AN ANALYSIS OF ECONOMIC AND NONECONOMIC FACTORS AFFECTING RETAIL SALES LEAKAGES

John F. Yanagida, Bruce B. Johnson, Joel Young and Michael Lundeen[*]

Abstract–This study develops an analytical framework for explaining both cross-sectional and intertemporal variations in the pull factors for retail sales. A reduced form equation derived from factors affecting the demand and supply of goods and services is used to explain changes in the pull factor measure. This pull factor equation is estimated for all agriculturally dependent counties and all counties in Nebraska for the years 1975, 1980 and 1985.

INTRODUCTION

A research tool often used to assess a community's retail activity is the pull factor for retail sales. Pull factor measures are used to indicate the leakages or lost sales from a community which has the effect of reducing the size of export base multipliers. There have been several studies estimating pull factors at various levels of population aggregation [Harris (1985); Stone (1986)]. Pull factor measures, when calculated over time, help decision makers become more aware of the community's market capture efficiency or inefficiency. Further understanding of this pull factor measure would require evaluating what economic and noneconomic factors affect the pull factor measure.

The basic purpose of this study was to develop and apply an analytical framework for explaining both cross-sectional and intertemporal variations in the pull factors for retail sales. The specific objectives are divided into four areas. First, a theoretical framework is developed which enables derivation of a reduced form equation to explain pull factor variations. Second, Nebraska county data are utilized to estimate this reduced form equation for different categories of Nebraska counties based on the USDA's classification of agricultural dependency. Third, regression results are evaluated in order to select major factors affecting this measure of retail sector activity. Last, implications are drawn from these findings of significant factors affecting sector leakages.

Subsequent sections of this paper include a description of the Nebraska economy, summary of retail trade analysis and central-place theory, development

[*]Yanagida is Professor, Department of Agricultural and Resource Economics, University of Hawaii, Manoa. Johnson is Professor, Young is a Research Assistant and Lundeen is a Research Technologist, Department of Agricultural Economics, University of Nebraska, Lincoln. Hawaii Agricultural Experiment Station Journal Article No. 3436. We thank three anonymous reviewers for helpful comments and suggestions.

of a theoretical framework explaining the pull factor measure and explanation of the data and presentation of estimation results. The last section summarizes our results and discusses implications for the Nebraska economy.

THE NEBRASKA ECONOMY

Nebraska is a relatively sparsely populated state whose principal industry historically has been agriculture. The state has more than 400 towns with population less than 1000, most of which are relatively isolated from metropolitan and regional trade centers. Many of these towns came into existence to serve as trade centers for the surrounding agricultural community and that continues to be their primary, although often declining, role. In a national study which classified counties according to economic characteristics, Nebraska had the highest number of "farming dependent" counties of any state [Bender et al. (1985)].

The diminishing role of agriculture in Nebraska's economy has occurred over the last two decades with the early 1980s intensifying this decline. Between 1960 and 1984, agriculture's share of Nebraska's gross state product declined from 16.2% in 1960 to 11.9% in 1984 (*Nebraska Statistical Handbook*). Employment in production agriculture has also declined more than 50% from 160,000 in 1960 to 76,400 in 1984 (*Nebraska Statistical Handbook*).

Although the state's population has increased, this population growth has been primarily occurring in the four metropolitan counties (SMSAs) and the ten regional trade counties[1] [Olsen et al. (1986)]. This out-migration from rural areas coupled with the structural change occurring in rural economies which are primarily dependent on agriculture, raises concerns about the economic future of these areas. Future economic viability of rural communities/counties will depend heavily upon their ability to generate retail sales and revenues.

RETAIL TRADE ANALYSIS AND CENTRAL-PLACE THEORY

A trade area is defined as the geographical area from which a commodity captures the majority of its customers [Hustedde, Shaffer and Pulver (1984)]. Analytical models, such as gravity models and relative price differential models, have been developed to measure spatial interaction among communities.

Gravity models are often used to help communities (i.e., cities) determine their retail trade boundaries and market access potential. For example, Reilly's Law of Gravitation [Reilly (1931)] estimates the maximum distance customers travel to shop in a certain community. Unlike gravity models, the relative price differential model provides a more rigorous theoretical basis for retail trade. Following traditional trade theory, comparative advantage determines the basis for specialization and trade between geographical areas or regions.

However, much of the current and past research on retail trade activity has centered around Central-Place Theory. This theory or set of theories was originally developed by Christaller (1933) and extended by Losch (1954). Central-Place Theory focuses on the location and the geographical size distribution of clusters of economic activity (Hoover, 1975). In essence, Central-Place Theory illustrates that communities have hexagonal trade areas with uniform distributions. The work, especially by Christaller, explains the size, number and distribution of cities/towns by generating a hierarchy of central-places [Emerson and Lamphear (1975); Alden and Morgan (1974)].

Central-Place Theory provides a formal structure of assumptions and derived propositions. Christaller's contribution to Central-Place Theory evolved around two concepts--the range and the threshold of the commodity [Craig, et al. (1984)]. The range is defined as the maximum distance consumers would be willing to travel in order to purchase the commodity. The threshold level is the minimum demand for this economically viable producer or firm.

Using different assumptions, Losch (1954) derived a system of central-places that was quite different from that proposed by Christaller. While Christaller's approach provided a spatial structure for retail and service businesses, the framework developed by Losch is better suited for market-oriented manufacturing firms [von Boventer (1963)].

The next section discusses the conceptual framework for the pull factor model as an extension of the central-place theory.

THEORETICAL FRAMEWORK

For Central-Place Theory, the spatial distribution of cities/towns reflects demand and supply forces operating in the market place. Although there are many measures of commercial sector activity, two commonly used measures include the concepts of trade area capture and the pull factor for retail sales.

The pull factor for retail goods and services estimates the extent of lost sales for an area and/or the area's ability to capture sales from outside its boundaries. This pull factor measure is the ratio of the trade area capture estimate to the community's population [Hustedde, Shaffer and Pulver (1984)]. This can be expressed below as equation (1):

$$PF_i = \frac{\hat{TAC}_i}{POP_i} \tag{1}$$

where PF_i = pull factor for community i,
$\hat{TAC}_i$ = trade area capture estimate for the i^{th} community, and
POP_i = population of the i^{th} community.

The trade area capture estimate for the i^{th} community is written as:

$$\hat{TAC}_i = \frac{SALES_i}{SE\frac{I_i}{SI}} \tag{2}$$

where $SALES_i$ = retail sales and services for community i,
SE = state per capita expenditure for these goods and services,
I_i = per capita income for the i^{th} community, and
SI = State per capita income.

Stone excluded the term $\frac{I_i}{SI}$ from his estimate of $\hat{TAC}_i$.[2]

The TÂC measure portrays the county's ability to capture trade at a rate similar to the rate at which county income changes across counties (or over time if data are pooled). For instance, a TÂC equal to 25,000 means that the county is able to capture the retail sales and services (on average) of 25,000 people. It does not mean the county sold 25,000 units of goods and services.

The pull factor, on the other hand, is a ratio that estimates the proportion of retail sales that remained in the county. If the pull factor measure is less than unity, then leakages to areas outside the county border occurred. For pull factors with magnitudes exceeding unity, this implies that the county was able to capture sales beyond its own borders.

As shown in equations (1) and (2), the pull factor is a relative measure of retail sales and services. The extent of retail sales activity in a given community is a function of both the demand and supply of goods and services.

At the aggregate level, the community's demand for goods and services is believed to be a function of income levels within the community, demographic characteristics of the community (e.g., age distribution of residents), and relative prices with respect to prices of goods and services sold in neighboring communities. Data for the latter variable, relative prices, are not available at an aggregated retail level for all goods and services. Instead, distance to major cities and trade centers proxies this substitution effect in accounting for leakages. The supply of available goods and services within a community is primarily a function of the number of retail outlets. Because of the agricultural crisis in the 1980s, an additional variable explaining fluctuations in the pull factor measure over different communities is the degree of agricultural dependency of that community.

The reduced-form equation combining the effects of the demand and supply of goods and services to explain the pull factor measure is shown below in equation (3). The level of population aggregation used in this study is the individual county. So the variables in equation (3) refer to Nebraska counties.[3]

PF = f(INC, AGE (18-64), AGE (65+), TRCENTER, RETOUT, PEAKYR, LARGTOWN, AGDEP) (3)

where PF = pull factor measure for each county;

INC =per capita Federal adjusted gross income for each county *relative* to that for the State;

AGE (18-64) =percent of each county's population between the ages of 18 and 64 *relative* to that for the State;

AGE (65+) = percent of each county's population 65 years of age and older *relative* to that for the State;

TRCENTER = distance to nearest trade center (city of at least 10,000 population) from the approximate geographical center of each county;

RETOUT = number of retail outlets in each county;

PEAKYR = percent county's population as a percent of county's peak population;

LARGTOWN = population of largest town in the county; and

AGDEP = percent of each county's total labor and proprietary income derived from sales of agricultural products.

The pull factor measure proposed in equation (3) is modified from that presented in equation (1) in two ways. First following Stone, the estimate of $\hat{TAC}_i$ excludes the term $\frac{I_i}{SI}$ in order to remove the relative income SI component from the pull factor. Rather, this relative income variable becomes an independent variable used in explaining the modified pull factor measure. This is consistent with the earlier discussion concerning the income component as an important factor explaining the demand for goods and services. Second, because "good" data on retail sales and services are not available, the pull factor measurement must be approximated using taxable retail sales levels as a proxy. Such sales are measured in an accurate and timely manner by the State Department of Revenue. However, they obviously do not include retail goods exempt from sales tax, nor do they include services. Nevertheless, they are deemed a reasonable proxy assuming that the proportions of exempt goods and services to taxable sales are consistent across counties.

The expected coefficient signs are based on economic theory, spatial analysis and demographic observations. First, the expected sign of INC is positive indicating that as per capita income of the county relative to the state's per capita income increases (decreases), generally, one would expect the county's pull factor to increase (decrease). Second, for the two age distribution variables, the expected coefficient signs are different. The expected sign for AGE (18-64) is negative since the younger population is presumed to be more mobile and would contribute to greater leakages from the county. The older age category, AGE (65+) would be generally less mobile and purchase a larger portion of retail goods and services within the county. The expected coefficient signs for TRCENTER, LARGTOWN, and PEAKYR are positive. Respectively, these signs indicate that counties situated farther away from trade centers, have a large town within their county borders, and have experienced lower population decreases (relative to the peak population) are more likely to have higher pull factors or lower sales leakages. Fourth, as the number of retail outlets (RETOUT) increases (decreases), one would expect sales leakages to decrease (increase). Of course, type and quality of retail outlets also influence the extent of sales leakages and the ability to draw customers from other counties. Fifth, the expected coefficient sign on AGDEP is negative because increased agricultural dependency would tend to stifle diversification and lead to increased retail leakages.

DATA AND ESTIMATION RESULTS

Data for demographic variables, LARGTOWN, AGE (18-64), AGE (65+), and PEAKYR were obtained from U.S. Bureau of Census reports. Distance to the nearest trade center (TRCENTER) variable was estimated from the approximate geographical center of each county. The Nebraska Department of Revenue publishes annual reports containing each county's Federal adjusted gross income (INC) and estimates the number of retail outlets declaring taxable sales (RETOUT). The AGDEP variable is estimated as the percent of each county's total labor and proprietary income that is derived from agriculture. The data for total labor and proprietary income are unpublished updated estimates for the period, 1980-1984, as previously found in U.S. Department of Agriculture material [Green (1987); Green and Carlin (1985)].

Using the definition of agricultural dependency by Green and Carlin (i.e., a Nebraska county is considered to be agriculturally dependent if AGDEP > 20%), fifty seven of the ninety three counties in Nebraska are classified as agriculturally dependent. As mentioned earlier, there are four metropolitan counties and ten counties having regional trade centers. The remaining twenty two counties fall into neither of these categories and form a residual class having somewhat greater economic diversity than the agriculturally dependent counties.

Table 1 shows the average pull factors of each of these county categories for 1975, 1980 and 1985. These data indicate that the agriculturally dependent counties category had the lowest average pull factor for all three years. Perhaps of greater importance is the magnitudes of the pull factors over time. The difference between a two means t-test was calculated for the period 1975 to 1980 and 1980 to 1985. The results are shown in Table 2. Statistically, the average pull factors by county categories did not differ from 1975 to 1980. However, from 1980 to 1985, a period of financial stress for agriculture and rural communities and often coined the "agricultural crisis" period, there is statistically significant declines in the average pull factors for agriculturally dependent and diverse county categories. These decreases also significantly reduce the state's average pull factor estimate.

TABLE 1
Average Pull Factors For Major County Categories and the State: 1975, 1980 and 1985

County Categories	1975	1980	1985
Agriculturally Dependent	0.67002[1]	0.66988	0.50193
(57 counties)	(0.33669)[2]	(0.29237)	(0.22523)
Diverse	0.82127	0.85159	0.70550
(22 counties)	(0.28013)	(0.29201)	(0.26987)
Metropolitan	0.88375	0.82050	0.91300
(4 counties)	(0.34786)	(0.41407)	(0.49740)
Regional Trade	1.1985	1.1576	1.0369
(10 counties)	(0.20344)	(0.17844)	(0.15958)
State	0.77182	0.77178	0.62529
(93 counties)	(0.34964)	(0.32317)	(0.30173)

[1] Mean or average pull factor value for each county category.
[2] Figures in parentheses below the average pull factor values represent standard deviations associated with the average pull factors.

There are two sets of ordinary least squares (OLS) regression results. First, equation (3) is estimated for only the fifty seven agriculturally dependent counties.[4] Second, the pull factor equation is estimated for all ninety three Nebraska counties. Each cross sectional set is estimated for the years 1975, 1980 and 1985.

Results of the estimated pull factor equation for agriculturally dependent counties are shown in Table 3. The coefficient signs are consistent with *a priori*

TABLE 2
Statistical Test of Differences Between Average Pull Factors from 1975 to 1980 and 1980 to 1985.

County Categories	Differences Between Two Means t-Test[1] (Absolute t-value) 1975 to 1980	1980 to 1985
Agriculturally Dependent	0.002	3.44*[1]
Diverse	0.35	1.72*
Metropolitan	0.23	0.29
Regional Trade	0.48	1.59
State	0.0008	3.20*

[1]Asterisk denotes statistically significant difference of the means at the 10% level.

TABLE 3
Estimated Pull Factor Equations for Agriculturally Dependent Nebraska Counties 1975, 1980 and 1985[1]

Explanatory Variables	1975	1980	1985
INTERCEPT	0.66093	0.61224	0.065224
	(0.50)[2]	(0.63)	(0.10)
INC	0.46662	0.65465	0.50670
	(3.40)*	(4.54)*	(4.14)*
AGE (18-64)	-1.3545	-1.1749	-0.50618
	(-1.15)	(-1.36)	(-0.88)
AGE (65+)	0.13690	0.059438	0.11596
	(0.72)	(0.40)	(1.12)
TRCENTER	0.004264	0.004004	0.0023185
	(3.37)*	(4.19)*	(3.60)*
RETOUT	0.000038	0.000059	0.000031
	(0.11)	(0.23)	(0.18)
PEAKYR	0.68472	0.42706	0.34961
	(2.17)*	(1.87)*	(2.38)*
LARGTOWN	0.000063	0.000057	0.000049
	(1.49)	(1.71)*	(2.16)*
$AdjR^2$	0.58	0.67	0.75
F-Stat.	11.84	17.00	24.56

[1]Estimated by OLS. For each year, the sample size is 57 (counties).
[2]Figures in parentheses represent t-statistics. An asterisk (*) denotes statistically significant at the $\alpha = 0.10$ level.

expectations. The independent variables explain approximately 58 to 75% of the variation in the pull factor measure. These results indicate that counties which are situated farther away from trade centers, have a large town within their county boundary, have larger Federally adjusted gross income, and have experienced lower population decreases (relative to their peak population) are more likely to have larger pull factors which imply lower sales leakages from the county.

The estimated pull factor equation results for all Nebraska counties are illustrated in Table 4. These results differ in two important respects from those presented in Table 3. First, the agricultural dependency variable, AGDEP, which measures the percent of each county's total labor and proprietary income derived from sales of agricultural products was included as an explanatory variable. As

TABLE 4
Estimated Pull Factor Equations for All Nebraska Counties 1975, 1980 and 1985[1]

Explanatory Variables	1975	1980	1985
INTERCEPT	-1.1755	-1.2085	-1.2441
	(-1.50)	(-1.80)*	(-2.27)*
INC	0.51641	0.83730	0.75240
	(4.38)*	(6.86)*	(6.09)*
AGE (18-64)	0.23744	0.45865	0.81909
	(0.35)	(0.78)	(1.70)*
AGE (65+)	0.31043	0.22845	0.14947
	(2.36)*	(1.96)*	(1.50)
TRCENTER	0.0042192	0.004037	0.002653
	(4.05)*	(4.56)*	(3.68)*
RETOUT	0.00026482	0.0001977	0.000094
	(1.61)	(1.69)*	(1.03)
PEAKYR	1.0077	0.57438	0.42917
	(4.50)*	(3.22)*	(2.95)*
LARGTOWN	-0.000006	-0.000006	-0.000002
	(-1.44)	(-1.56)	(-0.76)
AGDEP	-0.075078	-0.19520	-0.29118
	(-0.35)	(-1.08)	(-2.00)*
$AdjR^2$	0.63	0.68	0.76
F-Stat.	20.52	25.37	36.64

[1]Estimated by OLS. For each year, the sample size is 93 (counties).

expected, the coefficient of AGDEP was negative indicating that increased agricultural dependency tends to lower a county's pull factor. Second, the coefficient signs for LARGTOWN and AGE (18-64) are different from *a priori* expectations although statistically insignificant at the $\alpha = 0.10$ level in all but one year. For LARGTOWN, this variable is less likely to be an indicator of economic activity when the entire state is considered because non-agriculturally dependent counties have larger towns that tend to attract retail sales dollars from agriculturally dependent, adjacent counties. In the case of AGE (18-64), the positive coefficient reflects the contribution to economic activity from the increased proportion of county residents in this age category. Unlike the case of only agriculturally dependent counties, mobility of residents seems less likely to be a factor in explaining leakages from metropolitan and regional trade counties.

SUMMARY

This paper develops and applies a framework for explaining both cross- sectional and intertemporal variations in the pull factors for retail sales. The analytical model combines the effects of supply and demand for goods and services to explain the pull factor measure. The estimation of this pull factor equation for agriculturally dependent counties and for all Nebraska counties for the years 1975, 1980 and 1985 reveals that in all years lower sales leakages may be attributed to counties which are situated farther away from trade centers, have larger Federally adjusted gross income, and have experienced lower population decreases (relative to their peak population). For agriculturally dependent counties only, the smaller the population of their largest town, the more significant sales leakages occurred during the beginning and ending years of the "farm crisis" period in the early to mid- 1980s.

Estimated results for all Nebraska counties show that increased agricultural dependency tends to increase retail sales leakages. Coefficient signs for variables LARGTOWN and AGE (18-64) are different from *a priori* expectations. However, differences in county samples (i.e., agriculturally dependent counties only versus all counties) lend explanation of these unexpected results.

For all samples and years of observation, three variables, INC, TRCENTER and PEAKYR, were found to be statistically significant. State and county decision makers should find these results of particular interest. The statistical results reinforce the notion that increased relative per capita income induces more local spending; location of trade centers and coordinated regional economic growth require planning amongst neighboring counties; and relative population changes over time influence spending patterns (retail sales within or outside the county).

The research presented here is only a beginning. Further research is needed to investigate possible differential patterns in pull factor measures for disaggregated sales categories (e.g., food, automotive, building materials, etc.). Also, spending patterns for adjacent counties across state lines should be evaluated in terms of trade flows.

Clearly there are substantive changes occurring in retailing which carry important regional implications. Understanding the forces behind these changes will be important in assessing and developing policy directions.

ENDNOTES

[1]Regional trade counties contain a city with population of 10,000 or more (exclusive of the four metropolitan counties).

[2]This formulation enables examination of retail activity exclusive of relative income effects.

[3]Hustedde, Shaffer and Pulver (1984) cite similar factors as influencing the size of a community's income and employment multipliers.

[4]The variable AGDEP is excluded as an explanatory variable because this subset of counties includes only agriculturally dependent counties.

REFERENCES

Alden, Jeremy and Robert Morgan. *Regional Planning: A Comprehensive View.* New York, NY: John Wiley and Sons, 1974.

Bender, L. D., B. L. Green, T. F. Hady, J. A. Kuehn, M. K. Nelson, L. B. Perkinson and P. J. Ross. *The Diverse Social and Economic Structure of NonMetropolitan America.* U.S. Department of Agriculture, ERS, Rural Development Research Report No. 49, 1985.

Christaller, Walter. "Die Zentralen Orte in Suddeutschland." Jena, Germany: Fisher, 1933. English translation by C. Baskin: *The Central Places of Southern Germany*, Englewood Cliff, NJ.: Prentice-Hall, 1966.

Craig, C. S., A. Ghosh, and S. McLafferty. "Models of the Retail Location Process: A Review," *Journal of Retailing.* 60(1984):5-36.

Emerson, M. J. and F. C. Lamphear. *Urban and Regional Economics: Structure and Change.* Boston, MA: Allyne and Bacon, Inc., 1975.

Green, Bernal L. Personal communication updating agricultural dependency indexes for 1985, August, 1987.

Green, Bernal L. and Thomas A. Carlin. "Agricultural Policy, Rural Counties and Political Geography," U.S. Department of Agriculture, ERS, EDD, Staff Paper AGES850429, May, 1985.

Harris, Thomas R. "Commercial Sector Development in Rural Communities: Trade Area Analysis", Western Regional Extension Publication, Oregon State University, WREP 90, September, 1985.

Hoover, Edgar M. *An Introduction to Regional Economics*, Second Edition. New York, NY.: Alfred A. Knopf Inc., 1975.

Hustedde, Ron, Ron Shaffer and Glen Pulver. *Community Economic Analysis: A How to Manual.* North Central Regional Center for Rural Development, November, 1984.

Losch, A. *The Economics of Location.* New Haven, CN.: Yale University Press, 1954.

Nebraska Department of Economic Development. *Nebraska Statistical Handbook*, Lincoln, Nebraska, (various issues).

Olsen, D. A., J. F. Yanagida, B.B. Johnson, D. S. Hargrove, and R. L. Meile. "Some Preliminary Findings of Structural Change in Rural Communities Stemming from the Farm Crisis," Department of Agricultural Economics, University of Nebraska, Staff Paper #3, 1986.

Reilly, William J. *The Law of Retail Gravitation.* New York, NY: Knickerbocker Press, 1931.

Stone, Kenneth E. "Impact of the Farm Financial Crisis on the Retail and Service Sectors of Rural Communities," *Agricultural Finance Review*, Special Issue, (1986) 41-47.

von Boventer, E. "Toward a Unified Theory of Spatial Economic Structure," *Papers of the Regional Science Association.* 10(1963):163-187.