Where are the Veterinarian Shortage Areas Anyway?

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Introduction

THE FOOD ANIMAL VETERINARIAN (FAV) market has undergone dramatic changes in recent years. Food animal industry consolidation has resulted in more emphasis on herd-level health management (Kelly, 2005) and fewer practicing FAVs. This is a matter of concern for public policy because FAVs are best positioned to detect and report the entry of exotic infectious diseases as well as many food safety, animal welfare and bioterrorism incidents. Such events can disrupt international trade, commerce and living conditions in rural areas. Poorly controlled zoonotic disease outbreaks can threaten human health. Thus many believe that the private market provision of FAV services is below the socially optimal level.

The perceived FAV shortage has been addressed at the federal level. The Veterinary Medicine Loan Repayment Program (VMLRP) was implemented in 2010. For qualified veterinarians who agree to serve in certain designated counties for three years, the U.S. Federal government will repay up to $25,000 of student loans per year. Each state's animal health officer decides which counties to forward as applications, while the Secretary of Agriculture decides which applications to accept.

This paper uses two complementary methods to evaluate the VMLRP designated veterinarian shortage area that were chosen in April 2010. On the one hand, we investigate the possible factors that increase a county's chance of being designated as a FAV shortage area under VMLRP. On the other hand, we study determinants of FAV spatial location in equilibrium. And we compare our model- designated shortage areas with those designated by VMLRP, to evaluate whether the shortage designation process meet our objective criteria.

Data & Analysis

THE VMLRP FAV SHORTAGE situations are posted at NIFA Web site: *http://www.nifa.usda.gov/nea/animals/in_focus/vmlrp/vmlrp_shortage_situation_usmap.html.* Based on these data, all counties in the US were categorized as either private practice Program Designated (PD) or Program Non-Designated (PN) shortage counties. The AVMA website *http://www.avma.org/fsvm/maps/ default.asp* provides the number of FAVs for each county. Data for all livestock were obtained from the 2007 Census of Agriculture. We use a rurality index measured by Purdue University's Center for Regional Development. Distance to veterinary college is calculated by CDXZipStream software. A veterinary college dummy is also included, assigned the value 1 if a veterinary college is located in the county and zero otherwise. Population and average per capita income are extracted from the U.S. census of 2000. Data summary statistics are presented in Table 1.

To study the possible factors that increase a county's chance of being designated as a veterinarian shortage area under VMLRP, a logistic regression model was used. The response variable only takes two values, either 1 whenever the county is designated as a PD or 0 whenever it is a PN. Model (1) can be specified as:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \gamma_0 + \gamma_1 \text{FAV}_i + \gamma_2 \text{cattle}_i + \gamma_3 \text{hogs}_i + \gamma_4 \text{horses}_i + \gamma_5 \text{distance}_i + \gamma_6 \text{rurality} \quad (1)$$

Here p is the probability that a county is designated as the private veterinarian shortage county and the subscript i denotes the county identifier.

The estimated logistic regression coefficients for model (1) are displayed in Table 2. It shows when cattle count increases one unit (i.e., 10,000 cattle) then the odds ratio for being listed increases to 1.065. The corresponding odds ratio is 1.009 for hogs and 1.989 for horses. So, having controlled for the number of FAVs in the county, more valuable livestock will increase the odds ratio for being a PD county. As distance from the nearest veterinary college increased by one mile, the odds ratio for being a PD county increased to 1.004. Further, if a county changes from purely urban to purely rural the odds ratio for being listed increases to 6.375. This suggests that rurality has played a key role in deciding whether a county is listed as a veterinarian shortage county.

To characterize how supply and demand interact to provide an equilibrium allocation of FAVs across the counties of the United States, we apply a Negative Binomial regression. This model follows Getz's (1997) state-level analysis on early 1990s data, but does so at the county-level and is more comprehensive in the chosen explanatory variables.

$$\ln(E[\text{FAV}_i]) = \gamma_0 + \gamma_1 \text{cattle}_i + \gamma_2 \text{hogs}_i + \gamma_3 \text{horses}_i + \gamma_4 \text{distance}_i + \gamma_5 \text{college}_i + \gamma_6 \text{rurality}_i + \gamma_7 \text{income}_i. \quad (2)$$

The estimated coefficients for model (2) are provided in Table 3. We refer to a county as being model designated, or MD, whenever the Model (2) residual is negative. This is because there are fewer veterinarians than Model (2) predicts. The county is said to be model non-designated, or MN, whenever the residual is positive. Overall, 413 out of 657 (63%) PD counties and 964 out of 2412 (40%) PN counties are MN under Model (2).

We take Model (2) as a benchmark and seek to understand how the program performs in identifying counties that do and do not have shortages. The ratio of PD counties that are MD over all PD counties is referred to as sensitivity and the ratio of PN counties that are MN over all PN counties as specificity. We find that for over 40% of the states program designation sensitivity exceeds 70%. For another 50%, this sensitivity is between 30% and 70%. Also, program designation specificity exceeds 60% for 20% of the states and is between 30% and 70% for about 60%.

Table 1. County Descriptive Statistics

Variable	Year	Mean	Std Dev	Range
Shortage ∈{0,1}	2010	0.210	0.408	0-1
Veterinarians	2008	2.804	3.676	0-49
Cattle ($\times 10^4$)	2007	3.134	4.876	0-107.2
Sheep ($\times 10^4$)	2007	0.189	0.690	0-19.0
Hogs ($\times 10^4$)	2007	2.208	8.871	0-228
Horses ($\times 10^4$)	2007	0.131	0.150	0-3.11
Human) Population ($\times 10^3$)	2000	89.5	292.5	0.07-9519
Distance (miles)	-----	140.95	94.34	0-602
Veterinary College ∈{0,1}	2010	0.009	0.093	0-1
Rurality ∈[0,1]	See text	0.500	0.177	0-1
Income ($\times$$10^3$)	1999	17.13	3.916	4.96-44.3

Table 2. Parameter estimates for model (1)

Variable	Point Estimate	Pr >ChiSq
vet	0.924	0.0001
cattle	1.065	<0.0001
hogs	1.009	0.058
horses	1.989	0.058
distance	1.004	<0.0001
rurality	6.375	<0.0001

Table 3. Parameter estimates for model (2)

Variable	Estimate	p-value
Intercept	0.026	0.8555
cattle	0.084	<0.0001
hogs	0.019	<0.0001
horses	2.052	<0.0001
distance	-0.001	<0.0001
college	0.589	0.0002
rurality	-0.921	<0.0001
income	0.047	<0.0001

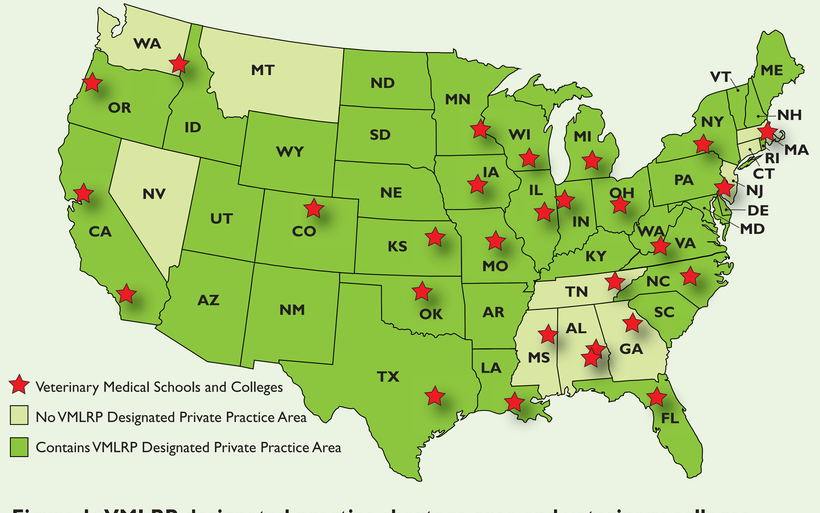

Figure 1: VMLRP designated practice shortage area and veterinary colleges

Conclusion

OVERALL WE FOUND THAT the factors that increase the likelihood of being designated are consistent with our model of determinants for FAV presence and the goals of the VMLRP. However, our models identify states where too few or too many counties have been designated, where the wrong counties may have been designated, and where the designation process seems to have been appropriate. The counties chosen in AZ, ID, IL, IA, KS, MD, MI, MN, MO, MT, OH and WI appear to have been well-chosen. However, efficient use of a given program budget would probably involve funding more counties from NC, VA and WV. Most strikingly, we suggest that FAV shortage is generally more severe in states that received no funding under the VMLRP than in states that did receive funding.

References

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