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THE REGIONAL EFFECTS OF GOVERNERMENT POLICIES AND CHANGING MARKET CONDITIONS ON DAIRY HERD SIZE

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Abstract

Many recent studies in the dairy industry have focused primarily on supply. This focus has been due, in part, to the necessity for the government to anticipate the effects of policy changes on dairy producers. The purpose of this paper is to present an analysis of the anticipated response of dairy herd size relative to changes in government program parameters relating specifically to dairy and market conditions. The focus of this paper differs from previous studies because it concentrates on regional dairy supply as opposed to U.S. supply. Before the data for this research was collected, the regions and states comprising them were determined. The United States was broken into eight regions: Appalachia, Southeast, Corn Belt, Northeast, Pacific, Southern Plains, Upper Midwest, and Other States. Equations were estimated for each region to determine the number of cows on farms. These equations were then evaluated to determine the response of regions to market and government program changes. This study suggested that response might differ across regions.

OBJECTIVE

The focus of many recent studies in the dairy industry has been primarily on the supply side of the industry. This focus has been due, in part, to the effort to anticipate the effects of government policy changes on dairy producers. Dairy price support programs have a significant effect on the supply of milk. Increases in milk prices may cause farmers to increase the herd size, and thus, milk supply. A goal of this research project is to attempt to analyze the anticipated response of herd size relative to changes in government program parameters relating specifically to the dairy industry and market conditions. This research differs from previous studies in that the focus concentrates on regional dairy supply as opposed to U.S. supply. One exception is the regional work of Chavas, Kraus, and Jesse. The main objective is to determine the differences in supply responses that occur among various regions in the United States.

BACKGROUND OF INDUSTRY

The U.S. dairy industry is primarily a domestic industry with dairy products accounting for 13 percent of total cash receipts from farming in 1989 (Dairy: Background for 1990 Farm Legislation). Although milk is produced in every state, 52.1 percent of the milk in 1989 came from five states: Wisconsin, California, New York, Minnesota, and Pennsylvania. In 1991 these same five states produced the majority of United States milk, however the percentage dropped from 52.1 percent to 51.6 percent. There has also been a regional shift in milk production from traditional dairy areas of the Upper Midwest and Northeast to the West and Southwest. This shift began almost three decades ago, but has been substantial in the past 20 years.

The pricing and marketing of milk in the United States is influenced primarily by federal dairy programs. The major programs include price supports, Federal milk marketing orders, import restrictions, and State regulations. The prices of dairy products, even those affected by government policies, still provide production and marketing signals to dairy farmers and processing and marketing firms.

The use of restrictive import quotas has been used to prevent subsidized dairy products from undercutting the U.S. dairy support prices. Import quotas on

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manufactured dairy products limit imports to approximately 2.5 billion pounds milk equivalent. In 1988, international dairy markets changed dramatically due to an increase in prices for milk powders, casein, and cheese. These increases in prices were a result of U.S. and EC-12 efforts to reduce dairy surpluses and stocks. This new international market for dairy products, especially nonfat dry, caused much volatility in the domestic market.

Overall, milk production costs in the United States appear to be in the middle-range of costs for major milk producing countries (Dairy: Background for 1990 Farm Legislation). This competitive situation can be influenced in the United States by dairy policy. The use of government supply policies does not allow the supply to respond accordingly to shifts in market prices. Those countries that are reliant on supply controlling programs are at more of a disadvantage in the international scene than those countries that operate under market-oriented policies due to a lack of flexibility.

LITERATURE REVIEW

Literature concerned with supply response in the dairy industry has focused primarily on the changes that occur in the aggregate dairy cow herd and the total U.S. industry. Producers may choose to save or retain heifer calves from the herd in an effort to increase the herd or replace older cows. Another option is to cull or sell cows for slaughter purposes to decrease herd size. In relation to the herd, Chavas and Klemme defined the dairy animal population as a biological asset producing milk, meat for slaughter, and offspring. Most animals are kept in the herd as long as the net present value of their expected production exceeds their salvage value, or in the case of dairy cows, their slaughter value (Chavas and Klemme). Retaining heifers is an investment in a capital asset, the dairy herd. Culling older cows is a disinvestment in the asset. For U.S. dairy, these investment/ disinvestment decisions are based on market conditions, but recognize the significant role played by government policy decisions on these markets.

As in most agricultural products, biological realities constrain the ability of individual policies of the supply side to respond to changing prices. According to Chavas and Klemme, there is a lag relationship associated with the dynamics of the heifer and cow population. They assumed the number of heifers over 500 pounds on dairy farms was a function of market prices last year and two years ago. This implies that the decision to retain heifers is determined by the market price at their birth and just before they turn two years old (Chavas and Klemme).

Howard and Shumway pointed out that heifers are typically bred around the age of two, and document the twelve month calving period (Howard and Shumway). These production cycles modify the effects of policy and market changes on production and the size of the milking herd. Another non-biological factor is asset fixity. At a certain level of supply

response a producer reaches the limits of the non-biological assets of the farm. Producers need to see a long term change in actual and perceived revenues before making capital investment or disinvestment decisions.

Howard and Shumway found that short term programs, such as the dairy diversion program, have had limited long term impacts on dairy supply. They suggested that long term programs may be more effective and indicate that it may take as long as a decade for herd levels to fully adjust to price changes. Their research also indicated production response is not geographically homogeneous (Howard and Shumway). Chavas and Klemme stated that their results also indicate that relatively high market prices, resulting from price support programs, appear to have given dairy farmers an incentive to increase milk production over the years. They also felt that the price support programs have created an excess supply of dairy products. Another suggestion made by Chavas and Klemme was that there was a need for future research concerning regional dairy supply.

METHODOLOGY AND DATA

Due to the lack of previous regional dairy research, data had to be collected from various United States Department of Agriculture (USDA) publications. Before this data was collected, the regions and states comprising them had to be determined. The United States was broken into eight regions: Appalachia, Southeast, Corn Belt, Northeast, Pacific, Southern Plains, Upper Midwest, and Other States. The breakdown of states per region is shown below.

Classifications of Dairy Regions

Region	# of States	States Included
Appalachian	4	Virginia, Kentucky, N.Carolina, Tennessee
Southeast	2	Georgia, Florida
Corn Belt	4	Iowa, Missouri, Illinois, Indiana
Northeast	9	Ohio, Pennsylvania, New York, Connecticut, Maine, Massachusetts, Vermont, New Hampshire, Rhode Island
Pacific	3	California, Idaho, Washington
Southern Plains	1	Texas
Upper Midwest	4	S. Dakota, Minnesota, Michigan, Wisconsin
Other States	23	Delaware, New Jersey, Oregon, N. Dakota, Maryland, Nevada, Wyoming, Arkansas, Montana, Utah, Nebraska, Louisiana, Colorado, New Mexico, Kansas, Alabama, S.Carolina, Arizona, Oklahoma, Mississippi, W.Virginia, Hawaii, Alaska

Classifications of regions were based, in part, on previous classification by the USDA (Economic Indicators of the Farm Sector; Kruse). After these regions were determined, data were gathered for dairy cows on farms, milk prices, feed ration values, and utility cow prices for each region. The data for cows, milk prices, feed ration values, and utility cow prices were compiled using state data from the USDA (Cattle; Milk Production; Milk: Production, Disposition and Income).

EMPIRICAL

After this data set was created, it was used to run Ordinary Least Squares (OLS) regressions. For each region, an equation to determine the number of cows on farms was estimated with a total of eight equations being estimated.

Tables 1 on the following pages include documentation of regional cows on farms equations and descriptions of the variables used.

The theoretical framework developed in the previous section laid out the necessary foundation from which each of the equations could be estimated. Each of the equations were specified as a function of the milk price, the ration value, and the utility cow price. In some regions, the utility cow price was dropped because of its poor performance. Further research is necessary to determine if a better variable can be found to identify the salvage value of a dairy cow.

In the table of results that follows, dummy variables were used to offset the effects of the Dairy Termination Program and the drought of 1988. The particular years that were dummied out varied from region to region depending upon how these factors affected the region in question.

Upper Midwest

The number of cows on farms in the Upper Midwest region was determined to be a function of cows on $farms_{t-1}$, (milk price/producer price $index_{t-1}$), (feed ration value/producer price $index_{t-1}$), (utility cow price/producer price $index_{t-1}$), and a dummy variable for 1986. The parameter estimates for LMWCOF and LMWPRICE were positive as was expected and the t-values for these variables indicated that they were significant in determining the number of cows on farms. The parameter estimates for LMWRATIO and LBFCAT were negative as expected. The t-values indicated that LMWRATIO was not a significant in determining MWCOF as the milk price was, and LBFCAT was not a very significant variable. The R^2 of .81 was acceptable as was the Durbin Watson of 1.45. The elasticity for MWCOF with respect to the milk price was more elastic than the elasticities for the ration value or utility cow price.

Northeast

The number of cows on farms in the Northeast region was determined to be a function of cows on $farms_{t-1}$,(milk price/producer price $index_{t-1}$),(feed ration value/producer price $index_{t-1}$), (utility cow price/producer price $index_{t-1}$), and a dummy variable for 1987. The parameter estimates for LNECOF and LNEPRICE were positive as was expected and the t-values for these variables indicated that they were significant in determining the number of cows on farms, however, the milk price was not a significant as it could have been. The parameter estimates for LNERATIO and LBFCAT were negative as expected. The t-values indicated that LNERATIO was not very significant in determining NECOF, and LBFCAT was a fairly significant variable in determining the number of cows on farms. The elasticity for NECOF with respect to the milk price was more elastic than the elasticities for the ration value or utility cow price.

Appalachian

The number of cows on farms in the Appalachian region was determined to be a function of cows on $farms_{t-1}$,(milk price/producer price $index_{t-1}$),(feed ration value/producer price $index_{t-1}$), (utility cow price/producer price $index_{t-1}$), and a dummy variable for 1988. The parameter estimates for LAPPCOF and LAPPRICE were positive as was expected and the t-values

Table 1: Regional Cow Numbers, OLS, 1972 to 1989

Region	Explanatory Variables	Parameter Estimates	t-statistic	R-squared	ni ro
Upper Midwest				0.811	5
	Intercept	88.806	0.167		
	LMWCOF	0.809	4.725		
	LMWPRICE	4918.477	2.928		
	LMWRATIO	-1295.268	-1.146		
	LBFCAT	-113.547	-0.864		
	DUM86	168.059	3.099		
Northeast				0.856	5
	Intercept	60.034	0.151		
	LNECOF	0.925	4.684		
	LNEPRICE	2075.163	1.345		
	LNERATIO	-1043.079	-0.802		
	LBFCAT	-211.592	-1.964		
	DUM87	-119.090	-2.993		
Appalachian				0.966	7
	Intercept	-103.940	-1.902		
	LAPPCOF	0.748	8.454		
	LAPPRICE	3599.967	4.156		
	LAPRATIO	-112.446	-2.417		
	LBFCAT	-2000.900	-3.023		
	DUM88	52.543	3.015		
Corn Belt				0.972	2
	Intercept	-214.727	1.949		

		LCBCOF	0.901	11.381		
		LCBPRICE	2978.121	2.547		
		LCBRATIO	-993.759	-1.348		
		LBFCAT	-76.087	-0.949		
		DUM86	101.226	3.640		
		DUM89	68.572	1.987		
	Southeast				0.952	7
		Intercept	53.336	1.641		
		LSECOF	0.823	5.759		
		LSEPRICE	348.561	1.594		
		LSERATIO	-573.876	-2.114		
		LBFCAT	-10.498	-0.495		
		DUM86	-39.836	-6.099		
		DUM88	-37.308	-5.573		
	Other States				0.959	1
		Intercept	-2.630	-0.014		
		LOSCOF	0.852	7.696		
		LOSPRICE	2500.552	1.019		
		LOSRATIO	-1130.536	-0.794		
		LBFCAT	-118.642	-0.792		
		DUM88	-106.902	-2.165		
		DUM89	136.395	2.173		
	Southern Plains				0.880	4
		Intercept	-28.419	-0.583		
		LSPCOF	0.938	7.631		
		DSPRICE	29.823	2.252		
		LBFCAT	-9.367	-0.434		
		DUM88	28.859	2.861		
		DUM85	-18.159	-1.998		
	Pacific				0.991	7
		Intercept	-64.267	-1.238		
		LPACCOF	0.968	19.994		
		DPAPRICE	77.470	2.315		

		DUM87	-68.380	-3.519	
		DUM86	70.739	3.973	
		DUM89	24.290	1.186	

for these variables indicated that they were very significant in determining the number of cows on farms. The parameter estimates for LAPRATIO and LBFCAT were negative as expected and the t-values indicated that LAPRATIO and LBFCAT were significant in determining APPCOF. The R^2 of .97 was acceptable as was the Durbin Watson of 1.57. The elasticity for APPCOF with respect to the milk price was more elastic than the elasticities for the ration value or utility cow price.

Corn Belt

The number of cows on farms in the Corn Belt region was determined to be a function of cows on $farms_{t-1}$, (milk price/producer price $index_{t-1}$), (feed ration value/producer price $index_{t-1}$), (utility cow price/producer price $index_{t-1}$), and dummy variables for 1986 and 1989. The parameter estimates for LCBCOF and LCBPRICE were positive as was expected and t-values for these variables indicated that they were very significant in determining the number of cows on farms. The parameter estimates for LCBRATIO and LBFCAT were negative as expected and the t-values indicated that LCBRATIO and LBFCAT were not very significant in determining CBCOF. The R^2 of .97 was acceptable as was the Durbin Watson of 2.12. The elasticity for CBCOF with respect to the milk price was more elastic than the elasticities for the ration value or utility cow price.

Southeast

The number of cows on farms in the Southeast region was determined to be a function of cows on $farms_{t-1}$, (milk price/producer price $index_{t-1}$), (feed ration value/producer price $index_{t-1}$), (utility cow price/producer price $index_{t-1}$), and dummy variables for 1986 and 1988. The parameter estimates for LSECOF and LSEPRICE were positive as was expected and the t-values for these variables indicated that they were fairly significant in determining the number of cows on farms. The parameter estimates for LSERATIO and LBFCAT were negative as expected and the t-values indicated that LSERATIO was more significant than the milk price in determining SECOF and LBFCAT was not very significant in determining SECOF. The R^2 of .95 was acceptable as was the Durbin Watson of 1.87. The elasticity for SECOF with respect to the milk price was slightly more elastic than the elasticity for the ration value and much more elastic than the elasticity for the utility cow price.

Other States

The number of cows on farms in the Other States region was determined to be a function of cows on $farms_{t-1}$, (milk price/producer price $index_{t-1}$), (feed ration value/producer price $index_{t-1}$), (utility cow price/producer price $index_{t-1}$), and dummy variables for 1988 and 1989. The parameter estimates for LOSCOF and LOSPRICE were positive as was expected and the t-values for these variables indicated that LOSCOF was fairly significant in determining the number of cows on farms and LOSPRICE was not significant. The parameter estimates for LOSRATIO and LBFCAT were negative as expected and the t-values indicated that LSERATIO and LBFCAT were not significant in determining OSCOF. The elasticity for OSCOF with respect to the milk

price was more elastic than the elasticity for the ration value and the utility cow price.

Southern Plains

The number of cows on farms in the Southern Plains region was determined to be a function of cows on $farms_{t-1}$, (milk price/feed ration $value_{t-1}$), (utility cow price/producer price $index_{t-1}$), and dummy variables for 1985 and 1988. In this region, the milk price deflated by the ration value was more effective as an independent variable than the two variables were separately. The parameter estimates for LSPCOF was positive as was expected and the t-value for this variable indicated that LSPCOF was fairly significant in determining the number of cows on farms. The parameter estimate for DSPPRICE, as expected, was positive. This suggests that a milk price greater than the feed ration value will encourage farmers to increase the number of cows on farms. The milk price deflated by the ration value was also a significant factor in determining SPCOF. The parameter estimate for LBFCAT were negative as expected, but the t-value indicated that LBFCAT was not very significant in determining SPCOF. The elasticity for SPCOF with respect to the milk price was the same as the elasticity for the ration value and both were greater than the elasticity
for the utility cow price.

Pacific

The number of cows on farms in the Pacific region was determined to be a function of cows on $farms_{t-1}$, (milk price/feed ration $value_{t-1}$), and dummy variables for 1986, 1987, and 1989. In this region, the milk price deflated by the ration value was more effective as an independent variable than the two variables were separately. Also, the utility cow price did not seem to be an effective variable in determining PACCOF. The parameter estimates for LPACCOF was positive as was expected and the t-value for this variable indicated that LPACCOF was fairly significant in determining the umber of cows on farms. The parameter estimate for DPAPRICE, as expected, was positive. This suggests that a milk price greater than the feed ration value will encourage farmers to increase the number of cows on farms. The milk price deflated by the ration value was also a significant factor in determining PACCOF.

FINDINGS

After evaluating each of the regional equations, it was found, as expected, that regions do not respond uniformly to market and government program changes. In the Upper Midwest, Northeast, Corn Belt, and Appalachian regions, the milk price, feed ration value, and utility cow price were helpful in determining the number of cows on farms. In each of these regions, the milk price was more significant than the ration value or the cow price. In the Southeast region the same specifications were used, but the ration value was more significant than the milk price. In estimating the Pacific and Southern Plains regions, the milk price deflated by the ration value provided more reasonable results than when the two variables were separated. The utility cow price was not significant in the equation for the Pacific region, so it was not used. The utility cow price was also found to be more significant in some regions

than in others.

The supply elasticities for cow numbers with respect to regional milk price and feed ration values were compared not only to one another, but also with respect to national elasticities. The following table summarizes elasticities for regions and for the United States.

Region	Elasticities	
	Milk Price	Ration Value
Appalachian	0.67	-0.24
Corn Belt	0.37	-0.08
Northeast	0.13	-0.04
Pacific	0.10	-0.10
Southeast	0.20	-0.17
Southern Plains	0.16	-0.16
Upper Midwest	0.20	-0.03
Other States	0.23	-0.06
United States (Bailey)	0.07	-0.07
(Chavas and Klemme)	0.11	-0.11

The elasticity with respect to milk price was higher in all regions than at the national level. The Northeast, Upper Midwest, and Other States regions had lower elasticities with respect to the feed ration value than the national elasticities, and all other regions had higher elasticities, or were more elastic.

CONCLUSION

One of the major concerns associated with this research has already been discussed, i.e. the problems associated with data sources. Specifying equations and analyzing them based on economic theory is a crucial part of determining the impacts of government policies and changing market conditions. However, without consistent and reliable data, it is difficult to determine the full effects of policies.

In studying the relationship of regional dairy supply responses to national dairy responses, it was found that the regional dairy was more responsive to milk prices. This was determined through analysis of elasticities with respect to milk prices and feed ration values. In all cases, the regions were more elastic, or supply responsive, to milk prices than the national supply was. In a few cases, the feed ration value was less responsive regionally. The regions with lower elasticities for both milk prices and ration value were the Northeast and Upper Midwest. One explanation for this less elastic supply could be due to the smaller size of farms and asset fixity. Many of these farmers have substantial fixed investment in milk parlors, milk equipment, and housing (Chavas and Klemme). It may be harder for dairy farmers in these regions to respond to changing prices. In regions of the South and West, warmer climates and longer growing seasons result in lower costs for housing, feeding, and manure disposal methods. These lower costs would enable producers in these regions to be more responsive to price changes due to less asset fixity. Another aspect that should be highlighted deals with the trend variable. The trend variable was not very effective in generating acceptable equations. Further study needs to be conducted to determine if this variable is really insignificant or if respecification is required.

In analyzing the fit of the regional equations, the R^2 ranged from a low of .81 to a high of .99. The R^2 of 0.81 was in the Upper Midwest Region. In this region there may be other variables affecting supply decisions such as shipping,

marketing and processing costs. The R^2 of 0.99 was in the Pacific region. This region proved difficult to estimate because the milk price had to be deflated by the ration value because it provided the most reasonable results, and the utility cow price had no measurable affect on supply decisions. One of the reasons this equation contained results different from other regions may be due to the increase in commercial dairies in the West as well as the fact that this region has the lowest production costs (Howard and Shumway). The significance of the ration value and the utility cow price were not as high in some of the equations as desired. This can again be linked to the various factors affecting different regions. Further research might include a more in-depth study of the regions. The parameter estimates for all the final equations contain the correct signs. Overall, the equations for dairy cow numbers in various regions provided a fairly good fit. One concern of this researcher were low t-values for the feed ration value and utility cow price in some regions. Future research is needed to determine if different specifications will prove to be more robust in estimating cows on farms.

This research was different from previous research in that it involved regional as opposed to national analysis of supply in the dairy industry. This research found, as did previous studies, that dairy herd supply responds positively to increases in milk prices and negatively to increases in feed ration value and utility cow prices, but this study showed that the degree of response is dependent on the region. This implies that supply responses to government policies and changing market conditions will vary across the United States. The dairy industry like other industries in agriculture, is constantly changing. Farmers do not respond to market conditions uniformly, and regions in the United States are not influenced uniformly by policies, prices, and production costs.

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