Do Purchasing Patterns Differ Between Large and Small Dairy Farms? Econometric Evidence from Three Wisconsin Communities

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Using farm data from three dairy-dependent communities in Wisconsin, this study addresses the question: Do small farms spend more locally than large farms? The work develops a theoretical model of farm cost functions with transaction costs varying between local and distant input sources. This model is then tested econometrically, describing farm costs and where they were spent as a function of transaction/search costs and farm characteristics. The results suggest that scale does matter to farm spending patterns.

Key Words: community economics, dairy industry, farm size, purchasing patterns

Much of the popular debate on the current wave of consolidation in farming has focused on the effects of increasing farm sizes on the viability of small towns and their businesses. A commonly expressed opinion suggests that increases in farm size cause the demise of small towns and their businesses (e.g., Strange, 1988). While the popular debate has accepted as fact that large farms erode nearby small towns, very few studies have sought to quantify this effect. In contrast, the typical community development study takes the multiplier effects of farms to be constant with respect to scale.

To our knowledge, only two recent studies have estimated the purchasing patterns of farms by location and scale—Chism and Levins (1994) and Lawrence, Otto, and Meyer (1997). Each of these analyses found larger farms spent a smaller percentage of their input expenditures at local businesses; however, both studies were constrained by data limitations.

Is there a relationship between farm size increases and local economic activity? Using farm data from three typical dairy-dependent communities in Wisconsin, our analysis addresses the question: What factors determine whether small farms spend more locally than large farms? This work extends previous studies by adding a theoretical model to describe the bypass decision and by incorporating more detailed local business and farm data. The results of this study have important implications for small-town agribusinesses and cooperatives and for community development planners as they attempt to manage structural change in small towns.

The remainder of the article is organized as follows. In the section below, previous work on the issue of farm scale and purchasing patterns is reviewed. We then develop a theoretical model of farm cost functions as a function of transaction/search costs and quantity discounts. Our model captures the idea that higher transaction costs of purchasing from distant input suppliers will be partially offset by quantity discounts. From this model we construct a set of local expenditure share equations for inputs bought near the farm and those

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Comments from Bradford Barham, the journal editor, three anonymous reviewers, and participants at the 2000 American Agricultural Economics Association meetings in Tampa, and the Rural Sociology meetings in Washington, DC, greatly improved the quality of this work. The authors, however, retain sole responsibility for any remaining errors.

purchased far away. The local expenditure share functions are then estimated using an upper-censored tobit econometric procedure for total costs and for feed costs. Next, the results of our analysis are summarized, followed by a final section presenting our conclusions.

Previous Research

The popular discussion about structural change in the livestock sector has often presumed the existence of striking differences in the spending patterns of large versus smaller farming operations. Indeed, community debates over proposed siting of large-scale livestock facilities throughout the U.S. are frequently characterized by assertions that these new facilities will offer fewer economic benefits to the community than smaller operations already in the area (see, e.g., Ivey, 2000; Mowris, 2000).

The empirical literature on the micro-relationships between farm scale and locality of purchasing behavior is relatively thin. To a significant extent, the notion that farm scale affects purchasing habits, and hence community well-being, derives from a widely cited 1947 study by Goldschmidt (reprinted 1978) who compared the two farming communities of Arvin and Dinuba in the Central Valley of California during the mid-1940s. Goldschmidt reported that the community surrounded by relatively large farms with predominantly hired labor forces (Arvin) had fewer business establishments, less retail trade, and lower spending on household supplies and building equipment than the community surrounded by more moderate-scale, family-labor farms (Dinuba). He also found Dinuba had higher levels of socioeconomic equality, participation in community life, and other indicators of social well-being.

In the half century since Goldschmidt first published his study, a succession of studies have examined the link between farm structure and community well-being, utilizing mostly aggregate, county-level data (Gilles and Dalecki, 1988; Labao, 1990; Labao and Schulman, 1991; Barnes and Blevins, 1992; see also a critique of Goldschmidt's original work by Hayes and Olmstead, 1984).

A few scholars have reexamined the farm-level economic spending patterns related to farm scale. Marousek (1979) investigated the economic importance of different sized farms to a rural Idaho community. Results of his study showed small farms represented a relatively small market for local businesses, but spent a larger share of their production expenditures in the community. Korsching (1985) reported finding no strong relationship between farm size and spending habits among his sample of Midwestern farms.

Using data from Iowa hog producers, Lawrence, Otto, and Meyer (1997) found larger farms (as measured both in terms of total hogs produced and total gross farm sales from all operations) were significantly more likely to bypass local suppliers. For example, roughly 70% of the small producers bought feed within 10 miles of their operation, compared to 43% of the large hog farms. For producers indicating they did not buy inputs in the nearest community, three main factors—price, quality, and service—were cited as important to their decision to source inputs from more distant businesses. Generally, pricing dominated the decision about where to buy general supplies and hog equipment. For feed purchases, larger operations went to non-local sources because of quality (47%) and price (40%), while smaller hog farm producers who bought feed from more distant sources reported that price (39%) and service (35%) were more important than quality (26%).

Drawing from a sample of 30 members of a farm business management association in Minnesota, Chism and Levins (1994) found considerable variation in the proportion of farm spending done locally. When ranked by gross sales volume, crop farms showed little systematic differences in farm business spending habits. However, the percentage of local farm expenditures made by livestock farms fell sharply with increasing scale of operation. Meanwhile, the relationship between scale and local spending per acre was relatively flat.

Research on the overall effects of dairy farms on local communities has often used input-output models as a starting point. In general, input-output models developed over the years to measure the impact of business spending on local incomes (for reviews of the literature, see Richardson, 1985; Dewhurst, Hewings, and Jensen, 1991; and Miller, Polenske, and Rose, 1989) have paid little attention to how differences in business size affect industry multipliers.

Much of this literature relies on fixed-factor coefficient models which have constant-returns-to-scale assumptions built in. Although advances in computable general equilibrium (CGE) models have allowed for more flexible modeling, most of the actual analyses valuing the effects of businesses on local economies still use multipliers based on constant-returns-to-scale assumptions. A few papers have addressed how the changing structure of both the economy and individual households affects multipliers (e.g., Blair and Wyckoff, 1989; Batey, 1991), but at a fairly aggregated level.

If there exists a relationship between spending patterns and farm size, it would present a number of challenges to the received input-output multiplier literature. First, if the local spending patterns of an industry differ by firm size, then multipliers for that industry will also be a function of firm size. Second, the multipliers of an industry may be affected by the size profile of firms in related industries. Thus, if size changes the marginal propensity of a farm to spend locally, then different measures of multipliers may need to be used—not only for changes within the industry, but also for related industries whose dollars pass through the farming sector.

Theoretical Model of Factor Demand

Cost Function Approach with Transaction Costs

This theory section derives a farm's purchasing patterns from a cost function with transaction costs. The transaction costs in the cost function create cost-share functions for local and distant purchases. Let a farm have two possible input suppliers for its inputs (e.g., feed, seed, chemicals). The farm purchases two items, one sold both locally and in a distant location, and the other sold only locally. One can think of the good sold in both locations as feed, seed, or chemicals, and the good sold only locally as land, labor, or veterinary services. For simplicity here, we designate the first good as feed and the other as labor.

Firms face a nonlinear price structure in most rural areas caused by a multiplicity of places to buy their inputs. Typically there will be a local supplier with whom the farmer is familiar. While this local purchase will have few transaction costs to the farmer, the products may have higher prices than can be found either by going to a larger supplier in a nearby larger town or by ordering supplies from out of the area in bulk.[1]

These latter two types of purchases will have different levels of transaction costs. At a minimum, there will be higher transport costs from purchasing out of the local area, but there also may be search costs in finding the supplier, and potential "membership" costs in a new buyers' club. While buying from farther away may engender transaction costs, these suppliers will at the same time offer lower prices and may provide quantity discounts.

Feed is assumed to be of uniform quality; that is, feed bought from a distant supplier is the same quality as the feed available from a local supplier. This makes local feed and distant feed perfect substitutes in production, so the firm will buy whichever type of feed has the lowest price. For simplicity, we also assume the farm production requires a fixed ratio of feed to other inputs (labor), with α being the proportion going to feed and $(1 - \alpha)$ to labor.

These assumptions on the farm production function and on feed quality set up an associated cost function for the firm with the following attributes: it is linear in feed and labor while having fixed factor proportions (Leontief) between feed types (Chambers, 1988).

Let the input prices be as follows: w_1 = the price of feed locally, w_2 = the price of feed distantly, and w_3 = the price of labor. Assume that the actual price to a farmer of distant feed will be some function of the posted price (w_2), the transaction costs the farmer incurs (τ), and the amount the farmer wishes to buy, which in this case can be described by the scale of production (y). The farm's cost function will then be:

$$(1)\quad C(w, y|\tau) = \alpha \min\left\{w_1 y, g(w_2, y, \tau)\right\} + (1 - \alpha) w_3 y,$$

where $g(w_2, y, \tau)$ is a function describing the relationship between the base price (w_2), the amount bought (y), and transaction costs (τ). Let the function $g(w_2, y, \tau)$ be described by:

$$(2)\quad g(w_2, y, \tau) = w_2 y + w_2 y^{-\gamma} + \tau,$$

where γ is a positive number. The first term is the standard cost of the input equivalent for w_1, the second term a markup price that decays as the quantity bought increases with a fixed exogenous parameter γ, and the last term is a fixed transaction cost incurred in the purchase.

The resulting cost function,

$$(3)\quad C(w, y, \gamma|\tau) = \alpha \min\left\{w_1 y, (w_2 y + w_2 y^{-\gamma} + \tau)\right\} + (1 - \alpha) w_3 y,$$

has constant returns to scale for $w_1 y < (w_2 y + w_2 y^{-\gamma} + \tau)$, and decreasing returns to scale other-

[1] The example we have in mind is an outside supplier who charges less if the delivery fills up a full truck, as for instance a tractor-trailer load of feed. Discussions with farmers in the town in this study suggested outside suppliers were cheaper for large quantities purchased. In the modeling that follows, we assume local inputs have higher prices.

wise. Thus the average cost and marginal cost functions will be constant until a threshold point at which there is equality between local and distant feed, with the average cost function declining and the marginal cost function increasing from that point on.

The local cost-share equation can be derived from the farms' cost-minimization problem: $\{\min C(w, y, \gamma|\tau), \text{ s.t.: } y \geq y_o\}$. Let C_L represent local purchases and C_D represent distant purchases. Then the associated local cost-share function is specified as:

$$(4)\quad \frac{C_L}{(C_L + C_D)} = \begin{cases} 1 & \text{if } w_1 y_o < \alpha(w_2 y_o + w_2 y_o^{-\gamma} + \tau); \\ \dfrac{(1-\alpha) w_3 y_o}{\alpha(w_2 y_o + w_2 y_o^{-\gamma} + \tau) + (1-\alpha) w_3 y_o} & \text{otherwise.} \end{cases}$$

Equation (4) implies that the local cost-share function will be a nonlinear function of the scale of production and the transaction costs of distant purchases. This nonlinearity will show up in an estimation of cost-share functions being censored at 1, or 100% local. Procedures for estimating this type of nonlinear relationship are addressed in the following section.

Graphs of Cost Curves and Cost Shares

In order to understand the behavior of the cost function described above, we present a graphical view of the associated marginal and average cost functions and of the cost-minimizing allocation of purchases between local and distant input supplies.

Figure 1 shows the marginal and average cost curves for this function at different farm size levels. As seen from this illustration, the average and marginal cost functions are constant at the local price (w_1), up to a breakpoint at which it makes sense to switch to buying from a distant source (w_2). After that point, the marginal cost drops below average costs, and the farmer then faces declining average costs and increasing marginal costs. The two curves would converge at infinity, implying increasing returns to greater farm sizes.

Thus, for small farms for whom local purchases are optimal, there are no economies of scale. But once a farm purchases some of its inputs outside the local economy and receives quantity discounts, there will be increasing returns to scale.[2]

Figure 2 depicts the cost-minimizing allocation of purchases between local sources (x_1 and x_3 combined) and distant purchases (x_2). It shows the percentage of dollars spent locally relative to those spent in a distant location with α, the parameter describing the proportions of feed and labor, set to 0.5. Since our data will not exhibit the strong assumption of perfect complementarity underlying our model, we expect that the line estimated from the data would show a gradual decline from 1 to 0.5.

Hypotheses from the Theory

Our theoretical model leads to a set of testable hypotheses. Initially, we are interested in how scale of operation is directly related to purchasing behavior (H1).

- H1: *The proportion of inputs bought locally declines with farm size.*

  If there are in fact scale effects, as suggested by the theoretical model, one should observe larger, more productive farms buying a lower proportion of their inputs locally.

Another major implication of the theoretical model is that the share of local purchases will depend on the transaction costs involved in the purchases. If lower transaction costs drive the decision to purchase locally rather than at a distant location, then this proportion should be a function of measures of transaction costs. This implication leads to two testable hypotheses—one related to the farm and farmer's own characteristics (H2), and another concerning the social capital the farmer has invested in the local community (H3).

- H2: *The proportion of inputs bought locally will depend on farm and farmer characteristics that will influence purchasing transaction costs.*

  Examples of farm and farmer characteristics influencing transaction costs would include

[2] This modeling exercise is not to suggest the optimal scale is infinitely large. We presume some other constraint—for example, land, labor, capital, or government regulation—would impose a maximum optimal size. Also note that very quickly the difference between average cost and marginal cost becomes economically insignificant, thus indicating the returns to increasing sizes flatten out.

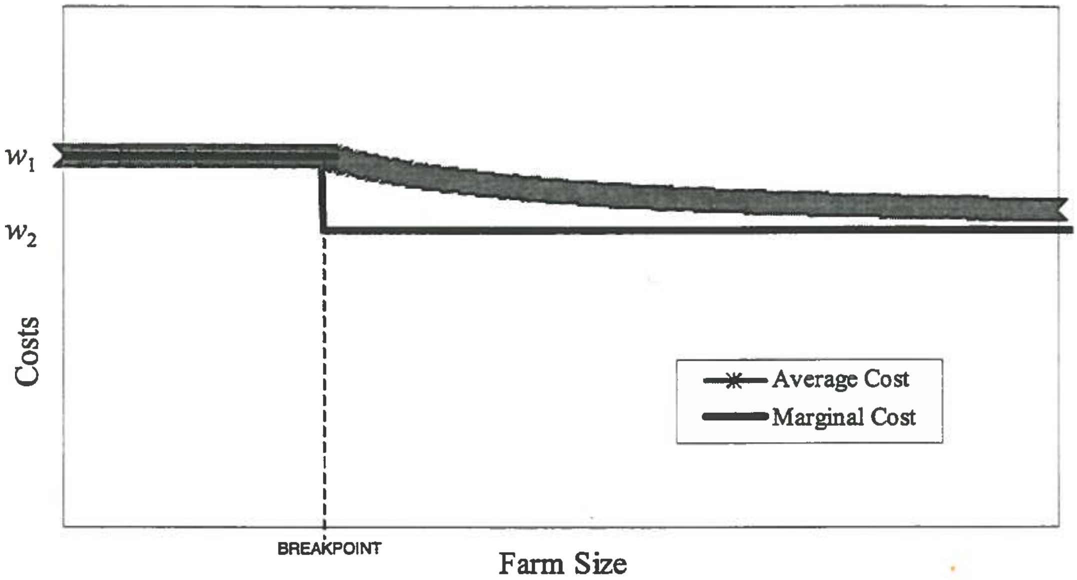

Figure 1. Average and marginal cost curves at different farm size levels

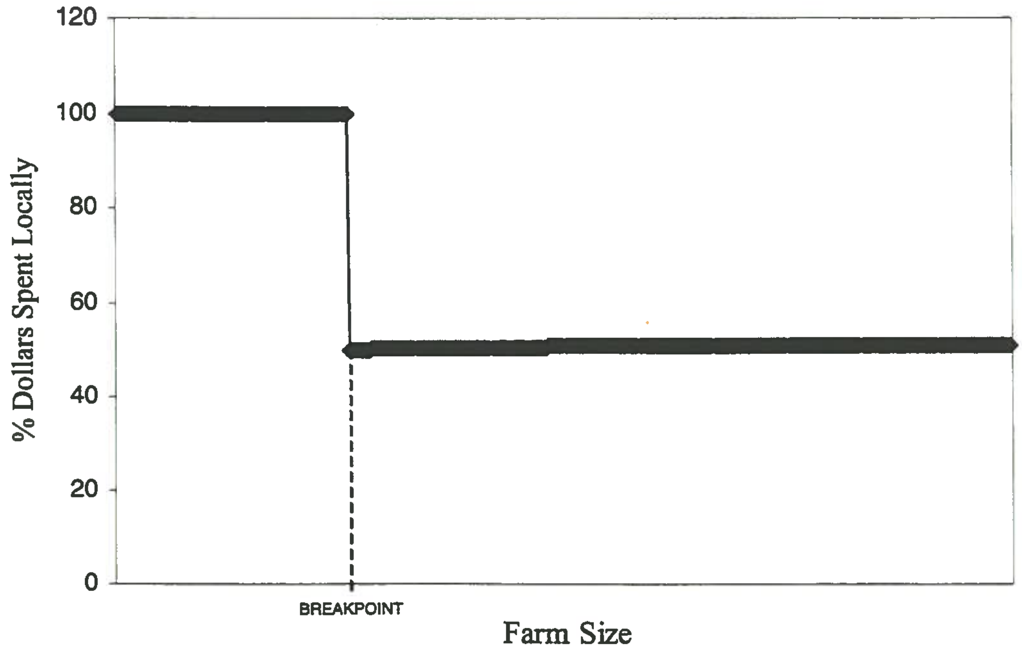

Figure 2. Cost-share graph: Cost-minimizing allocation of purchases between local and distant sources (with α set at 0.5)

the distance from farm to town, the farmer's age, and the farmer's education. Distance is expected to increase the costs of making purchases through a combination of travel time and transport costs. We expect younger, better educated farmers will have an easier time accessing nonlocal suppliers because of greater facility in traveling, reading magazines with supplier advertisements, entering into long-distance contracts, and potentially accessing suppliers through the internet.

The sociological literature on small towns also suggests residents with strong attachment to their community tend to shop more frequently in local establishments (Cowell and Green, 1994; Pinkerton, Hassinger, and O'Brien, 1995; Miller, 1998). In effect, that literature suggests the causes of purchasing decisions are as much noneconomic (psychic) as economic. This leads to the third possible hypothesis governing the decision of where to source agricultural inputs—i.e., transaction costs will be a function of the personal networks and relations an individual has in the local community.

- H3: *The proportion of inputs bought locally will depend on measures of a person's attachment to the community.*

  People who feel more attached to their communities have more personal networks there, and are therefore more likely to buy their inputs locally.

Data and Model Estimation

Data Description

The data used in the estimations come from on-farm interviews with 100 dairy farmers divided among three dairy-dependent Wisconsin communities: Athens, Chilton, and Richland Center, shown on the map in figure 3. Communities were defined using zip code boundaries, and three zip codes were selected based on the following criteria: (*a*) there were a large number of dairy farms (e.g., between 140 and 210 in our three sites); (*b*) there was a central community or town center located near the middle of the zip code; and (*c*) farming was a significant part of the local economy, in terms of both employment and income. According to *1997 Census of Agriculture* statistics (U.S. Department of Agriculture, 1999), dairying represented the main economic activity on 45% to 57% of the farms in the zip codes, and dairy sales provided between 60% and 67% of total farm receipts in the counties where these zip codes were located.

To isolate the importance of agriculture to the local community, the selected Wisconsin zip codes represented locations where the percentage of working adults reporting farming as their main occupation in 1990 was far greater than either the statewide or national average (13% in Chilton, 13% in Richland Center, and 28% in Athens). Meanwhile, between 12% and 24% of households reported some farm income, and from 5% to 16% of all personal income in the study areas came from farming.

The three towns were also chosen so as to represent contrasting regions of the state, as well as different facets of the evolving dairy industry. Athens is a traditional small dairy town in a relatively rural area. Chilton is a moderate sized commercial dairy town in an area witnessing considerable nonfarm growth pressures. Richland Center is an area of more marginal land with many dairy farms undergoing rapid expansion and/or moving toward intensive rotational grazing.

Farmers in our study were selected randomly from lists of dairy operations in each town zip code maintained by the State Department of Agriculture, Trade, and Consumer Protection.[3] Thus, while a case study methodology was used in choosing the towns, the results from the data will be statistically representative of the situation within each of the communities.

For purposes of this analysis, we defined farm expenditures as "local" if they were made within a 20–25 mile radius of the "core community" of interest (20 miles in the cases of Chilton and Richland Center, 25 miles in the case of Athens). Since farms in the study were located as much as 20 miles from the core community, and since there were often sources of farm inputs (feed, supplies, services, etc.) available from other farmers, individuals, or businesses located in smaller nearby towns, we determined that this definition of local purchasing best represented the phenomenon we were attempting to capture.

[3] Many of the farms had participated in an earlier mail survey of all dairy farms in the three communities, conducted in the spring of 1997. Initial contacts with farmers were made via telephone calls from the principal investigators. Significantly more than half of those called agreed to participate, and the resulting sample is quite representative of the population of dairy farms in each community as well as in the state as a whole. The interviews were conducted by trained enumerators in the spring of 1998, with all financial data referring to the 1997 calendar year.

Note: All boundaries and names are as of January 1, 1992.

Figure 3. Map showing Wisconsin study sites

Equations to Be Estimated

Using the percentage of costs paid to local merchants as a cost-share variable, we estimate two equations: (*a*) a cost-share function for local purchase of all inputs, and (*b*) a cost-share function for local feed purchases. While the first is the primary focus, we also estimate feed cost shares since feed is the largest and most accurately measured of the expense categories in the data set. The econometric estimation procedure used, described below, is an upper-censored tobit model (see Maddala, 1983, pp. 149–150, 160–162).

The theory established a nonlinear relationship between local cost shares, $C^* = C_L/(C_L + C_D)$, and farm/farmer characteristics, X, which describe scale and transaction costs. Local cost shares are censored from above at 1, or 100% local purchases. Rescaling C^* to percentage terms, the censoring of local purchases at 100% represents 14% of the observations for all purchases and 73% of the feed purchases.

The scale of this censoring and the nonlinearity in hypothesized spending patterns from the theoretical model necessitates an estimation procedure, an upper-censored tobit, which takes this censoring into account. For an individual datapoint with a vector of independent variables $\mathbf{x}_i$ and a vector of parameters to be estimated $\boldsymbol{\beta}$, an upper-censored tobit is written as:[4]

$$(5)\quad C_i^* = \boldsymbol{\beta}'\mathbf{x}_i + \varepsilon_i,$$

where

$$C_i = \begin{cases} 100 & \text{if } C_i^* \geq 100, \\ C_i^* & \text{if } C_i^* < 100. \end{cases}$$

The estimation procedure for this model maximizes a standard tobit likelihood function with the

[4] Note that we could also (but do not) account for censoring at zero local purchases. Since there were very few observations below 50% local, such a double-censored tobit would unnecessarily clutter the analysis.

changes for upper censoring rather than the more common lower censoring at zero. With 100% as C^u, the upper bound of our estimation, the likelihood function is constructed as follows:

$$(6)\quad \ln L = -\frac{1}{2}\sum_{C_i \le C^u} \ln(2\pi\sigma^2) + \frac{(C_i - \beta'\mathbf{x}_i)^2}{\sigma^2} + \sum_{C_i = C^u} \ln\left[1 - \Phi\frac{(C^u - \beta'\mathbf{x}_i)}{\sigma}\right],$$

where Φ is the normal cumulative distribution function and C_i is the cost share.

Table 1 presents selected statistical measures of the independent variables, X, used in the equations. These variables can be designated by the following categories, with their names and hypothesized signs in parentheses:[5]

- Farm Characteristics: Number of cows (*Herd Size*, negative), and productivity (*Milk Sold per Cow*, negative).
- Transaction Cost Proxies: Age (*Age*, negative), education (*Education*, negative), and distance from the farm to the local town (*Distance*, negative).
- Community Attachment: The level of a farmer's expressed attachment to the community, measured on a scale of 1 to 10 (*Community Attachment*, positive).
- Community Characteristics: Community dummy variables (*Athens* and *Chilton*, with the default town being *Richland Center*). We include these variables to help account for the different business structures in each of the communities. Athens and Chilton are both within 30 miles of small cities (Wausau and Fond du Lac,[6] respectively), and are also located near several smaller towns that offer agribusiness inputs and services. Richland Center is the only major town in the county. These characteristics allow farmers in the first two communities somewhat greater choices for nonlocal purchases. Thus, having controlled for other factors, we expect to find a significant negative effect on local purchasing patterns in these two towns.

Results and Discussion

Because of potential endogeneity between expressed community attachment and the distance between a farm and the community, we estimate two models. The first, a constrained model, omits *Distance*, while the second makes use of all variables.

Table 2 presents estimation results for the percentage-of-total-cost equation, for which 10 observations are right-censored 100%. Both models 1 and 2 show a significant negative effect for larger farm sizes (*Herd Size*) on the share of input purchases made locally. While model 1 demonstrates a positive effect for *Community Attachment* on local expenditures, the results from model 2 suggest much of this effect can be described by *Distance*. As expected, the farther a farm is located from town, the less likely it would purchase inputs in that town. The other transaction cost variables, *Education* and *Age*, do not show any significant effects, and only *Education* has the predicted sign. The regressions show no effect of farm productivity or of individual town characteristics on purchasing patterns.

The estimation results of the tobit equations for the proportion of feed costs spent locally are reported in table 3, with 73% of the 94 observations right-censored. In both models, *Herd Size* and a town variable (*Athens*) provide a statistically significant explanation of where a farm buys its feed. No other important parameters are significant in the estimations. *Age* does change signs from the total-cost equation, but in neither case is it significant. Contrary to our hypothesis and the total-cost equation results, the feed equations do not show an effect of either community attachment or distance from the community on feed purchasing patterns.

Although the parameter on *Herd Size* appears larger in the feed equation than in the total-cost equation, it is because the correction for censoring and the marginal effects are actually quite similar.

[5] Normally in parameterizing a cost-share equation, input prices are used; in the case illustrated here, however, reported prices cannot be used to estimate this model since they will neither include transaction costs nor will they account for the quantity discounts adequately. Since the quantity discounts given will be a function of the choices of the farmer (where to shop and how much to buy), input price data would not allow us to estimate the actual cost function. Thus this cost function must be defined using variables describing the choice sets of the farmer rather than the published prices.

[6] Purchases in Wausau and Fond du Lac were outside the radius we used to identify local purchases; consequently, these would be considered distant purchases.

Table 1. Selected Statistical Data for Model Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
% Total Expenditures Local	0.7986	0.2118	0.08	1.00
% Feed Expenditures Local	0.8466	0.3165	0.00	1.00
Herd Size	78.20	72.64	13.00	459.00
Milk Sold per Cow ($)	2,154.20	637.60	714.00	3,523.00
Community Attachment	7.3830	2.2818	1.00	10.00
Age	45.9574	9.8809	24.00	72.00
Education (years)	12.4894	1.7825	8.00	17.00
Distance (miles)	6.4894	4.0474	1.00	20.00

Note: $n = 94$ except for *% Total Expenditures Local*, where $n = 72$.

Table 2. Model Estimation Results: Percentage of Total Expenditures Made Locally

	MODEL 1		MODEL 2	
Variable	Coefficient	Std. Error	Coefficient	Std. Error
Herd Size	-0.108**	0.048	-0.108**	0.0463
Milk Sold per Cow	-0.0004	0.0046	-0.0002	0.0044
Community Attachment	2.44**	1.097	1.33	1.13
Age	-0.247	0.288	-0.251	0.276
Education	-2.14	1.522	-2.36	1.459
Athens	5.74	6.21	1.486	6.175
Chilton	-1.98	6.891	-4.824	6.693
Distance	—	—	-1.66**	0.635
Constant	107.20***	26.74	132.60***	27.47
Model Fit Statistics:				
No. of Cases	72		72	
Log Likelihood	-286.87		-283.54	

Note: *, **, and *** denote coefficient statistically significant at $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table 3. Model Estimation Results: Percentage of Feed Expenditures Made Locally

	MODEL 3		MODEL 4	
Variable	Coefficient	Std. Error	Coefficient	Std. Error
Herd Size	-0.230*	0.122	-0.266**	0.126
Milk Sold per Cow	-0.019	0.017	-0.021	0.018
Community Attachment	3.047	4.440	1.586	4.781
Age	0.881	1.010	0.793	1.099
Education	-3.852	5.668	-2.85	5.908
Athens	70.74**	28.57	63.41**	29.26
Chilton	15.53	22.71	12.45	23.62
Distance	—	—	-3.041	2.510
Constant	165.80*	96.24	200.20*	105.90
Model Fit Statistics:				
No. of Cases	94		94	
Log Likelihood	-176.32		-169.97	

Note: *, **, and *** denote coefficient statistically significant at $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table 4. Marginal Effects of a Change in the Significant Variables on the Dependent Variable

	MODEL 1 Total Costs		MODEL 3 Feed Costs	
Variable	Marginal Effect Conditional on Being Uncensored	Marginal Effect on the Probability of Being Uncensored	Marginal Effect Conditional on Being Uncensored	Marginal Effect on the Probability of Being Uncensored
Herd Size	-0.07	-0.001	-0.058	-0.001
Community Attachment	1.60	0.026	Not Significant	Not Significant

Table 4 presents the marginal effects of a change in the significant variables on the dependent variable.[7] The first column under each model presents the marginal effect conditional on being uncensored. This is the slope of the estimated line beyond the censoring point. The second column reports the marginal effect of the variable on the probability of being uncensored. This is equivalent to a marginal effect from a probit estimation of a dummy variable representing whether a farmer buys anything away from the local town.

In terms of elasticities with respect to *Herd Size*, the coefficients in table 4 are equivalent at two decimal places to elasticities, since mean *% Expenditures* and mean *Herd Size* are both close to 80. The *Herd Size* elasticities computed from the conditional marginal effects, -0.07 for all purchases and -0.058 for feed, are modestly small. At the average predicted dependent variable value of 79% local purchases, a doubling of herd size from 80 to 160 cows would only decrease local purchases by 5.5%, i.e., from 79% to 73.5%. Feed purchases show a similarly small effect. This finding suggests that while herd size is correlated with purchasing patterns, for reasonable changes in herd sizes in the areas where we conducted this study, local spending patterns do not appear to be dramatically affected.

Conclusions

The combination of micro-level data with a theoretical model and econometric testing has generated a number of insights into the relationship between farm size and purchasing patterns. The theoretical model presents a logic for why large farms might purchase more of their inputs from nonlocal sources. That theory would imply scale-neutral investigations of farm spillover effects could be biased. The econometric evidence for this phenomenon, using data from three dairy-dependent Wisconsin communities, does bear out these scale effects, although modestly. Both the percentage of all farm input purchases and the percentage of feed bought locally are negatively related to herd size.

Measures of the distance, either physical or psychic, from the farm to the community also are found to influence purchasing patterns. There is little statistically significant difference in local cost shares across the three communities examined here. Since the communities represent different local business structures, this finding would tend to suggest that in farm-dependent communities, overall business structure may not greatly influence spending patterns.

Despite the scale effects, our results do not indicate that a movement toward larger dairy farms in smaller Wisconsin communities will necessarily place local farm-support firms in jeopardy. Indeed, the small size of these scale effects points to a more likely interpretation. If (as often suggested) large farms spend more money in total per cow, via greater shares of purchased rather than on-farm produced inputs, the nominal level of expenditures at local businesses would change very little with farm size. Thus, lower numbers of cows in the area—and not simple increases in farm size—may actually represent the biggest threat to small-town agribusinesses.

This exercise has left a number of important issues for further investigation. First, it should be noted that the range of farm sizes found in our Wisconsin study communities (13 to 459 cows)

[7] Following Maddala (1983, p. 160), the marginal effect conditional on being uncensored is:

$$\frac{\partial E(C|C^* < C^u)}{\partial \mathbf{x}_i} = \beta_i\left[1 - \frac{z\cdot\phi(z)}{\Phi(z)} - \left(\frac{\phi(z)}{\Phi(z)}\right)\right],$$

where $z = \beta'\mathbf{x}_i/\sigma$, $\phi(\cdot)$ is the probability density function, and $\Phi(\cdot)$ is the cumulative distribution function of the normal distribution. The marginal effect on the probability of being uncensored is simply $\partial E(C^*)/\partial \mathbf{x}_i = \Phi(z)\beta_i$.

does not include any of the largest types of dairy facilities now being constructed in the Upper Midwest (often with 1,000–3,000 cows per facility). It would be informative to gather data on the purchasing practices of these newer "industrialized" operations to observe how very large firms behave.

Second, our analysis fails to evaluate the effects of larger farms on small-town labor markets. While larger farms do seem to source a greater share of their inputs from outside the local area, this practice may be partially offset by increases in wage employment they create. However, if demand for farm labor is met by the in-migration of lower-wage labor from outside the local labor market, the net economic gain to the community may be diluted.

An additional issue for future study would focus on the local economic impacts associated with a generalized shift away from dairy farming toward less intensive forms of commercial agriculture, part-time farming, and rural residential and recreational land development. Our analysis emphasizes the location of farm expenditures, but does little to capture the economic development impacts of household consumer purchases. It is certainly possible that a less intensive agricultural sector (or rural nonfarm housing) could generate more stable local economic activity through nonfarm purchases of consumer goods and services.

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