Explaining Economic Linkages Between Farms And Local Communities:

Looking Beyond Farm Size

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by

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Abstract: We explore the economic linkage between farms and neighboring communities using primary data collected from a state-wide cross section of 461 dairy farms. Empirical results implicate not only farm characteristics such as size, operator tenure and ethnicity but also the characteristics of the local community.

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In this paper we explore the economic linkage between farms and neighboring communities. This linkage often serves as the explicit or implicit rationale for policies that support farm incomes: if local farms are economically viable, they will help sustain local economies and improve the welfare of residents, particularly in rural communities with traditional dependency upon farms.

Over time, however, the size, structure, geographical concentration, and business models of farms have changed, which begs the question: Has the size and nature of the farm-community economic linkage also changed? Our purpose is to better understand how farms' economic linkages to local communities are affected by farm size, structure, geography and other evolving characteristics of farms and rural communities.

Seminal interest in the interface between farm structure and the welfare of nearby communities began with Tetreau's (1938) and Goldschmidt's (1947) pioneering case studies in the southwestern United States. Rural sociologists have expanded upon Tetreau's and Goldschmidt's original focus between farm size and local community welfare to include a broader conceptualization of both local community well being and the facets of farm and local communities that affect the linkage (see Lobao, 2000, for a comprehensive review).

Economists have a fundamental and continuing interest in such linkages as they serve as crucial elements in regional economic models (e.g., input-output models). Economists' focus has remained comparatively narrower, however, with most studies exploring how the percent of a farm's inputs and outputs that are transacted locally are associated with farm characteristics (mainly farm size). Some economic studies focus almost exclusively on the impact of farm size on percent of inputs purchased locally (e.g., Abeles-Allison and Connor; Chism and Levins, Marousek), though several more recent studies also include controls for social or physical distance from local communities (Foltz et al., Lawrence et al.), farmer age and education (Foltz et al.), and farm productivity (Foltz et al.).

This study continues in the tradition of previous economic studies by focusing on the percent of farm inputs purchased locally. It extends the previous literature by looking at a broader range of farm-level characteristics that might impact local purchase tendencies and, unlike previous economic studies, it includes explicit measures of local communities to help explain the intensity of local purchase patterns. While some previous studies have included dummy variables (e.g., Foltz et al.) to account for location specific differences or computed separate analyses by area (Lazarus et al.), there has been little attempt to decompose how different location characteristics systematically affect the relationship.

Community characteristics are increasingly important as highly specialized livestock farms relocate or begin operation in non-traditional production regions (e.g., large hog farms move into Utah). If farms depend upon highly specialized inputs (e.g., specialized equipment or services) that are commonly available only in traditional production regions and these farms are also large, it is important to disentangle the potentially collinear effects of farm size and lack of local supply infrastructures in assessing the impact on local stimulus.

Refining the understanding of the linkage in this manner will also allow us to address other critical questions. For example, will relationships between large livestock operations and local communities grow over time, i.e., will local communities respond by adding specialized services and sales? In the face of arrivals of new, large livestock facilities, how might a local community maximize local economic impact?

In this study we use primary data collected from a broad cross-section of dairy farms in Ohio. Unlike previous studies, data is collected from farmers in both traditional dairy production regions as well as emergent, non-traditional production regions. Previous studies (e.g., Foltz, Jackson-Smith and Chen; Lazarus et al.) often limit data collection to traditional production regions. By including non-traditional regions, we gain variation in location specific variables that might not be present in data gathered from traditional production regions and provide insight into potential impacts of facilities in regions that have the least personal experience with such enterprises.

Data

The primary data were collected by mail survey. Surveys were sent to 983 licensed dairy farms during August of 2002 with a follow up post card mailed two weeks later. Complete entries were entered in a raffle for several prizes. Four hundred sixty-one completed surveys were returned for a response rate of 47 percent. Item non-response to demographic questions further limits individual analyses to a base sample of 428, or about a 43 percent effective response rate.

Farmers were asked about the percent of various inputs (goods and services) produced on site, purchased within their home county, and purchased from a neighboring county. Table 1 provides an overview of 13 categories of inputs explored in this study. Data such as dairy herd size, tenure of operator, and distance to nearest town were also collected.

Herd size has been the focus of many previous studies and has commonly been found to be negatively associated with local purchasing, i.e., the community by-pass issue (Lazarus et al., Chism and Levins, Folz et al., Marousek). The common explanation is that larger size allows the farm to qualify for bulk discounts, which can be directly sent from regional wholesale distributors. This distributional system often bypasses local retailers, who tend to add value (and increase price) to such goods by re-packaging them into smaller lots. Also, larger operations may have more specific input requirements (e.g., special equipment or formulations) that might only be satisfied by a subset of all suppliers, and the probability that these suppliers are located nearby is smaller. Finally, larger operations may have more flexibility with regard to personnel to conduct broader searches of potential suppliers.

Distance to town has been explored previously by Folz et al., who found that farms located further from their local town spent less in that town. Such a result can arise from a simple transportation economics, e.g., the relative cost of sourcing from another town is lower if one's local town is so far away, or from a behavioral point of view, e.g., one is less likely to form relationships in a town if there is a larger physical distance to traverse.

Farm tenure has not been a covariate in previous studies. We expect that farms with greater tenure in their current location are more likely to make purchases locally due to increased knowledge and location-specific relationships. That is, over time, farm managers and owners have likely come to know all local input and service providers, which should foster local spending. Newer farms may have fewer personal connections to local suppliers.

We also construct and include a dummy variable for Amish ethnicity. Amish societies shun the use of grid electricity and other modern conveniences like the ownership of cars; hence, farmers are likely to have different purchasing patterns based on their needs for special (non-electric) equipment and, in part, to tendencies to locate close to one another to minimize the need for automobiles. The former suggests many transactions will take place locally while the latter may have mixed effects: some specialized equipment may be made locally while other specialized equipment may be imported from other Amish areas.

We did not explicitly ask farmers about ethnicity. However, several respondents wrote notes in the margins of the survey mentioning this as a reason for certain purchasing patterns. Responses were coded as Amish if three criteria were met: the respondent had a last name commonly associated with Amish ancestry (Sommerset County Pennsylvania Genealogy Society), if the respondent lived in a county known for Amish enclaves, and if the herd size was less than 50.

Several county-level variables were constructed from the 1997 Census of Agriculture, including corn acreage, soybean acreage, hay acreage, number of dairy farms, average dairy herd size, and non-dairy livestock sales. As more of a given crop is grown in a particular county, it would suggest that prices would be lower, supply sources would be more plentiful and, hence, there would be less motivation to source feed ingredients from outside the county. As a county is home to more and larger dairy farms and to more livestock activity in general, it would be more likely that services and inputs unique to dairy and livestock (e.g., veterinarians, nutrition consultants, etc., which will be referred to as the sector's business infrastructure) would be available to service local dairy farms and, hence, a lower incentive to source these from outside the county. Finally, we add human population as a control variable. As counties become more urbanized, we hypothesize that agricultural service providers will be driven out of a county, making it less likely that such inputs can be sourced locally. Summary statistics for the explanatory variables employed in the analysis are listed in Table 2.

Methods

A double-hurdle tobit model is used to determine the factors affecting the percent of a farm's inputs sourced locally, which is defined as obtaining the input from on-farm sources or sources within the same county in which the farm is located. The tobit model is necessary because many farms report either purchasing none of a particular good or service locally while others report purchasing all of a particular good or service locally; failure to account for such censoring of the data would lead to a bias in regression results. The mathematical derivation of tobit models is well documented in most econometric text books (e.g., Green) and will not be duplicated here.

Our definition of 'local' as within the same county is broader than previous farm-level studies cited above (Lazarus et al. is an exception as they examine factors that affect keeping purchases within the same state), which tend to focus on the linkage between a farm and its closest village or city. The county is chosen because of its practical importance to policy decisions in the realm of locating new dairy and livestock enterprises. While final authority for approving new livestock facilities in Ohio lies in the hands of state regulators, county officials can influence the local atmosphere as new or expanded facilities are developed and can shape local tax policies in a manner that is more or less favorable to such enterprises. These decision makers are likely to focus on how the facility stimulates county-wide activities rather than just the economy of the nearest town.

An overview of the results for all 13 categories of inputs is provided in Table 3. Each regression includes four farm-specific explanatory variables and four or five county-specific explanatory variables. Examination of Table 3 leads to several qualitative findings. First, both farm-specific and county-specific factors emerge as significant explanatory variables. Later, we will introduce the detailed results from several individual models and calculate how important each source of explanatory variables might be in influencing local purchase tendencies. This validates the intuition put forth in the introduction: locality matters in determining local purchasing patterns.

Second, the influence of key explanatory variables can change depending on the input. For example, larger farms are more likely to obtain soybeans and transport services from local sources and to obtain veterinary services, veterinary medicines, bedding and banking from sources outside the county (column 1, Table 3). Hay and feed supplements have quadratic effects. In the case of hay, for a farm that is average in every other aspect, the propensity to purchase locally increases until a farm reaches about 280 cows (about three and one-half times the mean herd size in our sample); after this point local purchase tendencies decline. For feed supplements, the quadratic works in the opposite direction. The percent purchased locally decreases until a farm reaches about 180 cows and then increases thereafter.

In the case of soybeans, larger farms may make it a point to source these important inputs, which are bulky and largely undifferentiated, close to home to minimize transportation costs. In fact, many new, large dairy farms specifically locate in areas with surplus feedstuffs to minimize transportation costs. With regard to transportation, it may be that large farms find it efficient to purchase their own trucking equipment to handle the rather intense needs of moving livestock, and that company employees may have greater incentive to handle the livestock with care than contractors.

The inputs that are more likely to be sourced from a distance by larger farms have lower transportation costs or may have greater variation in quality or type. For example, veterinary services may differ greatly in their degree of specialization and philosophy of practice. Larger herds are more likely to require veterinary visits more frequently; hence, engaging in a broader search for one that fits the farm's needs may pay greater dividends. Also, counties that feature new, large dairy facilities may not have a history of much livestock production; hence, a paucity of veterinary service options may exist.

Bedding is also a seemingly bulky, undifferentiated input. However, larger herds in Ohio increasingly use a highly mechanized bedding system where an external firm delivers sand to be placed under the cows and then removes soiled sand. Only a few services exist (several of them outside the state borders) that supply such services. Smaller farms often use more traditional, labor-intensive bedding systems, such as straw or wood shavings. In such instances, transportation cost is likely to trump quality issues and on-farm or in-county sources are likely to be chosen.

Other inputs, such as medicines and banking services also feature lower transportation fees such that a broader search for low prices and higher quality are warranted, particularly by firms that can buy in bulk or require specific quality specifications necessary for larger scale operations.

County level variables provide significant explanatory power in more than half of the input regressions. Counties with more and larger dairies tend to facilitate larger percentages of local purchases for corn, hay, transportation, and veterinary medicine inputs. Localities with more and larger farms are more likely to host dairy sector specific services or localization economies. Similarly other livestock activity also appears to contribute to a network of businesses that might serve dairies: higher county-level sales of non-dairy livestock products are associated with greater local purchases of consulting services and bedding inputs. Larger human populations are associated with fewer local purchases of veterinary medicines and other farm equipment, which is consistent with the hypothesized direction.

A third qualitative finding is that the estimated models have a relatively low fit with the data. Only five estimated models reject the null hypothesis that all explanatory variables are jointly equal to zero. This suggests that the farm and county characteristics included in this study are, at best, only part of the story behind local purchasing tendencies.

Tables 4 through 7 provide detailed estimates from four individual input category models. Each table also estimates the effect of altering several explanatory variables from mean values on the percent of the input that is purchased locally, where the formula for calculating the effect takes into account the censored nature of the dependent variable. These calculated scenarios provide a quantitative context for interpreting model results.

For example, marginal changes in the farm's herd size and the average number of herds in the area have similar, small, positive impacts on the percent of hay purchased locally (Table 4). A 10 percent increase in an average farm's herd size results in only a 0.7 percent increase in local purchases of hay, while a 10 percent increase in the number of dairy farms in a farm's home and surrounding counties is associated with a 0.5 percent increase in local hay purchases.

The changes associated with 10 percent alterations in base rates of cows and the number of dairy farms are quite small. Also, given the quadratic response of local purchases to herd size, a 10 percent change from the base of an average herd may not capture important effects that are of interest to policy makers. A more interesting contrast with respect to herd size might be the comparison between an average size dairy herd (about 82 cows in this sample) and one of a size that is commonly found among newly constructed dairies (about 700 cows). Such a difference lowers the expected value of local purchases (given all other attributes of the farm and county are average) by 31 percentage points.

The marginal effects of herd size are larger for feed supplements (Table 5) where a 10 percent change in herd size has twice the effect as a 10 percent change in the distance to the local town. As with forages, a quadratic effect exists for herd size. An average farm that increases herd size to 700 cows, while maintaining all other characteristics, increases local purchases by 51 percentage points.

Small changes in herd size continue to have rather small local purchases of transportation services (Table 6) and bedding (Table 7). Increasing an average farm's herd size to the 700 cow level pushes the expected level of local purchases of transportation services upward by 36 percentage points (from a base of 64 percent of local purchases to the censored level of all local purchases). In the case of bedding, a similar herd size increase will reduce local purchases for the average farm from a base of 61 percent local purchases to no local purchases.

Conclusions

In this paper we contribute to the economics literature that explores linkages between local farms and the communities that surround them by analyzing factors that influence Ohio dairy farms' tendency to purchase inputs from within their own county. Our contributions to the literature are several.

First, we expand our analysis to include a wider range of farm specific characteristics. Most previous studies focus solely on farm size and distance to local communities. We also explore how the tenure of the farmer and the ethnicity of the farmer may impact these purchase decisions and find statistical evidence that they are important.

Second, we also consider how the characteristics of the local community affect the purchase decision. Because we use a sample drawn from both traditional and non-traditional dairy production regions, we can decompose how local characteristics can limit or enhance local purchases. This confirms that economic linkages are indeed a two-way street, and that focusing only on farm-level characteristics as indicators of the strength of local linkages provides too narrow of a focus for policy.

Third, we provide analysis of purchase decisions on an input-by-input basis whereas previous studies focus on overall purchases or purchases in large categories of inputs. We find this to be important as key farm-level characteristics can have qualitatively different effects on local purchase coefficients across categories. Furthermore, individual category responses can provide more detail that can be incorporated into sector specific input-output models commonly used in regional economic planning exercises.

In total, the analyses present a more detailed and nuanced picture of the drivers of local purchase decisions which, in turn, allows one to explore more interesting local economic development questions. As livestock industries become more footloose, local and regional economic planners are attempting to assess the fruitfulness of accommodating or resisting the siting of facilities locally. This research provides some greater insight into how local relationships may evolve depending on the nature of the firm that is entering and the nature of the community.

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Table 1. Source of Inputs for Sample Dairy Farms.

Input (N)	% Input Sourced from …			
		Off-farm Source Located in …		
	On Farm	Home County	Neighboring County	Elsewhere
Corn (451)	70.4	15.5	9.2	4.9
Soybeans (381)	20.6	35.6	28.4	15.4
Hay (446)	86.0	7.9	3.1	3.0
Feed Supplements (451)	NA	46.3	34.1	19.6
Veterinary Service (452)	NA	59.1	36.6	4.3
Transport (447)	47.8	34.2	14.1	3.9
Vet. Supplies (449)	NA	50.8	27.6	21.6
Milk Equipment (443)	NA	30.0	37	33.0
Other Equipment (440)	NA	55.1	33.1	11.8
Consulting (300)	NA	47.8	35.0	17.2
Bedding (440)	56.4	26.7	13.1	3.8
Insurance (380)	NA	71.5	17.5	11.0
Banking (443)	NA	78.0	18.8	3.2

Table 2. Summary Statistics for Sample Farms

	Mean	Std. Dev.	Min	Max	N
Farm Size	82.5	156.2	1	2700	458
% <30 cows	28.6				
% 30 – 49 cows	18.8				
% 50 – 99 cows	18.6				
% 100 – 199 cows	17.4				
% ≥ 200 cows	6.6				
Years on Farm	25.2	14.9	0.5	60.0	455
Miles to town	8.7	7.3	0.0	60.0	449
Amish Ethnicity	0.19	0.40	0.0	1.0	462
County* Corn (mil. acres)	8.9	26.1	0.0	146.8	461
County Soybeans (mil. acres)	10.6	33.5	0.0	180.5	461
County Hay (mil. acres)	3.5	9.6	0.0	54.0	461
County # Dairy Farms	263.2	253.9	20.5	738.2	461
County Ave. Herd Size (head per farm)	49.0	17.0	4.4	83.7	461
County Ave. Non-dairy Livestock Sales (mil. $)	35.0	45.4	1.1	198.7	461
County Human Population (1000)	81.2	82.3	14.6	1017.3	461

*All county level variables are based on 1997 data reported in the U.S. Census of Agriculture or from the U.S. Census Bureau. Spatial averages equal ½ times the home county value of the variable plus ½ the average of that value of all neighboring counties.

Table 3. Sign of Significant Tobit Regression Parameters for Percent of Local Purchases by Category.

	Cows[C]	Miles	Tenure	Amish	County Acreage in this Crop[A]	County Non-dairy Livestock Sales[A]	County Dairy Farms[A]	County Dairy Size	County Human Pop	χ^2 *p*-val[B]
Corn							+	+		0.31
Soybeans	+[D]		-							0.30
Hay	+ then -						+			0.04
Feed Supp.	- then +	+			NA					0.04
Vet	-		+		NA					0.16
Transport	+			-	NA			+		0.02
Medicine	-				NA		+	+	-	0.03
Milk Eq.					NA					0.94
Other Eq.				-	NA				-	0.20
Consulting					NA	+				0.46
Bedding	-	-			NA	+				0.03
Insurance				-	NA					0.56
Banking	-				NA					0.13

A- These variables are constructed as spatial averages each farmer's home and neighboring counties.
B- The probability that we can reject the null hypothesis all parameter estimates are jointly equal to zero based on a likelihood ratio test distributed as a χ^2 with the degrees of freedom equal to the number of non-intercept covariates.
C- For the inputs hay and feed supplements, the variable herd size (Cows) enters both as a linear and quadratic term. In both cases the sign listed in this table refers to the direction of the effect over the entire range of observed herd sizes.
D- Each '+' or '-' refers to the sign of an explanatory variable that is significant at the 10 percent level or less.

Table 4. Tobit Results for Percent of Hay Sourced on Farm or within Home County

Variable	**Estimate**	**Std. Err.**	**p-value**
Intercept	0.4980	0.0724	<0.01
Cows in Herd (1000 head)[A]	1.2913	0.4694	<0.01
Cows in Herd Squared (1000 head)[A]	-0.0023	0.0008	<0.01
Miles to town	0.0009	0.0021	0.67
Years on Farm	-0.0004	0.0011	0.70
Amish Ethnicity	0.0504	0.0473	0.29
County Spatial Ave. Hay Acres (million)	0.0015	0.0018	0.40
County Spatial Ave. Dairy Farms	0.0002	0.0001	0.02
County Ave. Cows per Farm	0.0012	0.0010	0.22
Human Population in County (1000)*	0.0001	0.0002	0.89
Scale Parameter for Tobit	0.1612	0.0103	
Log Likelihood	-0.6471		
Scenarios			
Increase Cows in Herd by 10%	0.70[B]		
Increase Cows in Herd from 82 to 700	-31.09[B]		
Increase County Spatial Ave. Dairy farms by 10%	0.50[B]		

A - The quadratic effect reaches a maximum at 281 cows and becomes negative starting at 561 cows.
B – Units are percentage points, e.g., a 10% increase in herd size increases the local purchases by 0.7 percentage points.

Table 5. Tobit Results for Percent of Other Feed Sourced within Home County

Variable	**Estimate**	**Std. Err.**	**p-value**
Intercept	0.2893	0.1033	<0.01
Cows in Herd (1000 head)[A]	-1.0321	0.7141	0.15
Cows in Herd Squared (1000 head)[A]	0.0028	0.0013	0.04
Miles to town	0.0100	0.0036	<0.01
Years on Farm	0.0001	0.0036	0.94
Amish Ethnicity	0.356	0.697	0.61
County Spatial Ave. Other Livestock Sales (mil $)	0.0009	0.0006	0.18
County Spatial Ave. Dairy Farms	-0.0001	0.0001	0.94
County Ave. Cows per Farm	0.0017	0.0017	0.31
Human Population in County (1000)	-0.0001	0.0002	0.66
Scale Parameter for Tobit	0.1976	0.1743	
Log Likelihood	-0.5630		
Scenarios			
Increase Cows in Herd by 10%	-3.24[B]		
Increase Cows in Herd from 82 to 700	51.22[B]		
Increase Miles to Town by 10%	-1.94[B]		

A - The quadratic effect reaches a minimum at 184 cows and becomes positive starting at 369 cows.
B – Units are percentage points, e.g., a 10% increase in herd size decreases the local purchases by 3.24 percentage points.

Table 6. Tobit Results for Percent of Transport Services Sourced on Farm or within Home County

Variable	Estimate	Std. Err.	p-value
Intercept	0.4368	0.1195	<0.01
Cows in Herd (1000 head)	0.1112	0.0621	0.07
Miles to town	0.0040	0.0025	0.11
Years on Farm	0.0002	0.0017	0.90
Amish Ethnicity	-0.2761	0.1592	0.08
County Spatial Ave. Other Livestock Sales (mil $)	-0.0008	0.0007	0.28
County Spatial Ave. Dairy Farms	0.0001	0.0001	0.85
County Ave. Cows per Farm	0.0044	0.0018	0.02
Human Population in County (1000)	-0.0001	0.0002	0.54
Scale Parameter for Tobit	0.1678	0.0163	
Log Likelihood	-1.9052		
Scenarios			
Increase Cows in Herd by 10%	0.09[A]		
Increase Cows in Herd from 82 to 700	36.26[A]		
Amish rather than non-Amish Ethnicity	-27.36[A]		
Increase Ave. Cows per Farm by 10%	2.11[A]		

A - Units are percentage points, e.g., a 10% increase in herd size increases the local purchases by 0.09 percentage points.

Table 7. Tobit Results for Percent of Bedding Sourced on Farm or within Home County

Variable	Estimate	Std. Err.	p-value
Intercept	0.5973	0.1076	<0.01
Cows in Herd (1000 head)	-0.4996	0.1640	<0.01
Miles to town	-0.0050	0.0030	0.10
Years on Farm	0.0019	0.0014	0.19
Amish Ethnicity	-0.0549	0.0724	0.45
County Spatial Ave. Other Livestock Sales (mil $)	0.0009	0.0005	0.06
County Spatial Ave. Dairy Farms	0.0001	0.0001	0.25
County Ave. Cows per Farm	0.0002	0.0015	0.92
Human Population in County (1000)	-0.0001	0.0004	0.96
Scale Parameter for Tobit	0.1377	0.0130	
Log Likelihood	7.6204		
Marginal Effects			
Increase Cows in Herd by 10%	-0.41[A]		
Increase Cows in Herd from 82 to 700	-60.93[A]		
Increase Miles to Town by 10%	-0.43[A]		
Increase Other Livestock Sales by 10%	0.31[A]		

A - Units are percentage points, e.g., a 10% increase in herd size decreases the local purchases by 0.41 percentage points.