Economic Analysis of Agricultural Land Conversion in the Southeast

By

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ECONOMIC ANALYSIS OF AGRICULTURAL LAND CONVERSION IN THE SOUTHEAST

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ABSTRACT

We estimate a system of equation model to understand the factors that influence the loss of agricultural land to non-agricultural uses in the Southeast United States. This is done by analyzing the complex relationship between population, employment, and agricultural land density for the 1990/2000 period. From the results, it can be noted that growth in employment over time and the expansion of residential housing have to be compromised with the agricultural sector on the use and allocation of land.

Key Words: land use, growth equilibrium modeling, population, employment

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Introduction

Land use conflicts, especially the conversion of farmland to urban sprawl, have been identified to be the greatest threat to long term-viability of the agricultural sector (Oslon and Oslon, 1999; Koontz, 2001, 2001; Rosenberger et al, 2002). Although there have been efforts to minimize land conversion, the desire to preserve farmland conflicts with the pressure from the ongoing demand for residential, commercial, industrial and other land uses that have fragmented the agricultural land base, and has driven up land values, as the "market value" for non-agricultural land use is normally significantly higher than the value of the land for agricultural production. Particularly, sprawl has taken two main forms: urban sprawl in the form of expanding urban areas that has pushed outward into the countryside at densities of 1500 or more people per square mile; and scattered residential sprawl outside established settlements at densities of 500 to 1500 people per square mile. Even though states and local governments have devised efforts to reduce the opportunity costs of farming in areas where the city has encroached, the problem is proving to be overwhelming.

The causes, trends, and impacts of land conversion are all closely interrelated. Both post-conversion land uses and the impacts of those new uses can feed into the cycle and become causes in their own right. This can begin a pattern of land conversion that is often both scattered and land consumptive (Chazan and Cotter, 2001). Causes, such as government policies, explain trends in land conversion, which result in environmental, economic and societal impacts or consequences. There have been efforts to minimize land conversion, however, the desire to preserve farmland conflicts with the pressure for continued and expanded development (Mayard et al. 1995). Thus, studies are needed to examine the impact of these cumulative land-use changes on environmental quality and ecosystem processes as well as to determine the effectiveness of best management practices for the impact these phenomena contribute to the environment.

This paper seeks to understand the factors that influence land conversion from agricultural to non-agricultural uses. Previous land conversation studies excessively focused on county, state and national levels. Therefore, we shift our focus to examine the issue at the regional level. This is done by analyzing the complex relationship between population, employment, and agricultural land in the Southeast United States. We begin our study with a review of previous research, model specification and data description. Finally, we present the major findings and conclusions of the study.

Literature review

Since the 1970s, there have been more than 500 studies on the issue of sprawl, with a significant amount of literature published in the 1990s. Particularly, the Economic Research Service (ERS) of the U.S. Department of Agriculture has conducted several studies of land-use changes and the dynamics of urbanizing areas over the last three decades (Heimlich and Anderson 1987; Heimlich and Reining 1989; Vesterby and Brooks 1989; Vesterby and Krupa 1997). To address sprawl and related problems, American Planning Association (APA) has encouraged states to adopt "smart growth" measures to manage development. As APA defines it, smart growth is the planning, design, development and revitalization of cities, towns, suburbs and rural areas in order to create and promote social equity, a sense of place and community, and to preserve natural as well as cultural resources (Smart Growth Network, 2002). The first state to try to respond to the threat of urban sprawl was Hawaii, which passed a statewide planning program in 1961 (Flickinger, 1994). The literature has also shown that sprawl has social and economic consequences, including traffic congestion and related costs for petrol burned and time lost, deteriorating inner cities that are often fragmented along class and racial lines, and suburban problems of isolation and lack of sense of community (Raad and Kenworthy 1998; Jakle and Wilson 1992; Roakes 1996; Dowling 2000).

Sprawl-exacerbated congestion costs at an estimated US $72 to 78 billion a year for lost time and fuel in the United States, representing an estimated 4.5 billion hours of extra travel time and 25.7 billion liters of fuel wasted during traffic jams. The average annual delay per person rose from 11 hours in 1982 to 36 hours in 1999 (Dowling 2000; TTI 2001). Studies also reveal that low-density, noncontiguous settlement requires more money for municipal services and infrastructure than compact development does (Chen 2000). O'Meara contends that car-centered development can exacerbate disparities between the rich and poor and worsen the plight of the underprivileged. For example, although the automobile is the only practicable means of transport in some US cities, one third of the nation's population is too young, too old, or too poor to drive a car (O'Meara Sheehan 2001).

Methodology

Modeling the interaction of complex economic phenomena occurring in spatial dimensions is a very challenging task. In light of this challenge, the study relies on the traditional regional growth modeling technique as presented by Carlino and Mills (1987):

$$(1) \qquad E^* = \Psi_E + \Phi_E \Omega^E$$

(2) $P^* = \Psi_P + \Phi_P \Omega^P$

where E* and P* are equilibrium levels of employment (E) and population (P). Ω^E and Ω^P are vectors of exogenous variables that affect employment and population. The equilibrium levels of employment and population depend on the actual level of employment and population and on a vector of other factors belonging to the sets Ω^E and Ω^P. Population and employment are likely to adjust to equilibrium values with substantial lags (see Mills & Price 1984; Carlino & Mills 1987 for the full distributed lag adjustment equation).

Hailu (2002) and Hailu and Rosenberger (2004) have extended this approach to capture the simultaneous interaction of equilibrium population and employment, and their interaction with agricultural land as follows:

(3) $P^* = f(E^* | \Omega^P)$

(4) $E^* = f(P^* | \Omega^P)$

(5) $AL^* = f(P^*, E^* | \Omega^{AL})$

where P*, E* and AL* refer to equilibrium values of population, employment and agricultural land levels, respectively. Ω^E, Ω^P and Ω^{AL} refer to a vector of exogenous variables that have a direct or indirect relationship with population, employment and agricultural land, respectively. Thus, the linear expression of the equilibrium conditions, equations (3), (4) and (5) are presented as:

(6) $P^* = \alpha_{0P} + \beta_{1P} E^* + \sum \delta_{1P} \Omega^P$

(7) $E^* = \alpha_{0E} + \beta_{1E} P^* + \sum \delta_{1E} \Omega^E$

(8) $AL^* = \alpha_{0AL} + \beta_{1AL} P^* + \beta_{2AL} E^* + \sum \delta_{1AL} \Omega^{AL}$

With substitution and rearranging of term, the expression of the model is written as (see Hailu, 2002 for the full derivation of the partial adjustment equations):

$$(9) \qquad \Delta P = \alpha_{0P} + \beta_{1P} P_{t-1} + \beta_{2P} E_{t-1} + \beta_{3P} \Delta E + \Sigma \delta_{IP} \Omega^{P}$$

$$(10) \qquad \Delta E = \alpha_{0E} + \beta_{1E} P_{t-1} + \beta_{2E} E_{t-1} + \beta_{3E} \Delta P + \Sigma \delta_{IE} \Omega^{E}$$

$$(11) \qquad \Delta AL = \alpha_{0AL} + \beta_{1AL} AL_{t-1} + \beta_{2AL} \Delta P + \beta_{3AL} \Delta E + \Sigma \delta_{IAL} \Omega^{AL}$$

Equations (9) through (11) indicate that population and employment changes are dependent on initial levels, change in population and employment interchangeably as well as a vector of factors affecting the change of population and employment in a county. The change in agricultural land is affected by the initial levels, the change in employment and population and by a vector of other exogenous variables. In the current paper, the focus is on equation (11). The equation is estimated using Ordinary Least Squares Estimator, since changes in population and employment variables are exogenous to the agricultural land equation (Hailu, 2002; Hailu and Rosenberger, 2004).

Data

Any attempt to reasonably capture the effect of the changes of exogenous variables on land use practices demands extensive data gathering and organization. We identify a number of categories of data for analytical purposes covering the study decade from 1990 to 1999/2002. The first category of data is related to population and employment statistics. The data are obtained from the REIS 1969-1999 CD time series database provided by the US Bureau of Economic Analysis (BEA). The second set of data focuses on agricultural land, agricultural production, and agricultural income statistics. The data capture the relative strength of the agricultural sector vis-à-vis other economic activities in the southeast to enable the estimation of agricultural land conversion equation. These data are draw from the US Agricultural Census (US-ACEN) from 1992 to 2002. Other factors looked at include agricultural sales and farm income. The main source of this information is the U.S. Agricultural Census (US-AgCen) and BEA files.

A third set of data on urban influence and accessibility information is measured using county closeness to metro areas and highway density. Accessibility and nearness to metropolitan areas impact on agricultural land use pressure among other things through new changes in employment and residential location decisions. Accessibility and nearness data is obtained from the Bureau of Transportation Statistics and Beale 1993 Urban-Influence Codes. Also included is data relating to housing values, home ownerships and taxes information. These variables help to identify the impact of housing demand and fiscal factors on agricultural land conversion process. Such data were extracted from the U.S. Census Bureau, County and City Database.

Results

The estimated results are reported in Table 1. Most of the signs of the coefficients are as expected, though the explanatory powers of the model (adjusted R^2) is weaker than we had expected. However, the estimated F-statistics is significant. Relevant results have been identified leading to the derivation of necessary implications. For example, while the coefficients for change in population and employment have negative signs, meaning, that growth in population and employment over time compromise the use and allocation of agricultural land in the region, the coefficients are small and statistically significant only for the change in employment. The implication is that although population growth is identified among factors that increase pressure on agricultural lands, its impact in the southeast region was negligible over the study period.

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Conservation of farm land is found to significantly deter the conversion of agricultural land to other uses. Specifically, land conservation is positive and highly significant. Promotion of forests is also a significant way of preserving agricultural land as shown by the positive and significant woodland variable. Woods generally take a long time to mature and harvest and are a good way of preserving land. On the other hand pastures require big portions of land which ensure more land is put under agricultural uses. However, the observed effect of pasture land, though positive, is not statistically different from zero, meaning that its impact in not bounding.

The coefficient for agricultural sales is statistically different from zero at the 1 percent level and has a positive sign, meaning, that agricultural sale strongly influence land allocation in the region, as increased farm revenue could encourage land owners to put more land in agricultural production over time. An increase in agricultural sales could also lead to improvement in farm income, thus increasing the ability of the agricultural sector to compete with non agricultural sectors for land allocation. Also, the results for variables measuring metro influence (metro dummy and urban influence) are statistically not different from zero at the 5 percent level or higher. Previous studies have shown that the rate of agricultural land loss is high in areas closer to metropolitan regions and vice versa. However, the results in this study are not strong to support this conclusion.

The coefficients for road density and median housing values have negative signs. The negative effect observed for these variables is not so surprising, especially for median housing values, since high housing values make agricultural land uses less viable to land owners as compared to housing option. However, both variables are not statistically significant, meaning that these variables are not critical in explaining agricultural land loss in the region. On the other hand, the proportion of owner occupied housing has a negative sign, meaning, that an increase in the proportion of owner-occupied housing would increase pressure on the conversation of agricultural lands to residential use. Similarly, the coefficient on per capita taxes has strong positive influence on agricultural land conversion.

Conclusions

The southeast region has a lower economic standard and economic growth as compared to the rest of the United States. Economic development objectives may in this case emphasize the encouragement of new developments in the hope of generating more employment and growth opportunities to the region. From a regional development perspective, the encouragement of development per se may not be objectionable. However, the proper management of growth and its implication to the established local and rural economic activities need to be properly evaluated and tallied with the marginal benefits of new development undertakings.

From the results, it can be noted that growth in population and employment over time has to be compromised with the agricultural sector on the use and allocation of land. Particularly, the effects of home ownership, per capita taxes, employment expansion on agricultural lands are established. Policies focusing or affecting such important areas need to take proper judgment as to the possible implications on the agricultural communities.

To efficiently manage regionally varying developments and agricultural lands, a proper land use policy should be introduced to address both development targets and agricultural land preservation. To overcome regional variability of land use structure, state level land use management practices may need to be introduced to flexibly address the growing patterns of land use problems in the region. The findings derived from this study, though preliminary, sheds some light to the ongoing issue of land conversion in the Southeast and could provide a stepping-stone for further studies and inquiries.

References

Chen, Donald, D.T. 2000. The Science of Smart Growth. *Scientific American* 283 (6):84-91

Chazan, D. A., and Cotter, A. A. 2001. Evaluating the Impacts of Proposed Land Conversion: A Tool for Local Decision-Making." Center for Sustainable Systems, University of Michigan. Report No. CSS01-02.

Dowling, T. J. 2000. Reflections on Urban Sprawl, Smart Growth, and the Fifth Amendment. *University of Pennsylvania Law Review* 148 (3):873

ERS/USDA. 2002. State Fact Sheet. http//www.ers.usda.gov/stateFacts/Al.html

Flickinger, R. 1994. Hawaii's sleeping volcano, *Planning*, December, pp. 7–11.

Gardner, B. D. 1977. The Economics of Agricultural Land Preservation. *American Journal of Agricultural Economics* 59:1027-1036.

Hailu, Y. G., and Rosenberger, R. S. 2004. Modeling Migration Effect on Agricultural Lands. *Agricultural and Resource Economics Review* 33, 1: 50-60.

Hailu, Y. G., 2002. Growth Equilibrium Modeling of Urban Sprawl on Agricultural Lands in West Virginia. Unpublished Thesis, Morgantown, WV. West Virginia University.

Heimlich, R. E., and Reining, R.C. 1989. The Economic Research Service in Urbanization Research. In: *Land Use Transition in Urbanizing Areas*. Ralph E. Heimlich (editor). Proceedings of a workshop sponsored by USDA/ERS and Farm Foundation, Washington, D.C.

Heimlich, R. E., and Anderson, W.D. 1987. Dynamics of Land Use Change in Urbanizing Areas: Experience in the Economic Research Service, USDA. In: *Sustaining Agriculture Near Cities.* W. Lockeretz (editor). Ankeny, IA: Soil and Water Conservation Society.

Jakle, J., and Wilson, D. 1992. *Derelict landscapes: The wasting of America's built environment*. Savage, MD: Rowman and Littlefield.

Koontz, T. M. 2001. Money Talks—But to Whom? Financial Versus Nonmonetary Motivations in Land Use Decisions. *Society and Natural Resources*, 14:51–65.

O'Meara Sheehan, M. 2001. *City Limits: Putting the Brakes on Sprawl*. Washington DC, Worldwatch Institute

Raad, T., and Kenworthy, J. 1998. The US and Us: Canadian Cities are Going the Way of their US Counterparts into Car-Dependent Sprawl. *Alternatives* 24 (1):14-22

Ready, R. C., Berger, M.C., and Blomquist, G.C. 1997. Measuring Amenity Benefits from Farmland: Hedonic Pricing vs. Contingent Valuation. *Growth and Change* 28(4):438-458.

Roakes, S. L. 1996. Reconsidering land value taxation: The golden key? *Land Use Policy* 13(4):261–272.

Rosenberger, R.S., Gebremedhin, T. G., and Hailu, Y. G. 2002. An Economic Analysis of Urbanization of Agricultural Land in West Virginia. West Virginia Regional Research Institute, Research Paper 2002-8

Rosenberger, R. S., and Loomis, J. B. 1999. The Value of Ranch Open Space to Tourists: Combining Contingent and Observed Behavior Data. *Growth and Change* 30(3):366-383.

Rosenberger, R. S., and Walsh, R.G. 1997. Nonmarket Value of Western Valley Ranch Land Using Contingent Valuation. *Journal of Agricultural and Resource Economics* 22, 2:296-309.

Smart Growth Network. 2002. *Planning for Smart Growth*: *2002 State of the States*. (http://c1.planning.org/growingsmart/pdf/states2002.pdf)

TTI .2001. *2001 Urban Mobility Study*. Texas Transportation Institute http://mobility.tamu.edu/ ums/. Accessed 7 February 2002

U.S. Department of Agriculture. 1998/*1998, Agricultural statistics*, Table IX-10. Washington, DC: National Agricultural Statistics Service. <http://www.usda.gov/nass/pubs/agr98/acro98.htm>

Vesterby, M., and Brooks, D. H. 1989. Land Use Change in Fast-Growing Areas, 1950-1980. In: *Land Use Transition in Urbanizing Areas.* (Research and Information Needs). Ralph E. Heimlich (editor). Proceedings of a workshop sponsored by USDA/ERS and Farm Foundation, Washington, D.C.

Vesterby, M., and Krupa, K. S. 1997. *Major Uses of Land in the United States, 1997.* Statistical Bulletin No. 973. Washington, DC: US Department of Agriculture, Economic Research Service.

Table 1: Empirical Results for Change in Agricultural Land Model, Southeast US

Variable	**Coefficients**	**Standard Error**
Δ Population	-0.1774	0.1402
Δ Employment	-0.2310*	0.1252
Agricultural land 1990	0.18012**	0.03288
Net migration	0.0201	`0.2101
Woodland	0.0001**	3.5046E-05
Pastureland	0.0303	1.880
Conservation	0.0077**	0.0029
Agricultural sales	0.0348**	0.01921
Metro dummy	-0.7717	2.6398
Urban/Metro influence	1.0874	1.0540
Road density	-0.0773	0.0951
Median Housing Values	-0.363	2.392
Proportion of owner occupied housing	-0.1223**	0.0148
Per capita taxes 1997	0.0049*	0.0032
Constant	-1.0224	3.0311
R^2	0.2621	
Sample Size	580	

*, ** Represents 5 and 1 percent significance levels, respectively and standard errors are reported in parenthesis.