Impact of Broadband Access on Agritourism Operations in the United States

Claudia Schmidt
Department of Agricultural Economics, Rural Sociology, and Extension Education
Pennsylvania State University
112A Armsby, University Park, PA 16802-5602, USA
cschmidt@psu.edu

Luyi Han
Northeast Regional Center for Rural Development, Pennsylvania State University
Department of Agricultural Economics, Rural Sociology, and Extension Education
Pennsylvania State University
007-A Armsby, University Park, PA 16802-5602, USA
lhan@psu.edu

Arian Moghadam
Department of Economics
Bloomsburg University
400 E 2nd St, Bloomsburg, PA 17815
amoghada@commonwealthu.edu

Stephan J. Goetz
Northeast Regional Center for Rural Development, Pennsylvania State University
Department of Agricultural Economics, Rural Sociology, and Extension Education
Pennsylvania State University
207-C Armsby, University Park, PA 16802-5602, USA
sjg16@psu.edu

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Abstract

Agritourism is a growing sector that can provide opportunities for rural entrepreneurs and boost rural development in the US. Online presence is crucial for agritourism operators because they cater to consumers. In this study, we employ count data regression models to investigate the relationship between broadband adoption and the number of agritourism operations. Our analysis shows that access to fast broadband internet in 2012 significantly increased the number of agritourism operations in 2017, underscoring the pivotal role of broadband connectivity in facilitating farmer-consumer interactions.

Keywords: agritourism, broadband, rural development

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Introduction

As a diversification strategy for farmers and ranchers, agritourism incorporates various farming-related activities to entertain and educate local visitors and tourists (Gil Arroyo et al., 2013). This strategy is also an increasingly important opportunity for rural entrepreneurship (Barbieri, 2013; Barbieri & Mshenga, 2008; Dickes, 2020; Hollas et al., 2021; McGehee & Kim, 2004) with an impact beyond farm businesses towards supporting rural economies. As such, agritourism has the potential to increase rural economic growth and community well-being by capitalizing on the rapidly growing outdoor recreation and tourism sector (Schilling et al., 2008; Thilmany et al. 2019). Because of the local food connection, agritourism also has been shown to influence attitudes towards purchasing local foods and promote agricultural literacy (Brune et al. 2021). However, US agricultural census data show that less than 1.5% of all farms in the United States receive income from agritourism (Schmidt et al., 2023). Several local or "place-based" factors that contribute to growing numbers of agritourism operations and regional clusters development have been investigated, such as the proximity of activities to natural amenities (Gartner, 2005; Hill et al., 2014; Van Sandt, 2018; Schmidt et al., 2023), travel infrastructure and rurality (Van Sandt et al., 2018). However, no previous study has investigated broadband connectivity's impact on agritourism development. According to Audretsch et al. (2015), access to broadband infrastructure is more significant than highways and railroads for raising business startup rates.

Our underlying hypothesis in this paper is that operators offering agritourism activities on their farms require broadband internet access to connect with potential customers, promote their business and services through social media and other online channels, and process payments and bookings online. A recent survey found that reliable and expensive broadband access is challenging for the agritourism sector. Wang et al. (2022) find that operators in the Southern US

especially have significantly more e-connectivity issues than operators in the Northeast. As a key infrastructure component, broadband access has been widely acknowledged to lag in rural areas (Deller et al., 2022). To close this research gap, we explore the relationship between broadband adoption and changes in county-level agritourism operators in the United States.

The connection between broadband internet access and business activity in rural areas, particularly entrepreneurial activity, and rural infrastructure development, has been of growing interest in research (Conroy & Low, 2021; Duvivier et al., 2021; Kim & Orazem, 2016; Whitacre et al., 2014; Deller & Whitacre, 2019). While older studies indicate that increased internet access leads to more competition from online retailers, which can reduce the number of customers for local businesses and lower sales tax revenue (Bruce et al., 2009; Goldmanis et al., 2009), more recent studies have shown that access to high-speed internet services can positively impact a region's economic development. For example, Deller et al. (2022) found a positive relationship between broadband quality and rural entrepreneurship: speed is important, as more rural startups are associated with 50 Mbps download speed compared to the current 25 Mbps threshold. Deller et al. (2022) conclude that "improving wired and wireless internet access is a vital element for general rural economic development" (Deller et al., 2022 p. 999). In 2014, Whitacre and colleagues examined the relationship between broadband availability and economic growth in US counties utilizing data from 2000 to 2010. They find a causal relationship between higher incomes and high levels of broadband availability, but also that adoption plays a more significant role in economic growth measures than availability. Closing the "digital divide" is important, but ensuring that the intended audience also utilizes broadband services is crucial, as Richmond et al. (2017) conclude. The authors studied 1,000 businesses in North Carolina and find that while broadband availability has expanded in rural areas, small businesses still lagged in using the

latest social media marketing practices, suggesting that education is necessary to help businesses use these technologies effectively.

The USDA regularly conducts farm computer usage and ownership surveys. In 2021, 82 percent of farms across the country had internet access. Compared to 2019, the number of farms (29 percent) that used the internet to buy agricultural inputs grew by 5 percentage points. However, the number of farms (47 percent) that conducted transactions with non-agricultural websites in 2021 (USDA, 2021) fell by 6 percentage points. Importantly, 21 percent of farms used the internet to promote their agricultural activities, a 2 percentage points increase from 2019. LoPiccalo (2022) examined how better rural connectivity affects US farming outcomes, using broadband subscriptions from the Federal Communications Commission and agricultural statistics from the Agricultural Census; the author find that higher internet penetration rates with download speeds of 25 Megabits-per-second and upload speeds of 3 Megabits-per-second were associated with improved crop yields. Here we analyze whether broadband utilization affects the number of agritourism businesses. The paper is organized as follows: first, we present the methods and data. We then present and discuss results and conclude with suggestions for further research.

Method and data

We use county-level data, which is the smallest geographical unit possible with secondary data. All else equal, we hypothesize that the adoption of broadband in one period (2012) facilitates future economic activities, such as the establishment of more agritourism operations (in 2017). We use Poisson and Negative Binomial Models to analyze the number of agritourism operations in 2017. Although we do not have an excessive number of zeros - as only about 8 percent of

counties have zero agritourism operation, we include the corresponding Zero-Inflated regression models as a robustness check.

The number of agritourism operations at the county level is from the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) data collected every five years, the latest year being 2017. The data on broadband adoption, the main variable of interest, are retrieved from the Federal Communications Commission's Fixed Broadband Deployment Data Form (*i.e.*, Form 477; 2012). This measures county-level connections per 1,000 housing units for four tiers of broadband speed.[1] We use the mean of the grouped data to calculate the average broadband speed in U.S. counties. Thus, we examine the correlation between broadband adoption and agritourism operations while accounting for the fact that broadband access is not evenly distributed in the U.S. Additionally, we use lagged explanatory variables from 2012 to predict the number of agritourism operations in counties in 2017; the lag structure largely addresses concerns about endogeneity. The control variables provide a more complete model of the independent relationship between county-level agritourism operations and average broadband speed. For example, we include the county's median household income, median housing value, and poverty rate in 2012 to account for differences in economic development, as counties that are more developed may have greater access to broadband. These variables also control for the level of local economic wealth. We include 2012 population density to reflect the opportunity cost of land. We use the natural amenity index and the count of EPA toxic release facilities, and the rural-urban continuum code to account for how natural amenities, dis-amenities and different levels of rurality impact the success of agritourism in different counties. Also, certain policies or events may affect specific

[1] Tier 1 to 4 indicate residential fixed broadband connections with a downstream speed of at least 200 Kbps, 768 Kbps, 3 Mbps, and 10 Mbps, respectively.

regions or states, and we control for these using state-specific indicator variables. The unemployment rate is from the Bureau of Economic Analysis (BEA), while the natural amenity index, rural-urban continuum codes, and poverty rate are from the USDA Economic Research Service (ERS), and population density, median housing value, and median household income are from the American Community Survey (ACS) extracted from The National Historical Geographic Information System (NHGIS) (Steven et al., 2022). Table 1 presents summary statistics along with the number of observations available for each variable.

Table 1 Summary Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
# of agritourism operations in 2017	2,956	9.67	12.62	0	185
Avg. broadband speed	2,956	2.61	1.48	0	9
# of agritourism operations in 2012	2,956	11.22	15.60	0	236
# of farm proprietors (1k 2012)	2,925	0.61	0.50	0	5.66
Median household income (10k $2012)	3,142	4.48	1.14	2.21	12.13
Median housing value (100k $2012)	2,954	1.33	0.76	0.2	9.03
Population density (2012)	2,954	0.18	1.12	0	48.09
Poverty rate (2012)	3,142	17.20	6.58	3.1	51.2
Social capital index (2014)	2,954	-0.007	1.23	-3.18	21.81
Natural amenity index (continuous, 2012)	2,945	0.06	2.28	-6.1	11.17
# EPA toxic release facilities (2012)	2,954	0.40	0.42	0	5
Counties in metro areas (population $\geq$ 1 million)	2,955	0.14	0.34	0	1
Counties in metro areas (250k$\leq$population $<$1 million)	2,955	0.12	0.33	0	1
Counties in metro areas (population < 250k)	2,955	0.11	0.32	0	1
Urban area (population $\geq$20k) adjacent to a metro area	2,955	0.07	0.26	0	1
Urban area (population $\geq$20k) not adjacent to a metro area	2,955	0.03	0.17	0	1
Urban area (2.5k $\leq$ population < 20k) adjacent to a metro area	2,955	0.19	0.39	0	1
Urban area (2.5k $\leq$ population < 20k), not adjacent to a metro area	2,955	0.13	0.34	0	1
Completely rural (population < 2.5k) adjacent to a metro area	2,955	0.07	0.25	0	1
Completely rural (population < 2.5k) not adjacent to a metro area	2,955	0.13	0.34	0	1

Notes: Authors' calculations. Data sources include the BEA, ERS, ACS, among others. See the Data section for details.

Results

We first present descriptive figures to visualize our data. Figure 1 shows the distribution of the dependent variable – agritourism operations in 2017. The distribution centers to the left tail, the data are therefore not normally distributed. In addition, the agritourism operations are reported in non-negative integer values. Using models such as Poisson or Negative Binomial regressions instead of a linear regression may be more appropriate with this count data. Figure 2 shows the geographical distribution of the average broadband adoption speed in 2012. As discussed in the Data section, we map the county-level calculated average broadband speed. In general, darker green means adoption of faster broadband (e.g., higher Mbps, see footnote 1). The Figure shows a cluster of higher broadband adoption counties in the Northeastern states, Central Florida, Northwest Washington state, and the Bay area in California, among others. However, the Figure also indicates a lack of broadband adoption in many counties in the Southern states such as Texas, Oklahoma, Arkansas, and Alabama. Figure 3 shows the geographical distribution of our dependent variable – the count of agritourism operations in 2017. Previous research has found that agritourism operations are more likely to cluster close to metropolitan areas (Van Sandt et al., 2018; Schmidt et al., 2023). However, comparing the two maps shows that many Southern states, like Texas and the Central Plain areas, have more agritourism operations while lacking good broadband adoption. As Schmidt et al. (2023) pointed out, while the agricultural census does not collect data on the type of agritourism operations, anecdotal evidence indicates that operations in Texas and the Central Plains offer more hunting and ranch activities and not the consumer-faced type of agritourism along the coastal areas, which are more depended on broadband. In addition, this also aligns with Wang et al.'s (2021) findings that the Southern US especially has significantly more e-connectivity issues than operators in the Northeast.

We used different count data regression models, including Poisson, Negative Binomial, and their Zero-Inflated counterparts, to investigate how 2012 broadband availability influenced the number of agritourism operations in 2017. Using Akaike's and Bayesian Information Criteria (AIC and BIC) presented in Appendix A1, the Negative Binomial count models are favored. These results also favor the Negative Binomial over the Zero-Inflated Negative Binomial (ZINB) model. Therefore, in what follows, we only provide the results from the Negative Binomial model (results from both models are presented in Appendix A2, and it is worth noting that both models produce similar results).

Negative Binomial regression model results are reported in Table 2, where the control variables such as socio-economic factors, natural amenities and pollution, and rural-urban continuum are added in the second to fourth models, respectively; and the state indicator variables are included in the last model. After controlling for these variables, we find that broadband speed in 2012 still has a significant impact on the number of agritourism operations across U.S. counties in 2017. This supports our hypothesis that access to fast broadband internet is crucial for farmers who offer agritourism activities on their farms to connect with and serve potential customers. The finding is consistent with previous research demonstrating a positive correlation between rural entrepreneurship and broadband internet (Deller et al., 2022). It also is consistent with the argument that improved internet access offers benefits beyond the crop yield improvements and cost savings proposed by LoPiccalo (2022), enabling farmers to expand their sources of revenue through agritourism.

The results show that counties with more agritourism operations and farm proprietors in 2012 also had more agritourism operations in 2017. Although we do not know whether regulatory developments, economic incentives, community support, or the availability of local

resources are driving the establishment and success of farm proprietors and agritourism operations, once established, the established agritourism operations appear to promote future operations. These factors mentioned above would benefit from future research. The control variables which serve as proxies for income and wealth – median household income and median housing values, respectively – reveal that only wealth has a significant positive relationship with the number of agritourism operators. Furthermore, although the estimated coefficient for the poverty rate has the expected sign, the result is not statistically significant. These results indicate that for discretionary expenditures such as agritourism activities, wealth may be a more significant factor than income. Wealthier households are more likely to have resources available for discretionary spending or recreational activities such as agritourism.

Population density, which is a proxy for the opportunity cost of farming, shows a significant net negative relationship with the number of agritourism operations. This suggests that the negative effects of higher land prices and less availability of farmland on such operations dominate any positive effects associated with consumer demand, at least within the same county. The opportunity cost of converting land from other higher-value uses to farmland may be substantial, leading to fewer new agritourism operations being established. Similar to previous research (Gartner, 2005; Hill et al., 2014; Van Sandt, 2018; Schmidt et al., 2023), natural attractions are positively associated with the number of agritourism operations. Conversely, environmental pollution, as indicated by the proxy variable of EPA toxic release facilities, has a negative association. Presence of toxic release facilities may result in a negative perception of the area, reducing its attractiveness for tourists and agritourism businesses alike. Counties in metropolitan areas with a population of at least 250,000 tend to have more growth in agritourism establishments, all else equal. Although the estimated coefficients for the other rural-urban

continuum variables are not statistically significant, the joint significance test with a high level of confidence (*i.e.*, Prob > chi2 0.0018) rejects that all of these coefficients are jointly insignificant. The estimated coefficients demonstrate the critical role that proximity to metropolitan areas plays in the success of agritourism operations.

Table 2 Negative Binomial Regression: Effects of 2012 Broadband Availability on the Number of Agritourism Operations in 2017

	(1)	(2)	(3)	(4)	(5)
Avg. broadband speed	0.0882***	0.0465***	0.0596***	0.0552***	0.0306**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.041)
# of agritourism operations in 2012	0.0374***	0.0358***	0.0334***	0.0335***	0.0278***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
# of farm proprietors (1k 2012)	0.309***	0.311***	0.348***	0.324***	0.361***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Median household income (10k $2012)		-0.0259	0.0221	-0.00513	0.00157
		(0.364)	(0.445)	(0.869)	(0.963)
Median housing value (100k $2012)		0.200***	0.0602	0.0605	0.0972**
		(0.000)	(0.105)	(0.104)	(0.026)
Poverty rate (2012)		-0.00556	-0.00666	-0.00867**	-0.00501
		(0.176)	(0.109)	(0.040)	(0.280)
Population density (2012)		-0.0696***	-0.0503**	-0.0644***	-0.0787***
		(0.003)	(0.031)	(0.004)	(0.001)
Social capital index (2014)		-0.00677	0.00203	0.0160	0.00835
		(0.611)	(0.880)	(0.281)	(0.609)
Natural amenity index (continuous, 2012)			0.0534***	0.0548***	0.0360***
			(0.000)	(0.000)	(0.003)
# EPA toxic release facilities (2012)			-0.108**	-0.111**	-0.0775*
			(0.016)	(0.018)	(0.083)
Counties in metro areas (population ≥ 1 million)				0.177**	0.216***
				(0.023)	(0.006)
Counties in metro areas (250k≤population <1 million)				0.1000	0.132*
				(0.162)	(0.068)
Counties in metro areas (population < 250k)				-0.0508	-0.00236
				(0.486)	(0.974)

Urban area (population ≥20k) adjacent to a metro area				0.127*	0.115
				(0.097)	(0.122)
Urban area (population ≥20k) not adjacent to a metro area				-0.0455	-0.0112
				(0.642)	(0.912)
Urban area (2.5k ≤ population < 20k) adjacent to a metro area				0.102	0.0887
				(0.111)	(0.150)
Urban area (2.5k ≤ population < 20k), not adjacent to a metro area				-0.0618	-0.0823
				(0.345)	(0.184)
Completely rural (population < 2.5k) adjacent to a metro area				0.00495	0.0508
				(0.947)	(0.478)
Constant	1.189***	1.268***	1.256***	1.388***	1.331***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Controlling for state effect	N	N	N	N	Y
Ln(alpha)	-0.627***	-0.656***	-0.682***	-0.693***	-0.839***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	2925	2923	2918	2918	2918
ll	-8882.2	-8846.2	-8794.6	-8782.3	-8639.3
chi2	796.0	864.2	959.8	988.9	1877.4
p	0	0	0	0	0

Notes p-values in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. Data sources include the BEA, ERS, ACS, among others. See the Data section for details.

Conclusion

We use count data regression models to investigate the impact of broadband adoption on the number of agritourism operations. Our results show that broadband speed in 2012 had a significant impact on the number of agritourism operations in 2017 after controlling for other covariates. This supports the hypothesis that access to fast broadband internet is crucial for farmers offering agritourism services to connect with potential customers. Counties with a higher number of agritourism operations and farm proprietors in 2012 also tended to have a higher number of agritourism operations in 2017, and local wealth played a more significant role than local income in the growth of agritourism operations as discretionary spending is clearly important in this context. Additionally, natural attractions were positively associated with the

number of agritourism operations, while environmental pollution had a negative association. Lastly, the results show that proximity to metropolitan areas plays a vital role in the success of agritourism operations.

This study sheds light on the correlation between broadband internet access and agritourism operations, demonstrating that improved access can offer farmers additional opportunities to generate income. Expanding broadband adoption in rural areas could be vital for promoting agritourism activities, a finding that is consistent with other emerging literature about the importance of reducing the digital divide if all U.S. regions and areas are to have access to similar economic growth opportunities. The results also reveal intriguing differences between metro-adjacent and non-adjacent rural counties, warranting further research. In addition, future work could address the impact of Extension and other outreach on broadband utilization and the costs of broadband expansion in rural areas, compared to the benefits.

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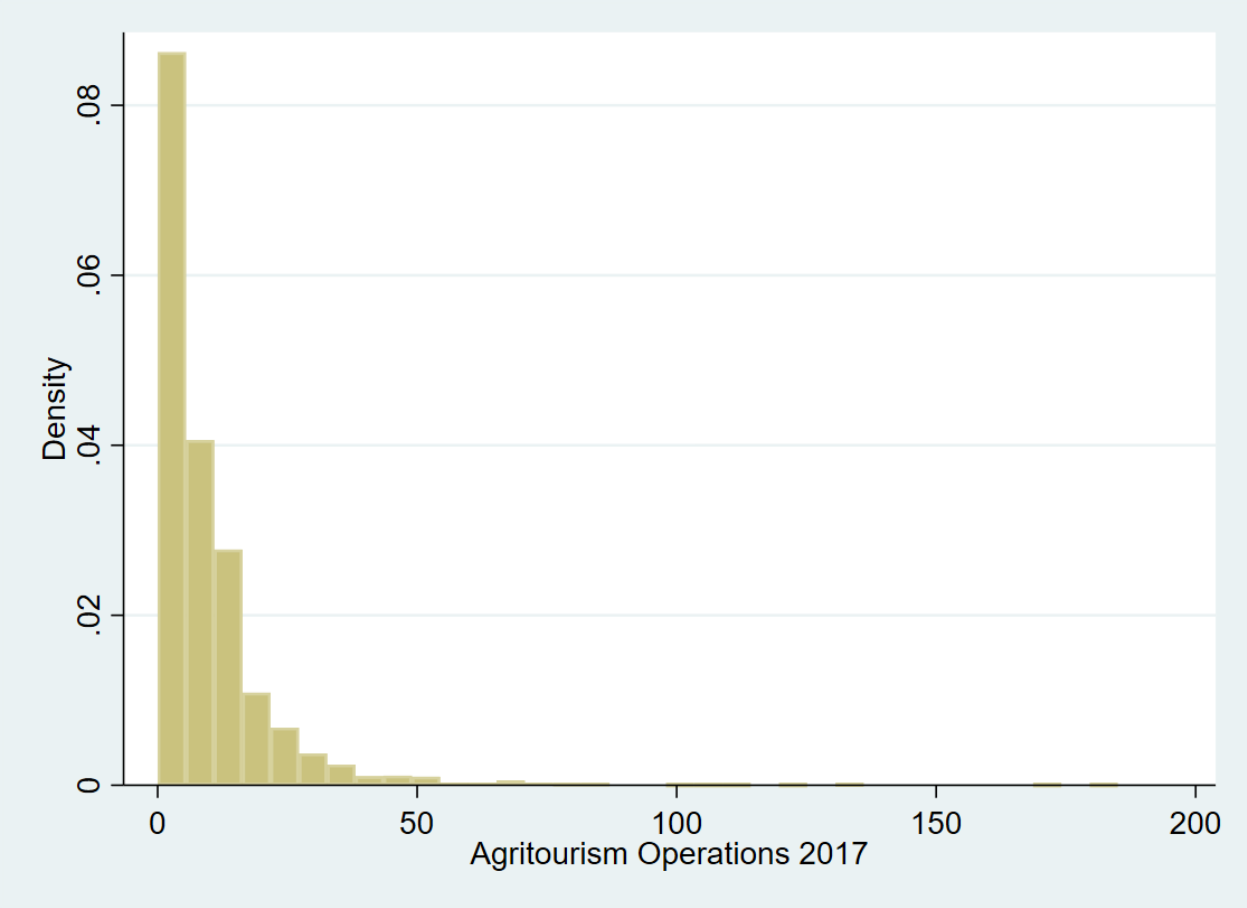
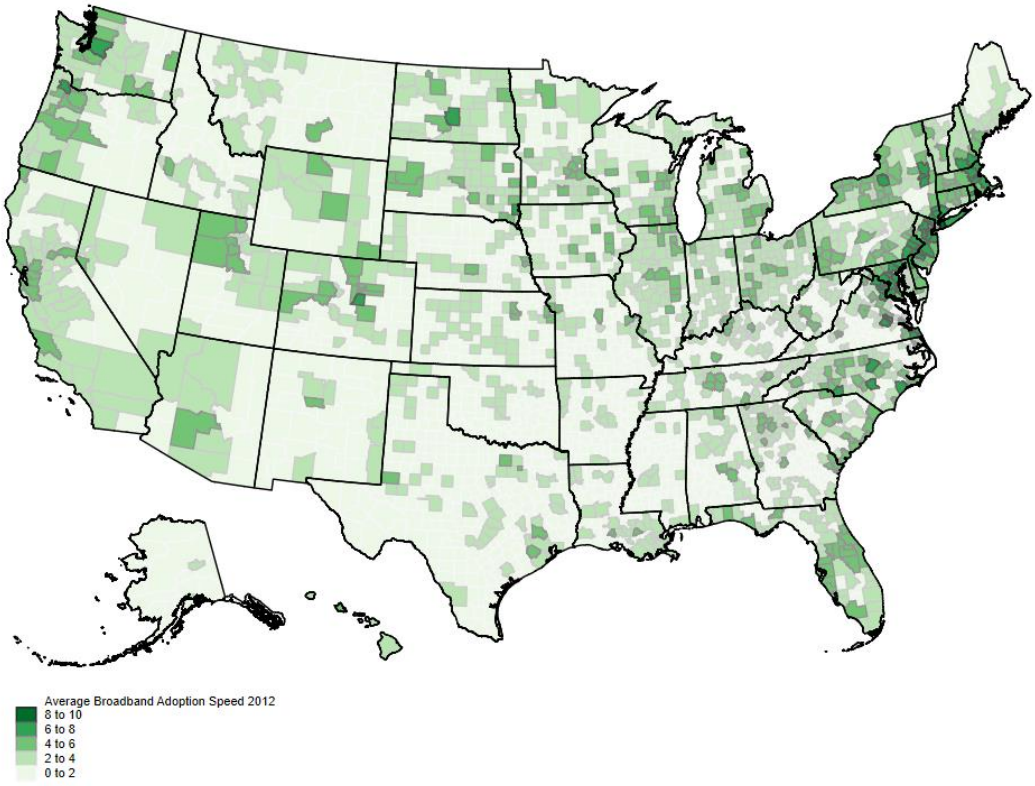
Figure 1 Histogram of Agritourism Operations 2017



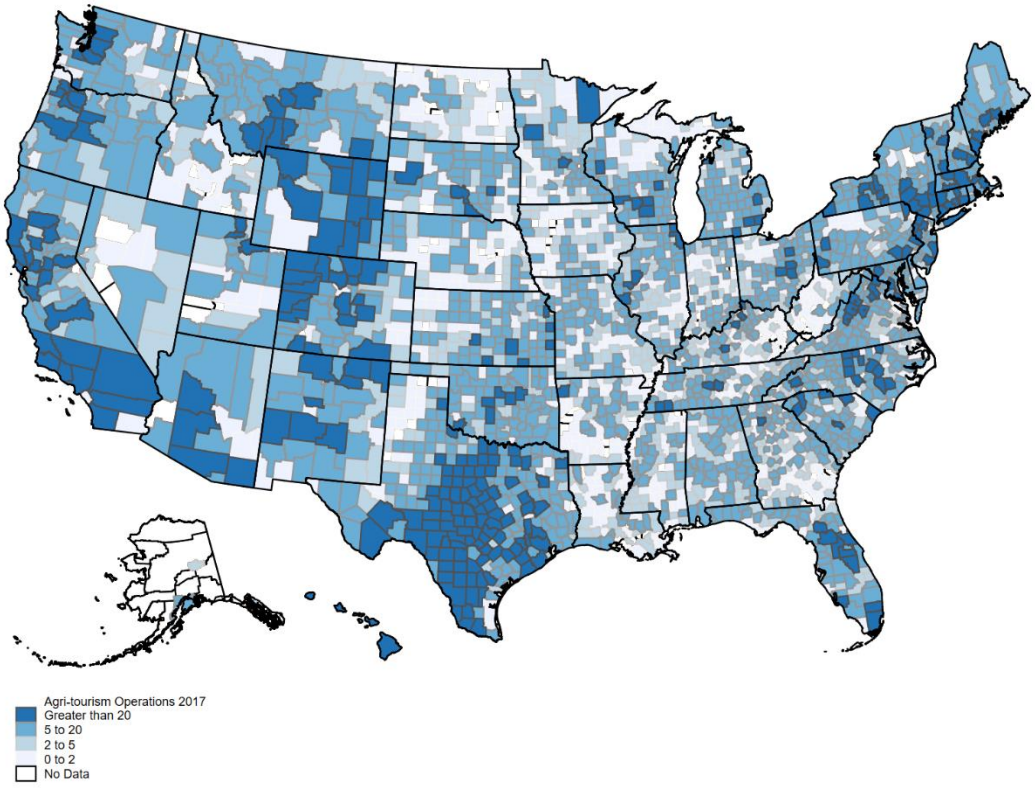
Source: United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS).

Figure 2 Average Broadband Speed 2012



Source: Federal Communications Commission (FCC).

Figure 3 Agritourism Operations 2017



Source: United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS).

Appendix A1

Table A1 Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
NB	2,918	-9649.32	-8639.29	67	17412.58	17813.15
ZINB	2,918	-9643.44	-8637.04	71	17416.09	17840.57
ZIP	2,918	-18684.72	-11262.31	70	22664.61	23083.12
Poisson	2,918	-20255.51	-11787.55	66	23707.10	24101.69

Appendix A2

Table A2 Results from (1) Negative Binomial, and (2) Zero-Inflated Negative Binomial

	(1)	(2)
Count - Negative Binomial		
Avg. broadband speed	0.0306**	0.0288*
	(0.041)	(0.059)
# of agritourism operations in 2012	0.0278***	0.0278***
	(0.000)	(0.000)
# of farm proprietors (1k 2012)	0.361***	0.361***
	(0.000)	(0.000)
Median household income (10k $2012)	0.00157	0.00265
	(0.963)	(0.937)
Median housing value (100k $2012)	0.0972**	0.0941**
	(0.026)	(0.030)
Poverty rate (2012)	-0.00501	-0.00516
	(0.280)	(0.266)
Population density (2012)	-0.0787***	-0.0653*
	(0.001)	(0.062)
Social capital index (2014)	0.00835	0.00801
	(0.609)	(0.623)
Natural amenity index (continuous, 2012)	0.0360***	0.0363***
	(0.003)	(0.002)

# EPA toxic release facilities (2012)	-0.0775*	-0.0774*
	(0.083)	(0.083)
Counties in metro areas (population ≥ 1 million)	0.216***	0.212***
	(0.006)	(0.007)
Counties in metro areas (250k≤population <1 million)	0.132*	0.132*
	(0.068)	(0.069)
Counties in metro areas (population < 250k)	-0.00236	0.00144
	(0.974)	(0.984)
Urban area (population ≥20k) adjacent to a metro area	0.115	0.116
	(0.122)	(0.118)
Urban area (population ≥20k) not adjacent to a metro area	-0.0112	-0.00926
	(0.912)	(0.927)
Urban area (2.5k ≤ population < 20k) adjacent to a metro area	0.0887	0.0888
	(0.150)	(0.149)
Urban area (2.5k ≤ population < 20k), not adjacent to a metro area	-0.0823	-0.0817
	(0.184)	(0.187)
Completely rural (population < 2.5k) adjacent to a metro area	0.0508	0.0505
	(0.478)	(0.481)
Constant	1.331***	1.336***
	(0.000)	(0.000)
Controlling for state effect	Y	Y
Ln(alpha)	-0.839***	-0.841***
	(0.000)	(0.000)
Inflate - Logit		
Real GDP (100m $2012)		0.0243***
		(0.000)
Unemployment rate (2012)		8.359***
		(0.000)
% of households without a vehicle		2.752***
		(0.000)
Counties in large metro areas (population≥250k)		-41.32***
		(0.000)
Constant		-239.6***
		(0.000)
Observations	2918	2918
ll	-8639.3	-8636.4
chi2	1877.4	1871.7

p	0	0

Notes p-values in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. Data sources include the BEA, ERS, ACS, among others. See the Data section for details.