ELSEVIER

Agricultural Economics 27 (2002) 197–200

AGRICULTURAL ECONOMICS

www.elsevier.com/locate/agecon

Introduction to the special issue on spatial analysis for agricultural economists

Gerald C. Nelson*

University of Illinois, Urbana-Champaign, 305 Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801, USA

Abstract

The goal of this special issue is to introduce agricultural economists to new analytical approaches involving spatial data. This paper provides a brief history of the special issue and an introduction to von Thünen's model of the determinants of land use and rent that underlies all spatial analysis.

Keywords: Spatial analysis

The goal of this special issue is to introduce agricultural economists to new analytical approaches involving spatial data (data that include the co-ordinates on the surface of the earth, sometimes referred to as georeferenced). The genesis of this issue was two learning workshops—at the International Association of Agricultural Economics Meetings, Berlin, August 2000 and the American Agricultural Economics Association Meetings, Chicago, August 2001. The format of the workshops was a morning session with overview papers and a series of afternoon hands-on sessions, where participants were able to experiment with software and data, working through a problem involving spatial data and techniques. The four papers following this introduction (Nelson and Geoghegan, 2002; Bell and Irwin, 2002; Bullock et al., 2002; Anselin, 2002) are based on the overview sessions. The remaining papers were selected from the submissions in response to a call for papers to complement the overviews.

The remainder of this article introduces the key concepts in spatial analysis—that location matters and that near things matter more than far things. For geographers, the importance of the related concepts of the centrality of location and the influence of neighbours parallels the centrality of constrained (by resource or budget) utility maximisation concepts for economists. Interestingly, the geographers' equivalent of Adam Smith, Johann Heinrich von Thünen,[1] used agricultural markets to illustrate the importance of location and the resulting transport costs to a central market in determining production (land use choices) at various locations and the resulting land

* Tel.: +1-217-333-6465; fax: +1-217-333-5538.
E-mail address: g-nelson@staff.uiuc.edu (G.C. Nelson).

[1] Johann Heinrich von Thünen was a "North German landowner from the Mecklenberg area. Although educated at Göttingen, he spent most of his life managing his rural estate, Tellow. In the first volume of his treatise, *The Isolated State* (1826), he laid down the first serious treatment of spatial economics, connecting with the theory of rent. His second volume (1850) developed the essence of the marginal productivity theory of distribution in a mathematically precise way .... Nearing his death, he asked that his famous equation for the marginal product of labour, or natural wage ($w = \sqrt{ap}$), be carved into his tombstone." From http://cepa.newschool.edu/het/profiles/thunen.htm, accessed on 14 August 2002.

0169-5150/02/$ – see front matter
PII: S0169-5150(02)00081-6

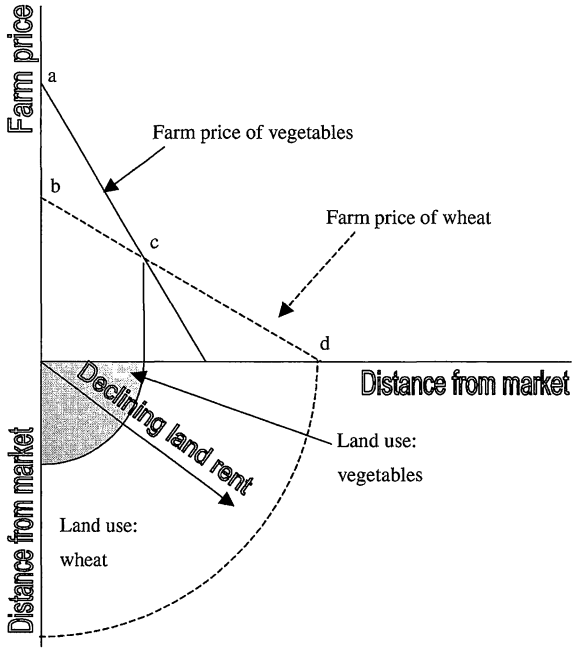

Fig. 1. The von Thünen model of farm price, land use and land rent.

rent.[2] The von Thünen concepts that underlie all spatial analysis are introduced next.

The basic von Thünen model is captured in Fig. 1. In a featureless plain, surrounding a central market, two crops can be grown—wheat and vegetables. All locations have identical production characteristics, including profit-maximising operators, but transport costs to the central market, with exogenously determined prices, differ by crop. The price of vegetables in the central market (a) is higher than the price of wheat (b) but vegetables are more expensive to transport. Hence, the farm vegetable price falls more quickly than the farm wheat price as distance from the market increases.[3] Beyond point 'c', the farm price of wheat is higher than vegetables. The result is a series of concentric rings of land use around the central market, indicated in the bottom part of the graph. In the shaded area, vegetables are grown; in the next ring wheat. Beyond 'd', neither crop is profitable and land is left in its natural state. Even though the productive characteristics of the farms are identical, the effect of transport cost is declining land rents with distance from the central market.

Once differences in land productivity, prices, transport costs and multiple markets are introduced, the analysis becomes more complex but the basic insights of the importance of location and transport cost in determining land use remain. Identifying and explaining those land uses quantitatively provides conceptual, data, and modelling challenges.

The four overview papers start from the basic insights of von Thünen. The first three papers provide reviews of the concepts, literature, data and examples of analysis in three topic areas—land use in developing countries, the rural–urban interface, and precision agriculture. The final overview paper introduces the econometric issues that arise when location information is available. The first overview paper (Nelson and Geoghegan, 2002) reviews the theory and practice of modelling land use in developing countries where official data sources seldom include georeferenced values. The use of remotely sensed data provides an especially important alternative. The motivating issue for the research in this area can be summarised in the phrase "do roads cause deforestation?" More generally, how does infrastructure development and policy changes that alter transport costs or prices at the central market alter the relative profitability of different land use choices? Does it become profitable to convert forested land to some other land use? Papers in this issue by Mertens et al. (2002), Müller and Zeller (2002), Munroe et al. (2002), Swinton (2002), and Vance and Geoghegan (2002) explore land use issues in several developing countries and with a variety of innovative techniques.

The second overview paper, by Bell and Irwin (2002), looks at the issues confronting planners, real estate developers and environmentalists at the changing rural–urban interface. As suburbs expand and single family home lot sizes grow, pressure follows to convert agricultural land to residential real estate or open space such as parks and forest preserves. These issues have received the most attention in developed countries where data sources are relatively more abundant and this paper emphasises analytical techniques in data-rich environments. It should be

[2] As is so often the case, Paul Samuelson has penetrating insights about the economic theory underlying von Thünen's work (Samuelson, 1983).

[3] Note that while output prices fall with distance from the central market, input prices increase. In this simple version of the von Thünen model, no purchased inputs are used.

noted, however, that the most rapid growth of urban areas is taking place in the developing world and the analytical techniques presented are applicable to those economies as well.

In all spatial analysis research, a key issue is the relevant unit of analysis. Should it be US counties, 1 km square grids from weather satellites, or 30 m cells from moderate resolution satellites or aerial photos? Ideally the scale should be closely associated with the area over which an individual decision-maker has control and information. Bullock et al. (2002) examine precision agriculture technologies and their relatively slow acceptance by farmers. This set of technologies (including yield monitors and precision input application) makes it possible to collect data on some important production attributes within a field. They demonstrate that complementary information can be essential to ensuring the profitability of a new technology. The paper by Florax et al. (2002) demonstrates that these concepts are relevant even for Sahelian farmers.

The final paper in the overview section (Anselin, 2002) introduces the reader to the additional complexities in econometric analysis that arise when spatial relationships exist. In a 'traditional' analysis involving spatial data (for example, estimating a production function based on input and output data) the location of the observations is assumed to be irrelevant. However, if there is some kind of spatial relationship, either among the dependent variables (a forest at one location causes neighbouring locations to have forests as well) or in the error structure (caused perhaps by similar soil types in neighbouring locations), parameter estimates can be inefficient and/or biased. Anselin reviews the conceptual issues that arise with spatial data and analysis, providing insights from the traditional spatial econometrics literature as well as from geostatistics, biostatistics and medical image analysis. Of particular importance to land use analysis is his discussion of latent variable estimation with spatial data. Since land use is the result of an unobservable decision process (choosing a land use that has the highest expected profit), qualitative choice estimation techniques are used. Anselin reviews the additional complications this causes and suggests techniques to correct for it.

The papers in this issue demonstrate the application of many different kinds of analytical techniques (logit, probit, hazard analysis, Bayesian analysis, combining remotely sensed and household survey data, simulation), to spatial economic problems in many areas of the world (The Amazon, Australia, Bangladesh, Honduras, Kenya, Mexico, Peru, The Sahel, Vietnam). The reader will find interesting new approaches to many important issues addressed in agricultural and regional economics.

Acknowledgements

I would like to acknowledge a great debt to all the reviewers for the papers considered for this special issue. I would also like to thank the organisers of the Berlin 2000 Meetings of the IAAE and the Chicago 2001 Meetings of the AAEA, and the editor of Agricultural Economics for making possible the development of these papers and the opportunity to make them available in a single publication. This material is based upon research supported in part by the Cooperative State Research, Education and Extension Service, U.S. Department of Agriculture, under Project No. ILLU 05-0361. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author, who is solely responsible for the analysis and conclusions presented here.

References

Anselin, L., 2002. Under the hood: issues in the specification and interpretation of spatial regression models. Agric. Econ. 27.

Bell, K., Irwin, E.G., 2002. Spatially explicit micro-level modeling of land-use change at the rural–urban interface. Agric. Econ. 27.

Bullock, D.S., Lowenberg-DeBoer, J., Swinton, S., 2002. Adding value to spatially managed inputs by understanding site-specific yield response. Agric. Econ. 27.

Florax, R., Voortman, R., Brouwer, J., 2002. Spatial dimensions of precision agriculture: a spatial econometric analysis of millet yield on Sahelian coversands. Agric. Econ. 27.

Mertens, B., Poccard-Chapuis, R., Piketty, M.G., Lacques, A.E., Venturieri, A., 2002. Crossing spatial analyses and livestock economics to understand deforestation processes in the Brazilian Amazon: the case of São Félix do Xingú in South Pará. Agric. Econ. 27.

Müller, D., Zeller, M., 2002. Land use dynamics in the central highlands of Vietnam: a spatial model combining village survey data with satellite imagery interpretation. Agric. Econ. 27.

Munroe, D.K., Southworth, J., Tucker, C.M., 2002. The dynamics of land-cover change in western Honduras: exploring spatial and temporal complexity. Agric. Econ. 27.

Nelson, G.C., Geoghegan, J., 2002. Modeling deforestation and land use change: sparse data environments. Agric. Econ. 27.

Samuelson, P.A., 1983. Thunen at two hundred. J. Econ. Lit. 21, 1468–1488.

Swinton, S., 2002. Capturing household-level spatial influence in agricultural management using random effects regression. Agric. Econ. 27.

Vance, C., Geoghegan, J., 2002. Temporal and spatial modeling of tropical deforestation: a survival analysis linking satellite and household survey data. Agric. Econ. 27.