The Identification and Formation of Clusters of Northeastern United States Farms Participating in Multifunctional Activities

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Poster prepared for the Committee on Women in Agricultural Economics section at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013

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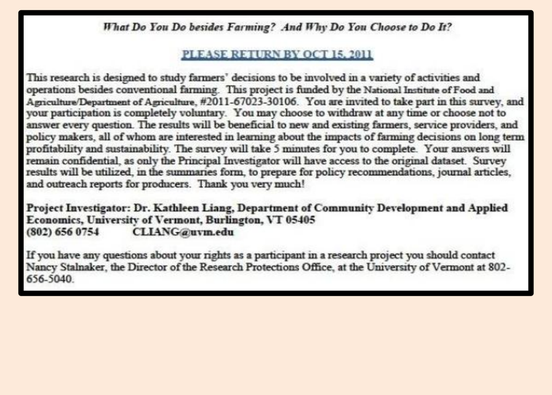
In collaboration with Dr. Mary Ahearn (USDA ERS), and Dr. Jason Brown (Federal Reserve Bank)
Project Funded by USDA AFRI Foundational Grant# 2011-67023-30106

Introduction

The purpose of this research is to investigate **factors impacting farmers' decisions to engage in multifunctional activities**, which are hypothesized to enhance the sustainability and prosperity of farms and their communities. To achieve this research goal, I will break it up into two specific objectives. The first objective is to **identify statistically significant hot spots** of farms participating in multifunctional activities (i.e., clusters of postal areas with highly correlated, large numbers of farms participating in multifunctional activities). The second objective is to investigate the **variables that impact the spatial distribution of farms participating in multifunctional activities** as well as the variables impacting the likelihood of participating in and the level of participation in multifunctional activities. The results of this research may have implications for policies related to encouraging farm participation in multifunctional activities**.**

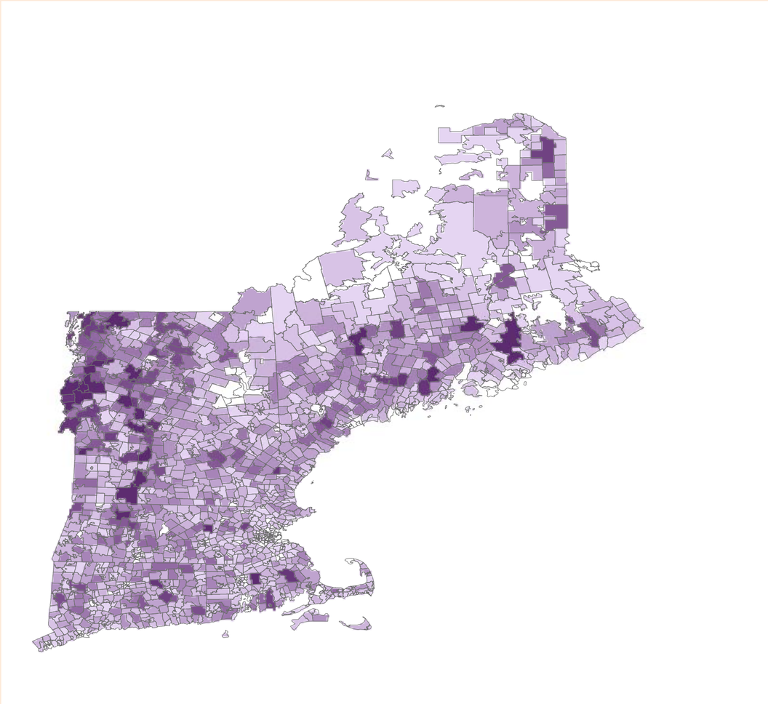
Post Card Survey



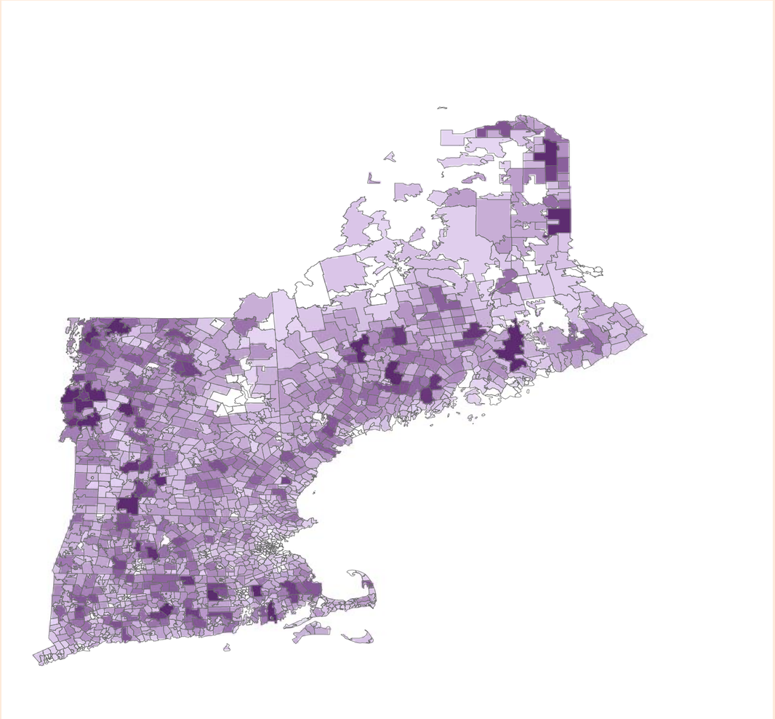
Sample population: All farm operations who responded to the **2007 USDA Census of Agriculture**

Distribution of respondents **compared** to the distribution of farm operations (farm numbers from the Census of Ag)

Raster map of **responses by zipcode**: light purple –dark purple => low number of responses (0) to high numbers of responses (24)



Raster map of **total farm operations by zipcode**: light purple –dark purple => low number of farms (0) to high number of farms (168)



Methodology:

Identifying clusters

Local Moran's I (Anselin, 1995)

$$I_i = (x_i - \bar{X})\Sigma_{j \neq i} w_{ij}(x_j - \bar{X})$$

Z-statistic used to test the **null hypothesis of no spatial autocorrelation**:

$$zstat = \frac{I_i - E(I_i)}{\sqrt{Var(I_i)}}$$

$$E(I_i) = \frac{-\Sigma_{i \neq j} w_{ij}}{n-1}$$

$$V(I_i) = E(I_i^2) - E(I_i)^2$$

Analyzing factors affecting spatial distribution while accounting for spatial lag and error:

Spatial Autoregressive Models

General spatial autoregressive model (Lesage, 1998; Anselin, 1999):

$$y = \rho W_1 y + x\beta + \mu,$$
$$\mu = \lambda W_2 \mu + \varepsilon,$$
$$\varepsilon \sim N(0, \sigma^2 I_n)$$

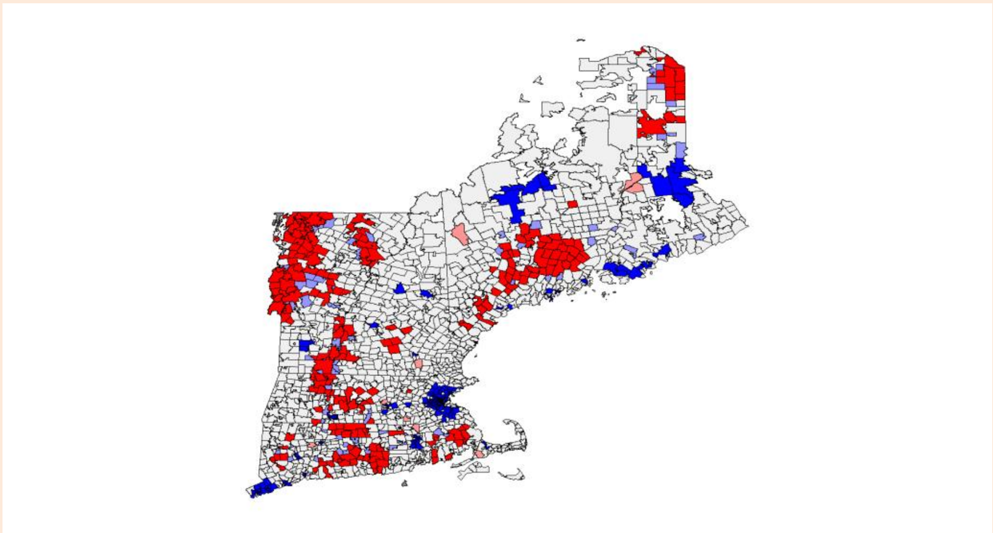
Different versions of this model are based on the presence of the **weighting matrices**

Results (Local Moran's I)

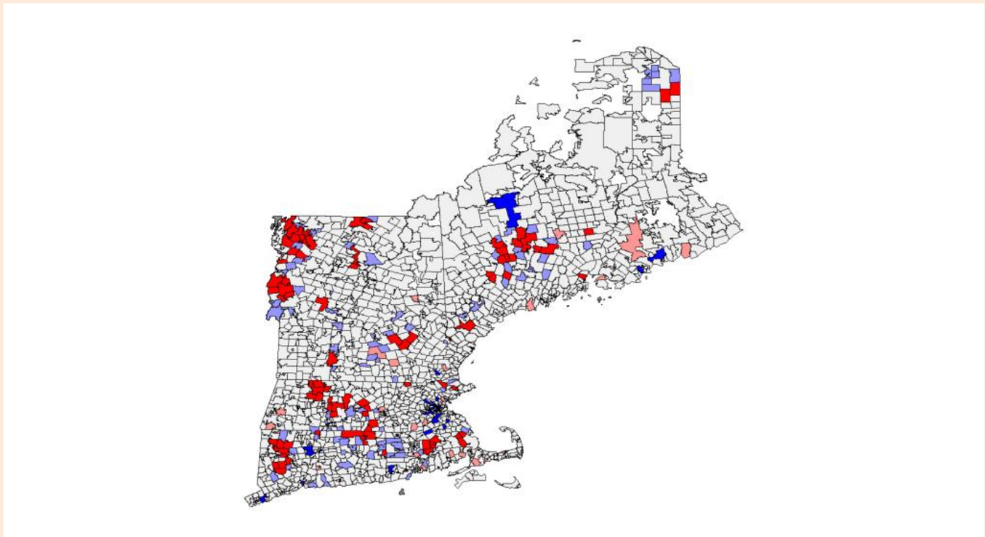
Results of Local Moran's I analysis (based on the **weighted counts** of farms participating in MFAs)

Red = high-high, Pink = high-low, Purple = low-high, Blue = low-low, White = not significant, Grey = no data

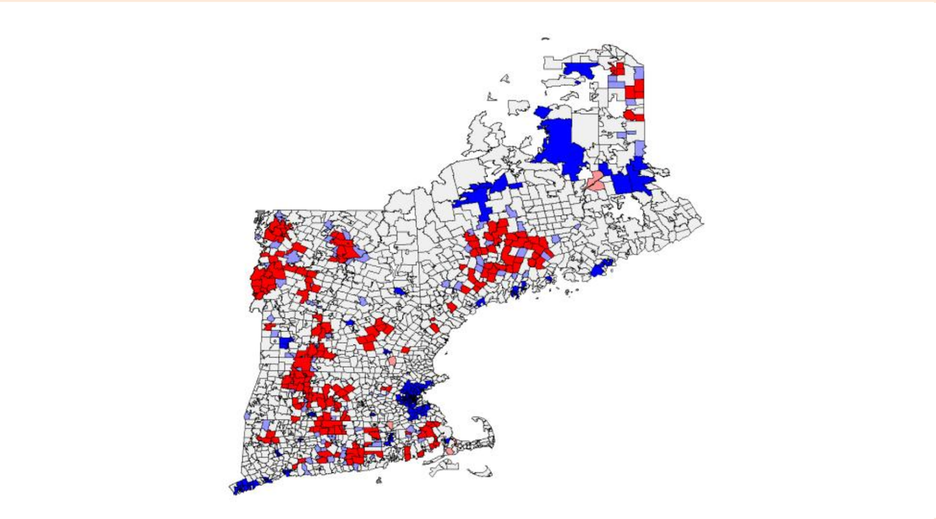
Farms participating in **any form of multifunctional activity**



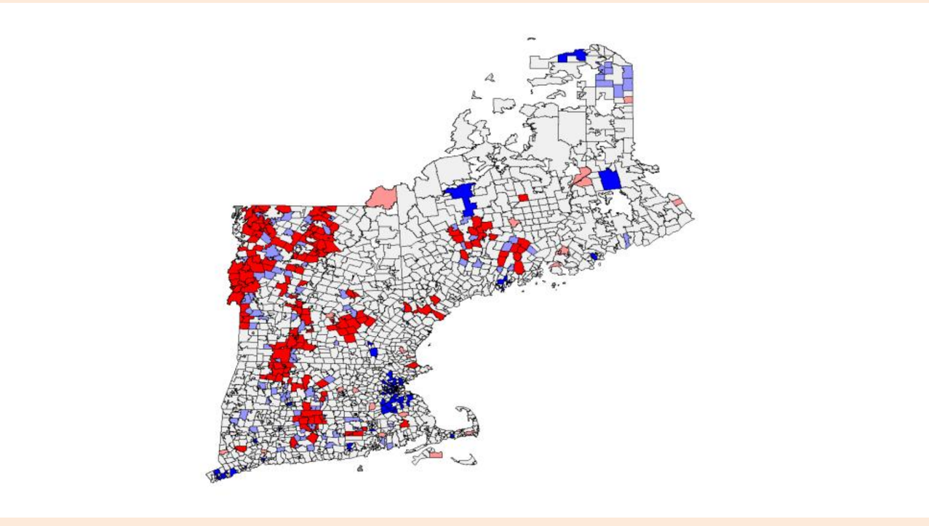
Farms participating in **agritourism**



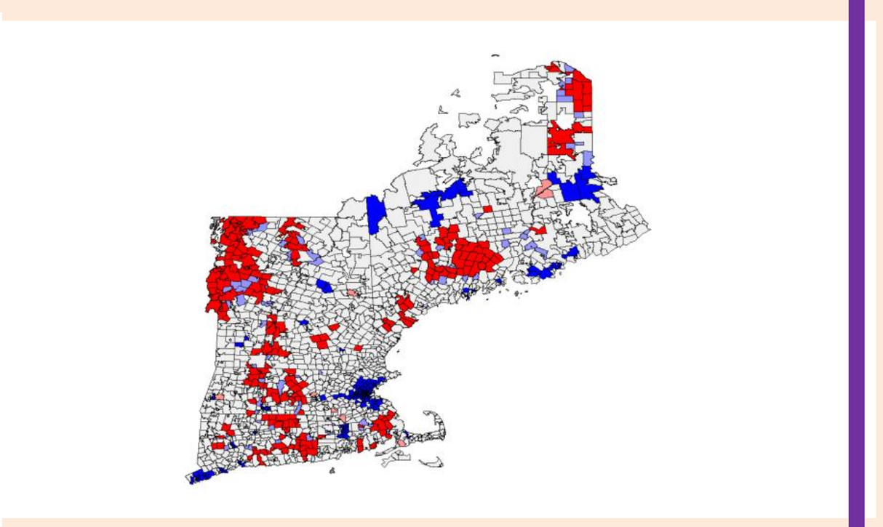
Farms participating in **direct market sales**



Farms participating in **value-added**



Farms participating in **off-farm activities**



Relevant zipcode- and county-level variables

Variable Descriptions

Variable	Level	Description
nummultiw	zipcode	weighted* number of farms participating in MFAs in general
numagrtw	zipcode	weighted number of farms participating in agritourism
numdmsw	zipcode	weighted number of farms participating in direct market sales
numvalueadw	zipcode	weighted number of farms participating in value added
numofffarmw	zipcode	weighted number of farms participating in off-farfm activities
number_respondents	zipcode	number of respondents to the survey
population_farms	zipcode	total number of farms determined by the 2007 Census of Ag
farm_receipt_per_op	county	receipts of income and farm related totals measured in dollars per operation
fed_gov_receipt_per_op	county	federal government program receipts measure in dollars per operation
dist_from_majorcity	zipcode	distance of the zipcode area from a major city measured in kilometers
ag_forest_fish_hunt	zipcode	number of establishments in agriculture, forestry, fishing and hunting
Averagefamilysizee	zipcode	average family size
medianage	zipcode	median age of total population
valuelandperacre07	county	value of land and buildings per acre
hhwithunder18	zipcode	number of households with children under 18
unemp11	county	unemployment rate in 2011
0to4907	county	number of farms size 0-49 acres (small)
cropins_op	county	number of operations participating in crop insurance programs
naturalamenScale	county	natural amenities scale

$$*\,weight_z = \frac{population\_farms_z / total\_population\_farms}{number\_respondents_z / total\_respondents}$$

Rationale for the possible effects on the **spatial distribution** of farms participating in MFAs

Rationale	Variables	Expected Effect
Opportunity Cost: A high value of assets implies a high opportunity cost of using them for multifunctional activities	valuelandperacre07 farm_receipt_per_op naturalamenScale	negative negative negative
Resources: Farmers may be more inclined to diversify if conditions are favorable, and if they are able to exploit their resources	ag_forest_fish_hunt shareorg_with_sales 0to49acres_07 Averagefamilysize Medianage fed_gov_receipt_per_op	positive positive negative positive positive positive
Risk: Farmers engage in diversification and off-farm activities to offset the risk/variation in income that comes from devoting their time to their regular farming activities. Variables related to agricultural conditions and agricultural market conditions can be indicators of risk.	ag_forest_fish_hunt shareorg_with_sales republican fed_gov_receipt_per_op farm_receipt_per_op	negative negative ambiguous negative negative
Avalilability of off-farm work: farmers are more inclined to engage in off-farm work if it is available	dist_from_majorcity_km unemp11	negative negative
Constraints: Family situations may make it difficult to pursue off-farm work	Averagefamilysize hhwithunder18	negative negative
Landscape: Attractiveness of landscape drives diversification	naturalamenScale	positive
Sustainability: High environmental sustainability drives multifunctional systems	fedconsvwet republican	positive ambiguous
Market access: proximity to roads and urban centers provide market access which encourages the development of farm operations	dist_from_majorcity_km	negative
Urban Sprawl: Protection from sprawling development may be beneficial to farm viability	dist_from_majorcity_km	positive
Family: Diversification can be used as a means to create more on-farm employment for family members	Averagefamilysize hhwithunder18	positive negative
Crop Insurance: Crop insurance encourages specialization	cropins_op	negative

Results (Spatial Autoregressive Models)

Results of **maximum likelihood estimations** of **the general spatial autoregressive** model for the **weighted number of farms** participating in MFAs in general, as well as for the weighted number of farms participating in specific categories of MFAs. The independent variables are **zipcode- and county level variables** that **correspond to the rationale table** above. An inverse distance weighting matrix is used for all models, with the exception of "numdmsw," which uses a queen contiguity weighting matrix.

	nummultiw		numagrtw		numvalueadw		numofffarmw		numdmsw	
	Coef.	z-stat	Coef.	z-stat	Coef.	z-stat	Coef.	z-stat	Coef.	z-stat
farm_receipt_per_op	-5.6E-05	-0.46	-9.2E-05	-1.87*	-6.01E-05	-1.16	-6.17E-05	-0.60	-6.38E-05	-0.73
fed_gov_receipt_per_op	-6.3E-05	-0.57	-4.3E-05	-0.94	7.01E-05	1.43	-2.1E-05	-0.22	5.03E-05	0.61
dist_from_majorcity	-1.6E-05	-2.6***	-5.34E-06	-2.28**	-6.01E-06	-2.51**	-1.13E-05	-2.29**	-1.5E-05	-3.19***
ag_forest_fish_hunt	0.012	1.26	-0.001	-0.11	-0.003	-0.51	0.015	1.70*	0.002	0.33
republican	0.498	1.64	0.101	0.78	0.153	1.08	0.502	1.88*	0.11	0.46
Averagefamilysize	1.992	3.72***	0.514	2.09**	4.4E-01	1.42	1.6	3.31***	1.177	2.71***
medianage	0.005	0.36	0.007	0.96	0.002	0.27	0.005	0.36	0.008	0.67
valuelandperacre07	-8.5E-05	-3.1***	4.45E-06	0.42	-2.7E-05	-3.30***	-3.9E-05	-1.60	-5E-05	-3.56***
hhwithunder18	2.6E-04	3.8***	3.95E-05	1.28	7.06E-05	1.88**	2.3E-04	3.76***	1.2E-04	2.18**
unemp11	-0.07	-1	0.046	1.49	2.6E-04	0.01	-0.058	-0.87	0.057	1.25
0to4907	0.002	1.74*	0.001	1.31	9.92E-05	0.23	0.001	1.38	0.001	1.01
cropins_op	0.001	0.56	-4.3E-04	-0.47	0.001	0.89	0.003	1.32	0.003	2.15**
naturalamenScale	0.158	1.15	-0.036	-0.68	-0.015	-0.30	0.1	0.89	-0.013	-0.16
_cons	1.839	0.71	0.546	0.51	-1.01	-0.84	-4.948	-2.76***	-1.786	-1.16
lambda	-1.812	-2.64***	-2.593	-3.3**	0.755	3.66***	1.16	7.59***	-0.27	-2.25**
rho	3.69	7.91***	2.425	18.18***	0.745	3.08***	3.082	10.01***	0.366	3.43***

* implies significance at 10%, **implies significance at 5%, and *** implies significance at 1%

Further Research

- Using the already identified hotspots and coldspots:
  - Determine the zipcode- and county-level variables affecting the likelihood that a postal code area belongs to a hotspot or coldspot
- Using data from another, more in depth, survey of farmers about MFA participation:
  - Determine the farm-level variables affecting participation in MFAs
  - Determine whether self-identified farmer characteristics related to innovativeness and creativity impact participation in MFAs, while accounting for possible endogeneity
  - Determine factors impacting the likelihood that a farm is in a hotspot or coldspot

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