Impacts of Concentration in Hog Production on Economic Growth in Rural Illinois: An Econometric Analysis*

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The size of livestock and agricultural farms has increased dramatically in recent years. Larger facilities are the consequence of agricultural industrialization, a form of food production relying on fossil fuel-based inputs such as fertilizers, pesticides, gasoline, and machinery, which began in the 1970s (Thau and Durrenberger, 1998). These structural changes in food and fiber production have had substantial social and economic consequences for rural communities and their impacts are controversial. Their defendants argue that larger farms often have lower production costs because of economies of scale in agriculture. In addition, they posit that larger farms are likely to have more negotiation power facing an increasingly concentrated food processing sector. However the literature has also pointed out several negative implications of large farms on rural communities such as the disruption of local social and economic systems, pollution problems resulting from intensive agriculture, and the negative impacts on the quality of life in rural communities.

Hog farming in the U.S. illustrates these major structural changes that have occurred in food and fiber production. In particular, the hog farming sector in Illinois, as well as in other hog-producing states, has experienced dramatic changes in the last decade. In just a ten-year period, for the period 1987-1997, large farms' share of total production increased threefold, and farms with annual sales greater than five thousand animals produce nearly half of total pigs. These structural changes in hog farming are expected to have substantial impacts on the dynamics of economic growth in rural communities.

The objective of this paper is to examine the case of Illinois' hog farm sector to assess the impacts of increasing concentration in food and fiber production. In particular, this work

develops an econometric model to estimate the impact of large hog farms on the economic vitality of rural communities in Illinois. The model uses data for more than one thousand towns in Illinois covering a period 1981-1997. The essential question is how these structural changes affect the economic welfare of rural communities? Contrary to mainstream positions in the agricultural economics literature, the results reject the hypothesis that large hog farming units contribute to the vitality of local economies. Instead, the several models developed here consistently suggest that large hog farms tend to hinder economic growth in rural communities. This study focuses on the economic aspects of increasing concentration, although it is recognized that rural development is a broad concept and may also involve social, political, and human aspects.

The remainder of the paper is organized as follows. Section 2 reviews the current issues associated with structural changes in agriculture and livestock production. In recent years promising insights are found in formally derived and rigorously tested models of economic growth. These are presented in section 3. Section 4 explains the econometric model and describes the data used in estimation. Section 6 presents findings from the study, and Section 7 concludes the paper.

Large hog operations: the issues

As many other agriculture and livestock sectors, hog farming has experienced significant changes in recent years. The first technology breakthrough occurred in the early 1970s when hogs were moved from the pastures to confinement in which every aspect of the production process is closely controlled. More recently, starting in the late 1980s, hog farming went through a second structural change: the rise of large production units in confinement. The case of hog

production in the state of Illinois is illustrative of these recent changes. In 1987, Illinois hog farms with sales greater than five thousand animals produced only fourteen percent of all hogs and pigs sold. In contrast, in 1997, farms with sales larger than five thousand animals produced nearly fifty percent of the total (USDA, 1999). Thus, in just a ten-year period, large farms' share of total production increased threefold in Illinois. These structural changes in hog farming are expected to have substantial impacts on the dynamics of economic growth in rural communities.

The consequences of large hog farms have received rigorous attention from social scientists. The literature has emphasized multiple aspects of these consequences since large farms are changing life in rural communities dramatically. Earlier studies cover a wide range of topics from mood changes of nearby individuals, to human health, to environmental, and to production efficiency implications of large hog farms. Nevertheless it is possible to classify these studies into two broad categories. One stream focuses on economic implications of large hog operations, and the other emphasizes social aspects of structural changes. In any case, the findings are controversial and, overall, it is not clear whether rural communities are better or worse off as a result of larger swine farms. The essence of the controversy is well known. On one hand is the Jeffersonian ideal of sustainable family farms providing widespread economic and social prosperity resulting from small family-run agricultural units. On the other hand is the idea of a highly efficient industry-like farms providing prosperity to local communities and maintaining low food prices to the benefit of food consumers.

Literature emphasizing social aspects tends to criticize the existence of large production units. These criticisms include the displacement of family farms by agricultural corporations, the negative consequences on the environment, and the disruption of social and economic systems in rural communities among several other factors (Thu and Durrenberger, 1998). For instance,

DeLind (1998) describes the impacts of corporate hog farming in a rural community located in Michigan: higher unemployment for local residents, losses on property values, water contamination, profits flying away from the community, and high human costs. In addition, political and legal systems in some states have also favored the development of large swine facilities and consequently, have gradually eliminated small farms (Morgan, 1998). Commonly these criticisms consider broader aspects associated with large farms beyond the economic issues involved. In the heart of the debate is the paradigm of urbanization of rural areas in the United States because life there has changed substantially as a result of widespread economic growth and national development.

Contrary to social assessments, economic analyses tend to favor, or at least do not criticize, large production units. In particular, the agricultural economics literature has examined concentration and coordination in the hog industry stressing the impacts on market structure, economic efficiency, and the environment. In most cases these analyses have stressed concentration and integration in the hog slaughter and packing industry and its implications for market structure and performance. For instance, Hayenga (1998) demonstrates the existence of economies of scale in hog slaughter and packing plants. In turn, Paarlberg et al (1999) presents clear evidence of increasing concentration and coordination in the hog-processing sector. Such structural changes raise issues regarding the competitiveness in both the input (hogs for slaughter) and output (pork meat) markets, and there are signs that the processing sector is exerting market power while independent hog producers are bearing more risks. These circumstances have either called for governmental surveillance to enforce antitrust regulation or have required hog producers to seek new strategies directed at increasing their negotiation power.

Nevertheless, the agricultural economics literature emphasizes the processing sector, and little has been done in assessing concentration at the production level, with few exceptions. For example, Rowland et al (1998) demonstrates economies of scale in hog production using non-parametric linear programming approaches. In addition, Rhodes (1998) describes major structural changes resulting from the industrialization of hog production. These changes can be summarized as increasing concentration; largest producers controlling many production units via production contracts; and the non-existence of diseconomies of size. The findings point out the growing use of hog production contracts, but contrary to the common belief of widespread use of vertical contracts (producers and processors), most arrangements are horizontal between growers and contractor-producers.

While most studies have focused on concentration at the processing level, little has been done to measure the economic impacts of large swine farms on rural communities. An exception is recent study by Palmiquist, Roka and Vulkina (1998) demonstrating that large hog operations tend to depress the sales value of nearby homes and real estate. However, little has been done to apply quantitative methods to measure the economic implications of structural changes in food and fiber production. This research addresses this gap in the literature by developing an econometric model to examine the consequences of large-scale farming on the economic vitality of rural towns, using the case of hog production in the state of Illinois.

Analyzing economic growth and its causes in rural communities

Recent advances in the economics literature provide promising insights into the modeling and testing of forces generating economic development at the local level. These approaches can be used to measure the outcome of changes in the economic structure of rural towns. Attention

has focused on the productivity of public capital, and whether and to what extent fiscal policies of local, state, and federal governments influence economic growth. Earlier studies examined how local and state taxes affect location decisions of firms (Due, 1961; Carlton, 1979; Bartik, 1985; Wasylenko and McGuire, 1985). Subsequent studies considered how state and local taxes and public investment policies together affect employment and output growth (Crihfield, 1989, 1990). More recently, Aschauer (1990) claimed to find large returns to increases in national public capital stocks. This was followed by studies that refined the analysis and, in general, found substantially lower returns to public-sector investment policies (examples of this research include Hulten and Schwab, 1991; Garcia-Milà and McGuire, 1992; Holtz-Eakin, 1994). More recently, these approaches have been applied to the examination of social capacity building programs in rural areas (Crihfield and Gómez, 2000).

These studies provide guidance to research the factors influencing rural economic development. First, they specify clearly using economic models, the mechanisms by which public policies such as taxes or development policies affect the economy. Second, they compile relevant data that correspond to relationships embodied in their models. Finally, they use formal econometric tools to test rigorously economic hypotheses implied by the models. Modeling and testing of this kind, when possible, should be extended to the evaluation of changing economic structure in rural communities.

In general, analyzing rural economic growth and its causes is complicated by lack of data, since federal agencies rarely compile economic data for small towns. This research therefore follows the alternative approach of using sources that are unique to individual states to tailor narrower sets of data to the study of local economies. More specifically, detailed annual sales tax data for all Illinois towns and cities for eighteen years were obtained. Using these data, retail

sales were then constructed to represent “gross town output”, which is a function of the economic engines that propel rural towns. The next section describes the data and the econometric model used to analyze the impact of large hog production units.

The model and data

The aim of econometric analysis in this paper is to reach beyond qualitative appraisals common in the assessment of large swine farms on rural communities. The starting point is the principle that assessing these structural changes can be measured in terms of their impact in economic well being. This does not mean that other social, political and even psychological factors are not important when assessing the consequences of hog production industrialization. However, exogenous shocks to rural communities are not “welfare improving” unless they generate economic benefits within the area. Thus this work focuses solely on economic impacts.

It is difficult, given the available data, to conduct a cost-benefit analysis of the rise of large hog farms in Illinois. However, it is possible to identify proxies of economic welfare for rural towns that are correlated with structural changes in agriculture and livestock production. The data are sales tax receipts by Kind of Business (KOB) collected annually by the Illinois Department of Revenue for all towns and cities in Illinois. These receipts are directly proportional to consumer expenditures, which are positively correlated with personal income. Income growth is, in turn, fundamental to improvements in economic well being.[1] The models presented below use a series of control variables to account for systematic temporal changes (e.g., recessions), spatial and temporal autocorrelation (e.g., "marketsheds"), other spatial variation (e.g., different cost structures between urban and rural areas), and overall trends (e.g.,

population). Thus the fundamental relationship being tested is: Does larger farms lead to higher incomes (and economic well being) in rural areas?

The estimating equations and data are developed to control for as many effects as possible. Monetary values are inflation adjusted using the Consumer Price Index (1982-1984 = 100). Annual sales-tax receipts by towns were available for the years 1981 through 1997. Annual expenditures (X) for a given town are calculated from the relationship X = R/T, where R is sales tax receipts and T is the retail sales tax rate. Calculations of expenditures take into account changes in state and local sales tax rates during the period. Beginning in 1985 food and drugs were exempted from Illinois state sales taxes, but not from local add-on sales taxes. Consequently, we constructed time series for total retail expenditures that include food and drug sales for the period 1985-1997, and for net retail expenditures that exclude food and drug sales for the period 1981-1997.[2] These time series by town are appropriate for monitoring the economies of towns and cities in Illinois.[3] Of the 17 years of data (13 years for total expenditures), nine are years of low concentration (1981-1989) and eight years correspond to a period of accelerated concentration (1990-1997). Thus, there are several years of data both prior to and after the initiation of rapid structural changes in hog production to assess the impact of large farms in rural communities.

Table 1 summarizes the expenditure data used in the study. In total 1,106 towns and cities are included in the sample. For a town to be included, data for it must be available for all years in the study period so that time-series, cross-sectional analysis can be performed. “Urban” towns and cities are those located in the 26 metropolitan Illinois counties as defined by the federal government in 1990. Towns located in the 76 non-metropolitan counties are designated "rural." Rural “hog_ producing” towns are located in rural counties with more than 50,000 hogs

sold annually (not including feeder pigs). "Rapid concentration" represents those rural hog-producer towns in which the percentage of hogs sold annually by farms with sales of 3,000 or more animals have increased by 30 percent or more between 1982 and 1997.

The table shows that over the period 1984-97, real per capita spending grew at a compound annual rate that was higher for urban towns than for rural towns (1.36% versus 1.06%); among rural towns, growth was higher in hog producing towns in than in other rural towns (1.55% versus 0.50%).[4] Considering only hog producing towns, those classified as with moderate concentration have experienced higher growth than rapid-concentration towns (1.93% versus 1.20%). These simple comparisons suggest that the economies of urban towns are growing faster than their rural counterparts. Within rural counties, those with important livestock sectors (hog production) have experienced higher spending growth rates. Moreover, this descriptive analysis suggests that rural towns with larger hog farms grew slower than rural towns experiencing less dramatic changes in their hog production sector. However, first impressions can be misleading; one could argue that other factors different than changing structure in swine production might explain these differences. Thus, the essential question is the effect of increasing concentration, holding constant other determinants of growth: an answer to this question requires systematic econometric analysis.

Pooled time-series, cross-sectional models were constructed for each net expenditure data series. They use four different types of dependent variables: (1) the annual change in inflation-adjusted ("real") retail spending (linear first-differences models); (2) the annual change in log of real spending (log-linear first-differences models); (3) the inflation-adjusted retail spending (linear models); and finally (4) the log of real spending (log-linear models). Town is the observation unit for the period 1981-1997 (see definitions in Table 2).

One of the main determinants of local spending in a given jurisdiction is total personal income, not only from the jurisdiction itself, but from the surrounding "market-shed." A town situated where incomes in surrounding towns are relatively high and increasing will benefit from spillover spending. Two variables were constructed in order to represent market-sheds. The first (MKT_S1) is inflation-adjusted total personal income by county and year, such that the market-shed for a given town in a given year equals aggregate total personal income for the county in which the town is located. A second marketshed variable (MKT_S2) equals the inflation-adjusted sum of income in this county plus all adjacent counties, which defines a much larger marketshed than MKT_S1.

Other spatial control variables include dummies for urban counties, rural contiguous counties, and rural noncontiguous counties, as defined in Table 2. Industrial sector variables (using 1990 data) control for employment concentrations in four major sectors: resources (RESOURCE, measured by the fraction of total county employment in agriculture, fisheries, and mining); manufacturing (MFG, measured by the fraction of total county employment in manufacturing and construction); services (SERV, measured by the fraction of total county employment in services); and government (GOVT, measured by the fraction of total county employment in the military or in federal, state, and local government). There are also time dummies for each sample year. Finally, a substantial degree of automatic control is built into a model's lag structure and error term in the linear and log-linear models. It is impossible, given the available data, to include all relevant determinants of growth. However, the influences of many of these are accounted for by one or more of the variables above. All variables used in the models are defined in Table 2.

These variables control for important structural developments in local towns and in the broader economy. The market-shed income variables account for one of the major spatial determinants of spending. The urban and rural dummies control for the relative growth of urban areas as compared to rural areas of the state. The industrial sector variables control for shifts toward services and away from manufacturing and agriculture. The time dummies control for expansions (1984-1989, 1992-1997) and contractions (1990-1991), and other time-specific events. When the linear and log linear dependent variables are used, the lagged dependent variable controls for (along with the time and spatial dummies) the steady decline in rural population and income and the steady rise in urban population and income.

Given these controls, several measures to explain the impacts of large farms were constructed.[5] The "Hog_prod" index equals 1 if a town is in a county classified as hog producer, and helps explain differences between producer and non-producer towns[6]. Two measures of concentration explaining differences among hog-producer towns were constructed. "Conc_2" and "Conc_3" show the county's percentage pig sales originating from farms with annual sales greater than 3,000 and 7,500 heads, respectively.

In establishing a bench-mark model, the analysis examined heteroskedasticity.[7] On the basis of four tests, significant levels of heteroskedasticity were identified in all models (first-differences in log and linear models; and linear and log-linear models).[8] The model also examined partial autocorrelation functions for net real spending for 21 cities for guidance in selecting lagged dependent variables. In all cases there was strong evidence of an AR(1) autoregressive process, but not for processes of higher order.[9] Therefore, a lagged dependent variable was added to the benchmark linear and log-linear models. The lagged dependent variable also made sense from the standpoint of a control variable, as mentioned above. The

benchmark models for each model (linear and log-linear; first differences and levels) are pooled time-series, cross-sectional analyses that use the Fuller-Battese variance components model for the error structure.[10] This method controls for heteroskedasticity and displays a general robustness to the underlying error structure.

Findings

Tables 3 through 5 present the major findings from the study. Questions regarding model identification are considered in Tables 3 and 4. A benchmark model from these tables is estimated using both the full sample and a subset of all rural hog-producing towns; and for the four different definitions of the dependent variable mentioned above (net expenditures and change in net expenditures, and their logarithmic transformations). Table 5 illustrates additional model formulations that include alternative measures of increasing concentration in hog production.

There is substantial stability in parameter estimates across different model formulations. In particular, coefficient estimates are similar whether one uses the annual changes or the value of net expenditures; their corresponding logarithmic transformations; and the various explanatory variables measuring the degree of concentration in hog production. Estimations shown in Table 3 test whether or not there are differences between towns in hog-producing counties and the others, using alternative specifications of the dependent variable. Most explanatory variables behave in the same way across all models tested. The lagged dependent variable is approximately 1 and highly significant in models 3-3 and 3-4 (linear and log-linear models). The market-shed variable is typically positive and highly significant in the linear and log-linear models, reflecting an income effect on sales. The urban dummy variable is positive and the

contiguous dummy is negative although significant in just one model.[11] The service, manufacturing, and government sector indices are positive, and significant in most cases. As indicated below, there is multicollinearity among marketshed, urban/contiguous, and services/manufacturing/government. When one variable set is omitted, the others typically become significant, without affecting the rest of the model. Time dummies tend to be negative and significant during the early 1990s recession and positive and significant during the growth trend of the 1990s. Finally, all the models indicate that there are not significant differences between towns located in hog-producing counties and the others since the hypothesis that "hog_prod" is different than zero cannot be rejected.

Models in Table 4 experiment using a more restricted sample: towns in rural counties that have swine farms. These models estimate the impacts of large hog farms on the economic welfare on rural communities. Similar to Table 3, the models use different specifications of the dependent variable (annual changes and value of net expenditures), their logarithmic transformations, and to measures of concentration (CONC_2 and CONC_3). Models 4-1 through 4-4 show results for annual changes in net expenditures (linear version and log transformations), and include the two measures of concentration. The coefficients of CONC_1 and CONC_2 are negative and significant in these four models. Thus, all models indicate an inverse relationship between hog production concentration and retail spending. Parameter estimates of others variables are similar to Table 3, showing that market-shade and economic structure are positive and significant.

Models 4-5 through 4-8 follow the same sequence as those described above, except that the dependent variable is the annual real value of net expenditures. The lagged dependent variable is approximately 1 and highly significant in all four models, similar to their counterparts

in Table 3. Models 4-7 and 4-8 uses log of net expenditures (the analog models 4-3 and 4-4) with very similar outcomes in both: CONC_2 and CONC_3 are negative and significant. Only in Models 4-5 and 4-6 concentration indices are insignificant although still negative.

The purpose of experimenting with different models, many of which are not reported in the tables, is to test the stability of the model in general, and the impact of large hog farming in rural communities in particular. The model is robust throughout these tests. Moreover, the results suggest that large farms are associated with lower economic growth in rural towns. The models exhibited in Table 5 extend the analysis in several ways as they present different versions of the concentration indices. In these, new variables are constructed representing the interaction between concentration indices and the time dummies. Thus, C280-84 equals CONC_2 if year is between 1980 and 1984, zero otherwise; C285-89 equals CONC_2 for years 1985 to 1989, zero otherwise, and so on. Models 5-1 to 5-8 resemble those in Table 4, but C285-89 through C295-97 replace CONC_2, and C385-89 through C395-97 replace CONC_3.

In comparing each of these models in Table 5 to its counterpart, the control variables behave almost identically, providing additional evidence of model stability. The six new concentration variables show a meaningful pattern: in models 5-1 through 5-4 (annual change in net spending is the dependent variable), there are not significant differences within hog-producing towns before 1990. It is convenient to recall that large hog units started in the late eighties and early nineties, thus supporting the econometric findings. Starting in the early 1990s, concentration indices become negative and significant. Similarly, the parameter estimates of the net expenditures models (5-5 through 5-8) suggest that significant differences start in 1990. According to these findings two things are clear. First, the hypothesis that the large hog farms have a net beneficial impact in rural communities requires consistent, positive and significant

coefficients for the concentration indices. There is no such evidence. On the contrary, the findings suggest that large farms might in fact hinder economic growth at the local level.

Figures 1 and 2 summarize the measured impact of concentration in hog production. The graphs plot coefficients for the dynamic concentration indices estimated in models 5-1 through 5-8. Significant coefficients (at the 10 percent level, using two-tailed tests) are highlighted by asterisks. Figures 1A and 1B show values for the concentration parameters when the annual change in net expenditures and the annual change in the log of net expenditures are the dependent variables respectively. In addition, figures 2A and 2B illustrate concentration parameters with the net expenditures and log of net expenditures as the dependent variables. These figures show that large hog farms have had negative impacts in rural economies in the 1990s.

Conclusions

Recent literature suggests that rural towns in Illinois satisfy the mature market hypothesis. According to this hypothesis, public investment in infrastructure and human capital has little or no impact on local economies because, as may be the case in a mature market, public goods externalities have been achieved. The Illinois economy has evolved from predominantly an agrarian base at the time of Lincoln's presidency, to manufacturing, to a service-based economy today. Productive resources have had long periods to seek higher returns, and substantial physical and social infrastructure has accumulated in the economy. It is because these capital stocks are already large and productive, relative to the work force and population, that marginal changes in them have relatively minor effects on local and state output. An important

reason for this is that externalities from public investments and from well-integrated social infrastructure have been largely exploited.

In contrast, changes in the local productive structure might have substantial consequences for local economies. In particular, structural changes in agriculture and livestock production can have substantial impacts in rural areas. This work, which focused on the hog-farming sector in Illinois, examined a current and controversial trend in agriculture and livestock production: the concentration of food production in the hands of few very large production units. The results reject the hypothesis that large hog farming contribute to the vitality of local economies. On the contrary, the several models developed here consistently indicate that large hog farms tend to hinder economic growth in rural communities.

These results have several public policy implications. For instance, consider two different policy objectives. One objective can be named “no intervention” policy, in which the policy maker accepts the decline of rural communities as an inevitable outcome of economic growth and of the urbanization process. In this case there is no need for government intervention because large farms are able to produce cheap food and fiber and thus benefiting an increasing urban population. A contrasting policy objective can be called “intervention”, in which the policy maker believes that it is necessary to protect and preserve the economic vitality of rural economies. Under this policy objective, the government could either influence the production structure (e.g. limiting the size of hog farms, or promoting cooperative of small producers) or directly subsidize small producers in rural communities (e.g. mechanisms supporting farmer’s income). Beyond the conflicting policy objectives, the alternative policy instruments, and their potential outcomes, one thing is clear: the economic vitality of rural communities depends on public policy. The results of this study suggest that without public policy to protect rural

communities, the most probable outcome is the continuing decline of rural communities in the future as the size agriculture and livestock production units continue to increase.

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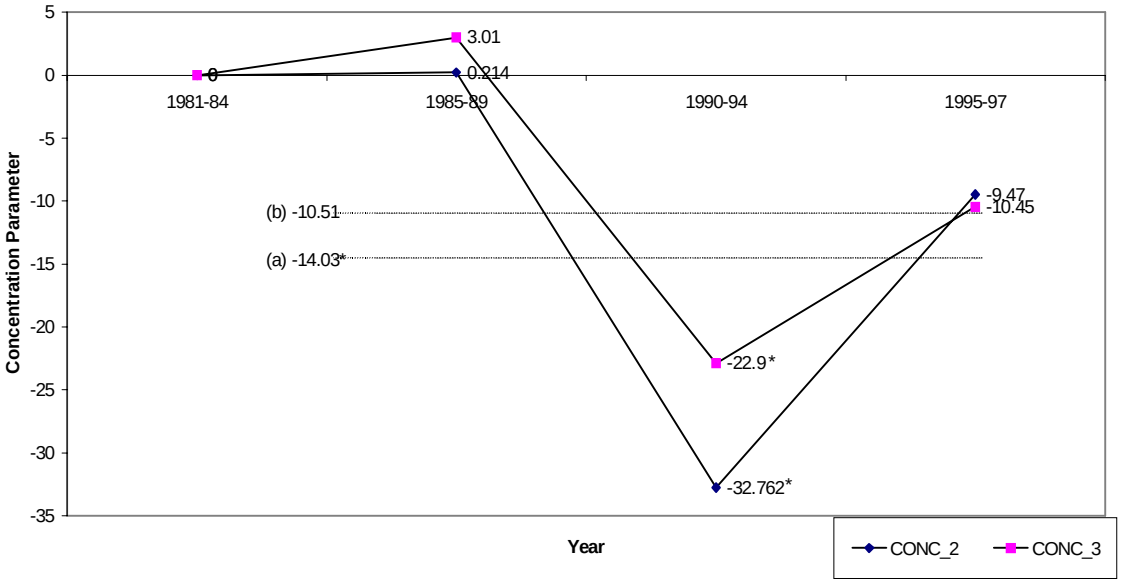
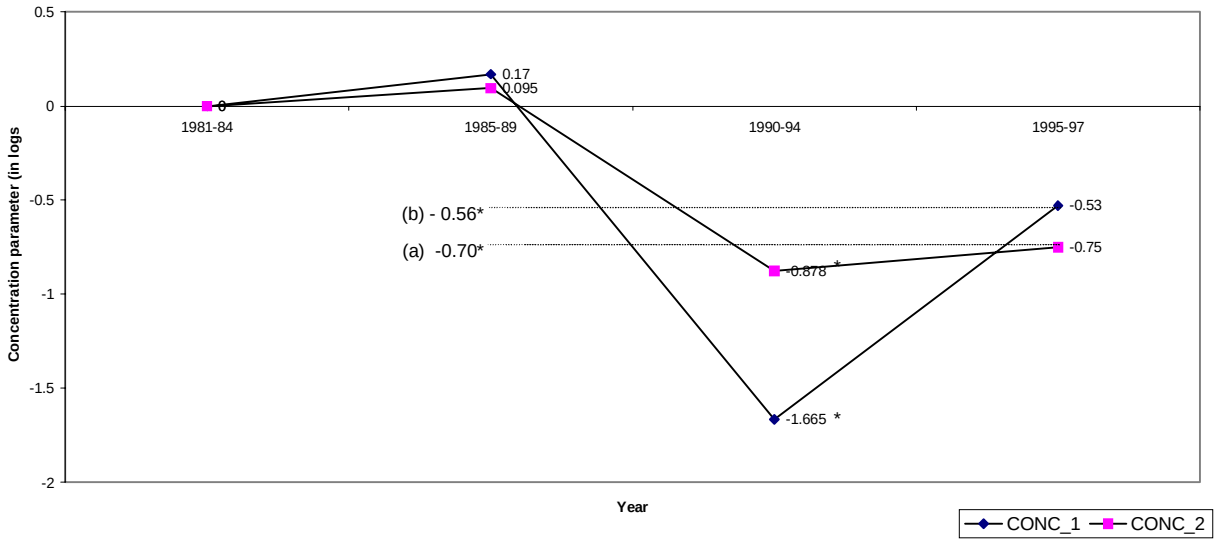
Figure 1A. Impacts of Concentration in Hog Production
(Dependent variable is change in net expenditures)



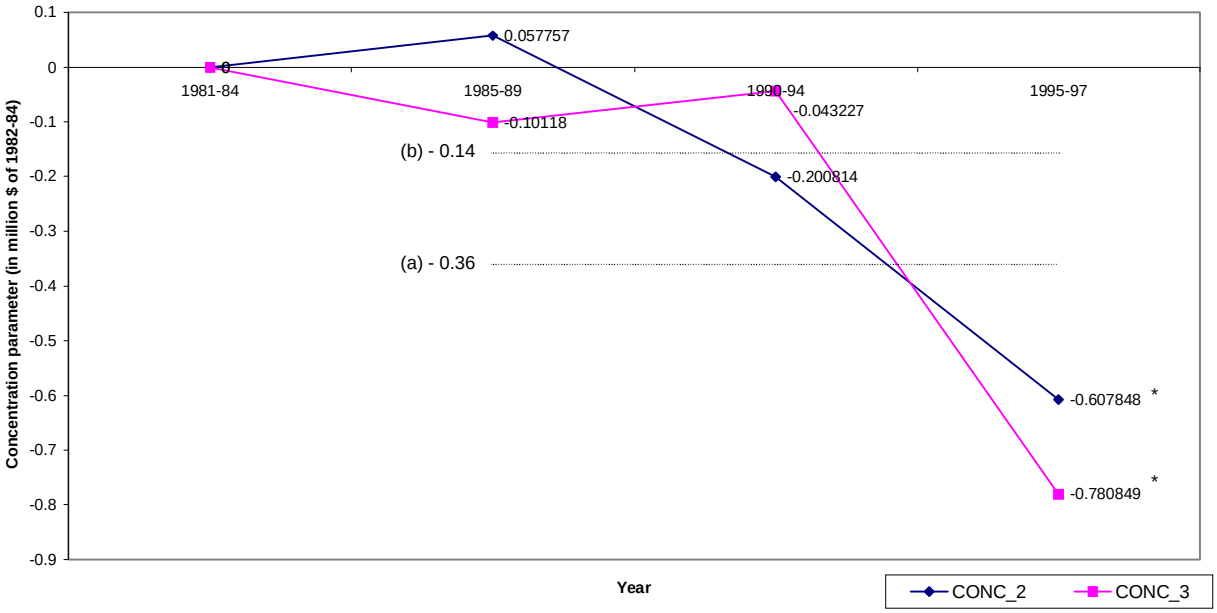
Notes: These results are based on pooled time-series, cross-sectional data using the Fuller-Battesse error structure.
The dependent variable is annual change net expenditures. Explanatory variables include
time dummies, urban/rural dummies (when appropriate), industrial structure, marketshed, and concentration indices.
* Coefficient significant at the 10% level (two-tailed test).
a Parameter of CONC_2, percentage of pigs sold by farms with sales of 3,000 or more pigs per year.
b Parameter of CONC_3, percentage of pigs sold by farms with sales of 7,500 or more pigs per year.

Figure 1B. Impacts of Concentration in Hog Production
(Dependent variable is change in log of net expenditures)



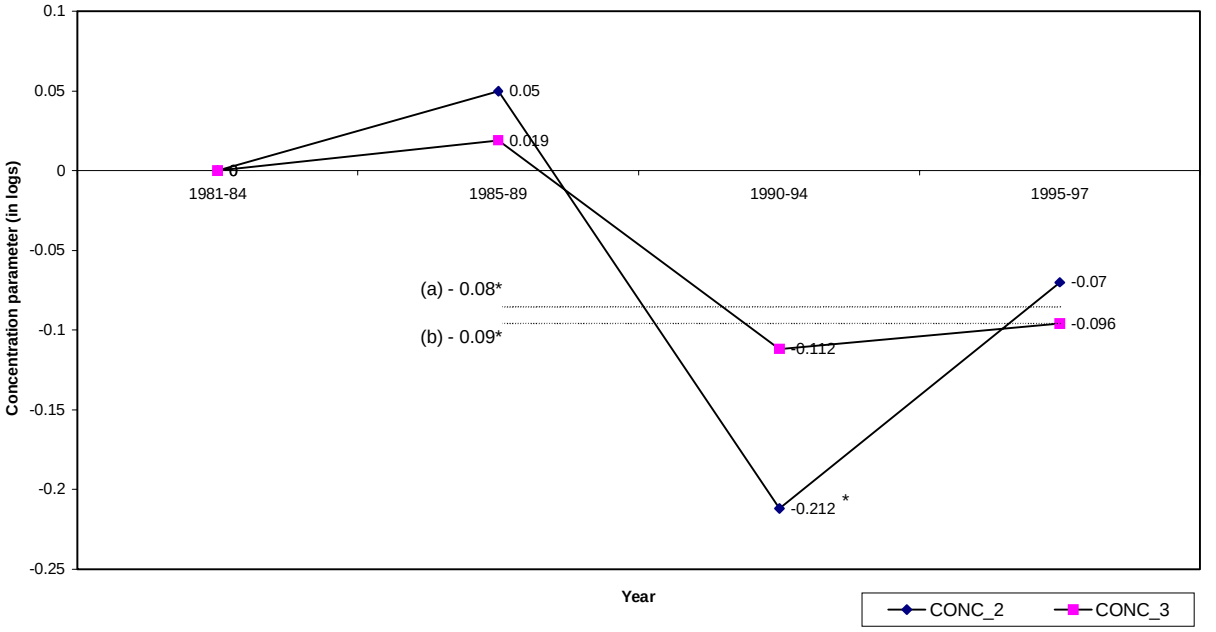
Notes: See Figure 1A. The dependent variable is change in log of net expenditures

Figure 2A. Impacts of Concentration in Hog Production
(Dependent variable is net expenditures)



Notes: See Figure 1A. The dependent variable is net expenditures

Figure 2B. Impacts of Concentration in Hog Production
(Dependent variable is log of net expenditures)



Notes: See Figure 1A. The dependent variable is log of net expenditures

Table 1.
Compound Annual Growth Rates (1984-1997) for Illinois Towns and Cities Included in the Sample

	Total Retail Spending (Millions of contant $; 1982-1984=100)										Population		Compound Growth Rates (Percent)	
Towns	**No.**	**1984**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1980**	**1997**	**Level 1984-97**	**Per-Capita 1984-97**
All towns	1,106	40,223	43,512	40,691	42,867	44,258	46,692	47,209	47,212	50,287	11,427,409	11,989,352	1.73	1.36
Urban	512	34,693	38,123	35,521	37,472	38,623	40,748	41,146	41,138	44,195	9,339,601	9,983,637	1.88	1.36
Rural	594	5,530	5,388	5,169	5,395	5,635	5,943	6,063	6,074	6,092	2,087,808	2,005,715	0.75	1.06
Not hog producers	287	2,664	2,468	2,373	2,472	2,583	2,725	2,751	2,743	2,720	1,000,902	958,595	0.16	0.50
Hog producers	307	2,866	2,920	2,797	2,923	3,052	3,219	3,311	3,331	3,371	1,086,906	1,047,120	1.26	1.55
Moderate concentration	115	1,362	1,389	1,338	1,399	1,469	1,556	1,591	1,623	1,662	475,828	453,201	1.55	1.93
Rapid concentration	192	1,505	1,531	1,458	1,523	1,583	1,662	1,720	1,708	1,709	611,078	593,919	0.98	1.20

Notes: Towns and cities included in the sample are those for which data are available in each year for the period 1984-1997. Moderate concentration towns are those "Level" refers to retail spending and "per-capita" refers to per-capita retail spending.
The last columns show the compound annual growth rates for these measures over three time periods. In calculating per-capita growth rates, spending data for 1984 are divided by 1980 population, and spending data for 1990 and 1997 are divided by1990 population. Expenditure data are net of food and drug sales.

Table 2. Definitions of Variables

Variable	Definition
Net expenditures	Value of total retail spending (in 1982-84 dollars) for each town less spending on food and drugs
Δ net expenditures	Annual change of total retail spending (in 1982-184 dollars) for each town less spending on food and drugs
MKT_S2	Marketshed variable, equal to the sum of total personal income for the county where a town is located, plus total personal income in all adjacent counties
ΔMKT_S2	Annual change in MKT_S2
D84, ..., D97	Time dummies (e.g., D84=1 if year=1984, and is zero otherwise)
MFG	Fraction of employment in manufacturing and construction in 1990
SERV	Fraction of employment in services in 1990
GOVT	Fraction of employment in government in 1990
RESOURCE	Fraction of employment in agriculture, fisheries, and mining in 1990
URBAN	Towns located in metropolitan counties (as defined by the federal government)
CONTIGUOUS	Towns located in rural counties that are contiguous to metropolitan counties
HOG_PROD	Dummy variable that equals 1 for a town with annual pig sales of 50,000 or more during the period 1981-1997
CONC_2	Percentage of pigs sold by farms with annual sales of 3,000 or more in the county where the town is located
CONC_3	Percentage of pigs sold by farms with annual sales of 7,500 or more in the county where the town is located
C285-89, …, C295-97	Time-specific concentration variable. (For example. C285-89 equals CONC_2 in years 1995, …, 1997 and zero otherwise, etc.)

able 3. Time-Series, Cross-Sectional Models for Net Expenditures: All Towns[a]

odel: **ependent Variable:**	**3-1** **Δ Net Expenditures[a]**	**3-2** **Δ Log Net Expenditures**	**3-3** **Net Expenditures**	**3-4** **Log Net Expenditures**
et expenditures(1)[b]	------	------	0.952 (0.001 797.5)*	------
og net expenditures(1)	------	------	------	0.975 (0.002 554.8)*
og_prod	0.018 (0.900 0.02)	-0.017 (0.034 -0.48)	-443,970 (477,911 -0.93)	-0.007 (0.007 -1.06)
KT_S2	------	------	0.024 (0.007 3.23)*	------
Δ MKT_S2	0.000 (0.001 0.03)	------	------	------
og MKT_S2	------	------	------	0.017 (0.004 4.72)*
Δ Log MKT_S2	------	-0.002 (0.006 -0.25)	------	------
rban	1.261 (1.405 0.90)	0.159 (0.054 2.97)*	806,674 (1,092,021 0.74)	0.021 (0.013 1.59)
ontiguous	-1.287 (1.180 -1.09)	-0.036 (0.045 -0.81)	-684,538 (905,446 -0.76)	-0.023 (0.011 -2.16)*
FG	20.229 (7.797 2.59)*	1.022 (0.297 3.44)*	8,039,484 (6,076,692 1.32)	0.188 (0.069 2.75)*
ERV	15.367 (7.762 1.98)*	0.561 (0.296 1.90)*	15,811,238 (6,244,753 2.53)*	0.101 (0.072 1.40)
OVT	30.385 (9.571 3.17)*	0.860 (0.365 2.36)*	513,154 (7,405,110 0.07)	0.088 (0.081 1.08)
84	1.923 (6.307 0.30)	0.168 (0.429 0.39)	2,522,158 (2,002,685 1.26)	0.027 (0.047 0.56)
85	0.762 (6.307 0.12)	0.119 (0.429 0.28)	1,812,516 (2,003,353 0.90)	0.017 (0.047 0.37)
86	2.297 (6.307 0.36)	0.087 (0.429 0.20)	3,671,713 (2,003,467 1.83)*	0.016 (0.047 0.33)
87	5.563 (6.307 0.88)	0.384 (0.429 0.90)	1,859,754 (2,003,555 0.93)	0.053 (0.047 1.13)
88	5.956 (6.307 0.94)	0.414 (0.429 0.96)	2,863,948 (2,003,679 1.43)	0.061 (0.047 1.29)
89	4.153 (6.307 0.66)	0.299 (0.429 0.70)	585,873 (2,003,746 0.29)	0.040 (0.047 0.84)
90	19.493 (6.307 3.09)*	0.966 (0.429 2.25)*	422,224 (2,003,914 0.21)	0.123 (0.047 2.60)*
91	-1.659 (6.307 -0.26)	-0.045 (0.429 -0.10)	-1,179,011 (2,003,880 -0.59)	-0.010 (0.047 -0.21)
92	8.162 (6.310 1.29)	0.562 (0.429 1.31)	3,653,536 (2,005,119 1.82)*	0.085 (0.047 1.81)*
93	9.023 (6.309 1.43)	0.650 (0.429 1.59)	2,570,608 (2,004,134 1.28)	0.090 (0.047 1.90)*
94	9.292 (6.307 1.47)	0.684 (0.429 1.59)	3,558,920 (2,004,274 1.78)*	0.090 (0.047 2.09)*
95	9.629 (6.307 1.53)	0.760 (0.429 1.77)*	1,822,519 (2,003,677 0.91)	0.103 (0.047 2.17)*
96	2.237 (6.307 0.35)	0.245 (0.429 0.57)	1,360,222 (2,003,838 0.68)	0.035 (0.047 0.74)
97	7.769 (6.307 1.23)	0.023 (0.429 0.05)	4,115,090 (2,004,058 2.05)*	0.004 (0.047 0.09)

et expenditures = Total expenditures less spending on food and drugs.

1) refers to a variable lagged one period.

he first number in parentheses is the standard error of the coefficient; the second number is a two-tailed t-statistic for the hypothesis that the coefficient is zero. Significant at the 0.1 level or lower.

otes: All models are estimated using pooled time-series, cross-sectional data. We use the Fuller-Battese variance components model for the error structure. This ethod displays a general robustness to the underlying error.

able 4. Time-Series, Cross-Sectional Models for Net Expenditures: Rural Hog-Producing Counties Sample

Model: **Dependent Variable:**	**4-1** **Δ Net Expenditures**	**4-2** **Δ Net Expenditures**	**4-3** **Δ Log Net Expenditures**	**4-4** **Δ Log Net Expenditures**
Net expenditures(1)[b]	------	------	------	------
Log net expenditures(1)	------	------	------	------
CONC_2	-14.030 (5.989 -2.34)*	------	-0.701 (0.278 -2.53)*	------
CONC_3	------	-10.051 (6.789 -1.48)	------	-0.547 (0.315 -1.74)*
MKT_S2	------	------	------	------
Δ MKT_S2	0.003 (0.003 1.19)	0.003 (0.003 1.18)	------	------
Log MKT_S2	------	------	------	------
Δ Log MKT_S2	------	------	0.056 (0.022 2.50)*	0.056 (0.023 2.49)*
Contiguous	0.669 (1.390 0.48)	0.121 (1.359 0.09)	0.019 (0.064 0.30)	-0.006 (0.063 -0.09)
MFG	18.122 (10.382 1.75)*	18.272 (10.481 1.74)*	1.281 (0.481 2.66)*	1.300 (0.486 2.68)*
SERV	12.852 (10.752 1.20)	10.832 (10.812 1.00)	0.481 (0.498 0.97)	0.373 (0.501 0.75)
GOVT	9.965 (14.046 0.71)	9.742 (14.132 0.69)	0.918 (0.651 1.41)	0.920 (0.655 1.41)
D84	0.964 (3.186 0.30)	0.964 (3.187 0.30)	0.065 (0.273 0.24)	0.065 (0.273 0.24)
D85	0.069 (3.195 0.02)	0.521 (3.264 0.16)	0.069 (0.273 0.25)	0.097 (0.275 0.35)
D86	-0.423 (3.195 -0.13)	0.029 (3.264 0.01)	-0.078 (0.273 -0.28)	-0.050 (0.275 -0.18)
D87	7.220 (3.195 2.26)*	7.671 (3.264 2.35)*	0.542 (0.273 1.99)*	0.569 (0.275 2.07)*
D88	6.529 (3.195 2.04)*	6.981 (3.264 2.14)*	0.491 (0.273 1.80)*	0.518 (0.275 1.89)*
D89	5.068 (3.195 1.59)	5.519 (3.263 1.69)*	0.350 (0.273 1.28)	0.377 (0.275 1.37)
D90	26.575 (3.262 8.15)*	26.833 (3.436 7.81)*	1.431 (0.275 5.21)*	1.452 (0.279 5.20)*
D91	4.368 (3.262 1.34)	4.626 (3.436 1.35)	0.302 (0.275 1.10)	0.323 (0.279 1.16)
D92	8.952 (3.274 2.73)*	9.213 (3.445 2.67)*	0.634 (0.275 2.31)*	0.656 (0.280 2.35)*
D93	14.339 (3.262 4.40)*	14.597 (3.436 4.25)*	0.964 (0.275 3.51)*	0.986 (0.279 3.53)*
D94	17.436 (3.262 5.35)*	17.694 (3.436 5.15)*	1.070 (0.275 3.89)*	1.091 (0.279 3.91)*
D95	17.428 (3.657 4.77)*	16.668 (3.947 4.22)*	1.168 (0.285 4.10)*	1.146 (0.293 3.91)*
D96	8.874 (3.657 2.43)*	8.114 (3.947 2.06)*	0.531 (0.285 1.86)*	0.508 (0.293 1.73)*
D97	13.271 (3.657 3.63)*	12.511 (3.947 3.17)*	0.270 (0.285 0.95)	0.248 (0.293 0.84)

Table 4. (Continued)

Model: **Dependent Variable:**	**4-5** **Net Expenditures**	**4-6** **Net Expenditures**	**4-7** **Log Net Expenditures**	**4-8** **Log Net Expenditures**
Net expenditures(1)[b]	1.010 (0.001 1,181.3)*	1.010 (0.001 1,180.9)*	------	------
Log net expenditures(1)	------	------	0.983 (0.003 325.5)*	0.983 (0.003 325.6)*
CONC_2	-363,286 (234,604 -1.55)	------	-0.085 (0.042 -2.01)*	------
CONC_3	------	-139,688 (270,590 -0.52)	------	-0.089 (0.056 -1.58)
MKT_S2	0.002 (0.007 0.31)	0.002 (0.007 0.26)	------	------
Log MKT_S2	------	------	0.006 (0.014 0.45)	0.009 (0.014 0.68)
Contiguous	1,710 (57,985.6 0.03)	-17,775 (56,671 -0.31)	-0.002 (0.019 -0.10)	-0.007 (0.018 -0.38)
MFG	218,308 (423,616 0.52)	192,104 (425,488 0.45)	0.233 (0.102 2.29)*	0.234 (0.102 2.29)*
SERV	148,718 (433,138 0.34)	116,553 (437,383 0.27)	0.083 (0.107 0.78)	0.057 (0.108 0.53)
GOVT	55,485 (581,613 0.10)	18,730 (582,376 0.03)	0.189 (0.145 1.30)	0.180 (0.145 1.24)
D84	257,841 (553,847 0.47)	257,958 (553,991 0.47)	0.017 (0.023 0.73)	0.017 (0.023 0.71)
D85	-104,437 (553,933 -0.19)	-105,155 (554,680 -0.19)	0.009 (0.023 0.41)	0.015 (0.024 0.62)
D86	579,058 (553,934 1.05)	578,371 (554,679 1.04)	-0.007 (0.023 -0.30)	-0.002 (0.024 -0.07)
D87	511,370 (553,935 0.92)	510683 (554,678 0.92)	0.074 (0.023 3.18)*	0.080 (0.024 3.32)*
D88	631,313 (553,934 1.14)	630,618 (554,679 1.14)	0.070 (0.023 3.01)*	0.076 (0.024 3.16)*
D89	310,168 (553,940 0.56)	309,516 (554,675 0.56)	0.053 (0.023 2.27)*	0.058 (0.024 2.43)*
D90	579,237 (554,521 1.04)	563,297 (556,291 1.01)	0.187 (0.024 7.86)*	0.194 (0.026 7.61)*
D91	5,020 (554,519 0.01)	-10,954 (556,297 -0.02)	0.037 (0.024 1.57)	0.044 (0.026 1.72)*
D92	819,370 (554,624 1.48)	803,831 (556,280 1.45)	0.092 (0.024 3.83)*	0.098 (0.026 3.84)*
D93	830,321 (554,522 1.50)	814,392 (556,287 1.46)	0.128 (0.024 5.36)*	0.134 (0.026 5.26)*
D94	944,359 (554,527 1.70)*	928,459 (556,278 1.67)*	0.146 (0.024 6.11)*	0.152 (0.026 5.97)*
D95	766,278 (558,260 1.37)	705458 (561554 1.26)	0.158 (0.027 5.96)*	0.163 (0.030 5.42)*
D96	523,485 (558,261 0.94)	462,697 (561,534 0.82)	0.075 (0.027 2.83)*	0.080 (0.030 2.65)*
D97	590,918 (558,263 1.06)	530,167 (561,518 0.94)	0.035 (0.027 1.30)	0.039 (0.030 1.29)

Notes: See footnotes to Table 3.

Table 5. Alternative models with dynamic concentration variable: Rural Hog-Producing Counties Sample

Model: **Dependent Variable:**	**5-1** **Δ Net Expenditures**	**5-2** **Δ Net Expenditures**	**5-3** **Δ Log Net Expenditures**	**5-4** **Δ Log Net Expenditures**
Net expenditures(1)[b]	------	------	------	------
Log net expenditures(1)	------	------	------	------
C285-89	0.214 (12.346 0.02)	------	0.170 (0.572 0.30)	------
C290-94	-32.762 (11.222 -2.92)*	------	-1.665 (0.520 -3.20)*	------
C295-97	-9.478 (8.730 -1.09)	------	-0.530 (0.405 -1.31)	------
C385-89	------	3.010 (11.204 0.27)	------	0.095 (0.519 0.18)
C390-94	------	-22.949 (11.864 -1.93)*	------	-0.878 (0.549 -1.60)
C395-97	------	-10.451 (15.816 -0.66)	------	-0.750 (0.733 -1.02)
Δ MKT_S2	0.003 (0.003 1.21)	0.004 (0.003 1.23)	------	------
Δ Log MKT_S2	------	------	0.056 (0.022 2.49)*	0.056 (0.023 2.48)*
Contiguous	0.528 (1.392 0.38)	0.019 (1.354 0.01)	0.010 (0.064 0.16)	-0.013 (0.063 -0.22)
MFG	19.927 (10.503 1.90)*	17.535 (10.538 1.66)*	1.365 (0.487 2.81)*	1.280 (0.487 2.63)*
SERV	13.649 (10.787 1.27)	10.887 (10.796 1.01)	0.519 (0.499 1.04)	0.467 (0.511 0.91)
GOVT	12.145 (14.118 0.86)	9.265 (14.156 0.65)	1.022 (0.654 1.56)	1.055 (0.698 1.51)
D84	0.963 (3.186 0.30)	0.962 (3.187 0.30)	0.065 (0.273 0.24)	0.065 (0.273 0.24)
D85	-0.583 (4.629 -0.13)	-2.307 (7.360 -0.31)	-0.006 (0.314 -0.02)	-0.017 (0.411 -0.04)
D86	-1.075 (4.629 -0.23)	-2.799 (7.360 -0.38)	-0.154 (0.314 -0.49)	-0.164 (0.411 -0.40)
D87	6.568 (4.629 1.42)	4.843 (7.360 0.66)	0.466 (0.314 1.49)	0.456 (0.411 1.11)
D88	5.878 (4.629 1.27)	4.153 (7.360 0.56)	0.415 (0.314 1.32)	0.405 (0.411 0.99)
D89	4.416 (4.629 0.95)	2.691 (7.360 0.37)	0.274 (0.314 0.87)	0.264 (0.411 0.64)
D90	36.296 (5.030 7.22)*	40.479 (8.646 4.68)*	1.926 (0.327 5.89)*	1.943 (0.461 4.21)*
D91	14.089 (5.030 2.80)*	18.272 (8.647 2.11)*	0.797 (0.327 2.44)*	0.814 (0.461 1.77)*
D92	18.665 (5.033 3.71)*	22.843 (8.636 2.65)*	1.130 (0.327 3.45)*	1.147 (0.461 2.49)*
D93	24.059 (5.030 4.78)*	28.242 (8.646 3.27)*	1.460 (0.327 4.47)*	1.477 (0.461 3.20)*
D94	27.157 (5.030 5.40)*	31.339 (8.646 3.62)*	1.565 (0.327 4.79)*	1.582 (0.461 3.43)*
D95	18.239 (5.615 3.25)*	21.907 (13.529 1.62)	1.238 (0.347 3.57)*	1.581 (0.668 2.37)*
D96	9.685 (5.615 1.72)*	13.353 (13.529 0.99)	0.601 (0.347 1.73)*	0.944 (0.668 1.41)
D97	14.083 (5.615 2.51)*	17.750 (13.529 1.31)	0.341 (0.347 0.98)	0.683 (0.668 1.02)

Table 5. (Continued)

Model: Dependent Variable:	5-5 Net Expenditures	5-6 Net Expenditures	5-7 Log Net Expenditures	5-8 Log Net Expenditures
Net expenditures(1)[b]	1.010 (0.001 1177.2)*	1.010 (0.001 -1181.0)*	------	------
Log net expenditures(1)	------	------	0.983 (0.003 332.9)*	0.983 (0.003 324.8)*
C285-89	57,757 (480,848 0.12)	------	0.050 (0.080 0.62)	------
C290-94	-200,814 (438,701 -0.46)	------	-0.212 (0.073 -2.89)*	------
C295-97	-607,848 (339,686 -1.79)*	------	-0.070 (0.054 -1.30)	------
C385-89	------	-101,180 (438,262 -0.23)	------	0.019 (0.075 0.25)
C390-94	------	-43,227 (466,876 -0.09)	------	-0.112 (0.080 -1.40)
C395-97	------	-780,849 (615,691 -1.27)	------	-0.096 (0.100 -0.96)
MKT_S2	0.002 (0.007 0.30)	0.002 (0.007 0.27)	------	------
Log MKT_S2	------	------	0.007 (0.014 0.55)	0.005 (0.015 0.33)
Contiguous	-6,695 (58,298 -0.11)	-14,573 (56,531 -0.26)	-0.005 (0.019 -0.24)	-0.004 (0.019 -0.23)
MFG	133,943 (429,175 0.31)	168,172 (427,362 0.39)	0.243 (0.103 2.35)*	0.235 (0.105 2.24)*
SERV	105,893 (435,819 0.24)	103,971 (436,453 0.24)	0.085 (0.108 0.79)	0.086 (0.114 0.75)
GOVT	2,268 (585,535 0.00)	17,452 (582,932 0.03)	0.198 (0.147 1.35)	0.214 (0.165 1.30)
D84	257,856 (553,575 0.47)	257921 (553944 0.47)	0.017 (0.023 0.72)	0.017 (0.023 0.73)
D85	-135,500 (568,810 -0.24)	-59,799 (611,605 -0.10)	-0.008 (0.032 -0.25)	-0.005 (0.050 -0.11)
D86	548,000 (568,808 0.96)	623,721 (611,595 1.02)	-0.024 (0.032 -0.77)	-0.022 (0.050 -0.44)
D87	480,311 (568,810 0.84)	556,031 (611,588 0.91)	0.057 (0.032 1.78)*	0.060 (0.050 1.19)
D88	600,253 (568,810 1.06)	675,968 (611,590 1.11)	0.053 (0.032 1.66)*	0.056 (0.050 1.11)
D89	279,113 (568,816 0.49)	354,848 (611,542 0.58)	0.036 (0.032 1.12)	0.038 (0.050 0.77)
D90	606,347 (574,017 1.06)	566,078 (637,567 0.89)	0.251 (0.034 7.30)*	0.253 (0.059 4.31)*
D91	32,126 (547,029 0.06)	-8,162 (637,613 -0.01)	0.101 (0.034 2.93)*	0.103 (0.059 1.76)*
D92	846,531 (573,925 1.47)	806,476 (636,960 1.27)	0.155 (0.034 4.50)*	0.158 (0.059 2.69)*
D93	857,432 (574,010 1.49)	817,168 (637,535 1.28)	0.191 (0.034 5.56)*	0.194 (0.059 3.30)*
D94	971,473 (573,993 1.69)*	931,221 (637,457 1.46)	0.209 (0.034 6.09)*	0.212 (0.059 3.61)*
D95	979,293 (582,005 1.68)*	1,306,583 (753,933 1.73)	0.170 (0.037 4.60)*	0.212 (0.086 2.46)*
D96	736,503 (582,000 1.27)	1,063,808 (753,892 1.41)	0.087 (0.037 2.35)*	0.129 (0.086 1.50)
D97	803,941 (581,996 1.38)	1,131,265 (753,856 1.50)	0.046 (0.037 1.24)	0.089 (0.086 1.03)

Notes: See footnotes to Table 3.

Endnotes

[1] In economic theory income and prices, and the budgets they imply, are the building blocks in understanding the determination of economic welfare. See, for example, the discussion of Laspeyres and Paasche on measures of welfare change in Layard and Walters (1978). Similarly, because of this budgetary constraint, there is a close relationship between consumer expenditures (retail sales) and income via the marginal propensity to consume.

[2] In deriving total retail expenditures, T is defined as the local add-on sales tax rate (which varies by town) and R is local tax collections, because local jurisdictions did not exempt food and drugs from the sales tax. In deriving net expenditures, T is defined as the state sales tax rate and R is state tax receipts raised locally.

[3] Per capita spending and income measures would be preferable to aggregate (town level) measures. However, per capita measures could not be constructed because annual population estimates are unavailable. (In most cases, only 1990 Census measures are available.) In the regressions, time dummies and spatial dummies pick up systematic effects of population shifts. In addition, with a lagged dependent variable, spending in period t is largely determined by spending in period t-1. Presumably, much of this is driven by population and income levels, which change gradually from year to year. Nonetheless, increases in the dependent variable (real spending), as discussed later in this section, are not necessarily "welfare improving" in the sense implied by microeconomic theory.

[4] Growth rates are for group aggregates, and are not averages for towns in a group. Per-capita growth rates are approximate because population data are available only for 1980 and 1997. See notes to Table 1 for methods of calculation.

[5] The data are from special tabulations carried out by the National Agriculture Statistics Service (NASS) on the Census of Agriculture for years 1982, 1987, 1992, and 1997.

[6] For a county to be classified as "hog producers", the annual pig sales (not including feeder pigs) must be 50,000 or more during the period 1982-1997.

[7] The bench-mark net expenditure models are identified in Table 4.

[8] In performing these tests, we regressed the dependent variable on all exogenous variables (including the lagged dependent variable) and saved the residuals and the estimates of the dependent variable. In the first test the square of the residual was regressed on the estimate of the dependent variable. In the second test the square of the residual was regressed on the square of the estimated dependent variable. In the third test the square of the residual was regressed on the log of the square of the estimated dependent variable. The fourth test was the Breusch-Pagan test. All models tested significantly for heteroskedasticty, with the problem most pronounced in the linear models. These tests were carried out previously by Crihfield and Gómez (2000) obtaining similar results.

[9] The 21 towns and cities consisted of 7 cities from metropolitan counties, 7 towns from rural nonprogram counties, and 7 towns from program counties. In all cases the partial autocorrelation parameter between X_t and X_{t-1} was found to be .9 or higher; partial autocorrelation parameters for X_t and X_{t-i} ($i>1$) were very small.

[10] For further discussion of the Fuller-Battese procedure, see Greene (1997).

[11] Omitted dummies are for rural-contiguous counties, resource-based counties, 1984 (for net expenditures), and 1985 (for total expenditures).