.

- Whitacre et al., 2014

- Some states with significant harvested acres have limited access to 3 MBPS upload speeds
Current Federal Legislative Efforts

- **Precision Agriculture Connectivity Act of 2018 (H.R. 4881)**
  - Establishes Task Force for meeting connectivity / technology needs of precision agriculture
    - Identify gaps in service coverage of cropland
    - Assemble comprehensive guide of relevant Federal programs / resources
    - Develop policy recommendations
  - Goal: Reliable service on 95% of croplands / ranchlands by 2025

- **Rural Broadband Deployment Streamlining Act (S. 1363)**
  - Streamlines process for considering applications to locate certain types of broadband facilities

- **Community Broadband Act (H.R. 4814)**
  - Preserves ability of local governments to provide broadband capability
    - Note: 21 states currently limit municipal ownership
Examples of State-level Efforts

- Iowa: Broadband Targeted Service Area
  - 100% property tax exemption for installation of infrastructure that meets 25 / 3 threshold

- New York: Broadband Program Office
  - $500M in funding to bring 100MBPS to most areas, and 25 / 3 to all areas (part of CAF program)

- Other States with Broadband Grant Programs:
  - Colorado ($20M – 1-time basis in 2017)
  - Minnesota ($34M)
  - Massachusetts
  - Ohio (pending - $50M)
  - Most programs require 50/50 matching from private firms

- Elements of Good Broadband Policy
  - Dedicated state-level office
  - Telecom modernization bills
  - Broadband data collection and mapping
  - Direct funding of broadband development