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ANALYSIS

The geography of market failure: Edge-effect externalities and the location and production patterns of organic farming

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ABSTRACT

Perceptions of increasing land scarcity and negative impacts of chemical-based agriculture have led to increasing concern regarding the sustainability of food systems. Incompatible production processes among farming systems may lead to spatial conflicts and production losses between neighboring farms, and the magnitude of such losses may depend not only on the scale of each activity, but also on patterns of land use. Such conflicts can be classified as "edge-effect externalities"—spatial externalities whose marginal impacts decrease as distance from the border generating the negative impact increases. This paper tests the hypothesis that edge-effect externalities have influenced the location and production patterns of certified organic farms, using data from California Central Valley certified organic farmers. Using concepts from landscape ecology and spatial statistics, we investigate difference in parcel geometry and surrounding land uses between organic and non-organic parcels. Using a generalized method of moments (GMM) spatially autoregressive econometric model, we demonstrate that both parcel geometry and surrounding land uses influence the probability of a given parcel being certified organic. We conclude with suggestions for policies to encourage development of organic farming regions.

1. Introduction

Increasing rates of conversion of agricultural land in the United States have led to concerns regarding future scarcity of high-quality agricultural land (Vesterby and Krupa, 2001). In addition, there is concern regarding the potential environmental impacts of high chemical input agriculture. As an alternative technology, certified organic agriculture may play an important role in sustainable food production, as it potentially has fewer negative impacts on biodiversity, water quality, and other important ecosystems services. To ensure the sustainability of our food systems, we must develop policies to make most efficient use of increasingly scarce agricultural land, ensure that land markets function efficiently to achieve societal goals, and encourage development of more sustainable agricultural practices.

There are numerous examples of incompatibilities between different agricultural practices. In California, recent examples include conflicts between Northern Central Valley rice and cotton producers due to the use of pheonoxy herbicides, conflicts between cotton and olive producers related to the spread of verticillium wilt, the need for

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coordination between hybrid seed producers to prevent cross-pollination, and conflicts between certified organic and conventional agricultural producers (Parker, 2000). Conflicts also arise between agricultural producers and suburbanites at the urban–rural fringe over noise, dust, and pesticide use, potentially harming the viability of peri-urban agriculture (Wacker et al., 2001; Hammond, 2002). These incompatibilities may influence grower location decisions, crops grown, and production practices.

All of the above examples exhibit distance dependence, decreasing in severity as distance between parcels increases. Such conflicts can be classified as "edge-effect externalities"—spatial externalities whose marginal impacts decrease as distance from the border generating the negative impact increases. An externality is defined in this case as an action taken by one producer that affects others' production, where the negative production effects are not taken into account when the first producer makes his or her production decisions. In keeping with standard externality theory, when edge-effect externalities (EEEs) are present, more land than is socially optimal may be devoted to the externality-generating use in an unregulated market. In addition, the arrangement of production sites may impact the economic efficiency of land use. Specifically, landscape productivity will decrease non-linearly with landscape fragmentation, in parallel with results related to ecological edge effects (Kapos et al., 1997; Parker and Meretsky, 2004). This result implies that free market land use patterns may not be socially efficient, and that policy interventions designed to encourage development of efficient land use patterns may be needed. In practical terms, such interventions may be needed only if these spatial externalities constitute an economically significant cost for affected growers. Thus, a policy response is justified only if these conflicts can be shown to have a substantive influence on the locations and patterns of production of affected agricultural producers.

Of the many examples mentioned, potential conflicts between organic and conventional agricultural producers may have the broadest policy implications. Both demand for organic products and their domestic production, particularly in California, have been steadily increasing in recent years (Dimitri and Greene, 2002; Greene and Kremen, 2003). In addition, since adoption of the new national organic standards, all producers using the term "organic" are required to have their production practices certified by an external certification agency. Previously uncertified land must undergo a three-year transition period during which organic production practices are used, before its agricultural products can be labeled as organic. Thus, organic certification represents a significant investment in a given piece of land (Greene and Kremen, 2003; United States Department of Agriculture, 2005).

There are many reasons to expect spatial patterns in the location of organic farms. Certification requires that an organic grower's production site be free from potential contamination by prohibited materials. One of the most probable sources of contamination can be spatial spillovers from surrounding land uses, including drift of prohibited chemicals or possible cross-pollination with genetically modified crops (Hanson et al., 2004). Therefore, in cases where an inspector determines that contamination is possible from a neighboring use, the organic producer is required to leave a 25 ft. buffer zone between the edge of his certified production site and the neighboring land use. Thus, a certified organic grower's average cost of production increases when borders are shared with an incompatible land use, since the grower losses potentially productive land to buffer zones. Organic growers may also incur production losses when located next to conventional production sites due to incompatible production practices. (Conventional producers may also incur such losses when located next to organic farms, for different reasons.) Growers may have difficulties maintaining populations of beneficial insects at borders with conventional farms (Capay Valley Organic Growers, 1996; Hanson et al., 2004) and managing pest migrations from surrounding conventional farms (Hanson et al., 2004). Thus, they are potentially impacted by edge-effect externalities that would increase their costs of production even absent a buffer zone requirement.

Organic growers may benefit from being close to other organic growers for reasons aside from EEEs (Hanson et al., 2004). Neighboring organic farmers may share information, expertise, equipment, political lobbying power, and processing infrastructure, and therefore having organic neighbors may increase a grower's chances of succeeding at organic farming. Neighboring farms may also cooperate with respect to marketing, such as through a CSA (community supported agriculture) (Hanson et al., 2004). With many local organic neighbors, conventional neighbors may be more familiar with the requirements for organic farming, and as a result, fewer conflicts may occur. Conventional growers with successful organic neighbors may decide to emulate their success and therefore might be more likely to transition to organic production (Deffuant et al., 2003).

Both factors — negative edge-effect externalities and positive external scale economies between growers — imply that organic farms will be clustered in space. Negative EEEs lead to a specific set of hypotheses regarding local-scale clustering, surrounding land uses, and parcel geometry. This paper focuses on testing these hypotheses empirically, with a goal of determining whether negative edge-effect externalities have an effect on locations and production patterns of organic farms. Positive external scale economies based on proximity may also lead to spatial clustering, but potentially at a coarser spatial scales. These effects do not have the same implications for surrounding land uses and parcel geometry as EEEs. However, empirical evidence supporting both EEEs and external scale economies would lend support to policies designed to encourage spatial concentration of organic agriculture. (Separate work by the authors focuses on coarser-scale clustering (Parker and Munroe, 2004b,a).)

The paper proceeds as follow. Strategies to measure the effects of EEEs and the potential implications of the results are discussed in Section 1.1, and relevant literature is briefly reviewed in Section 1.2. In Section 2, using a sample of certified organic and comparable non-certified organic agricultural parcels in 1997 from Yolo county, CA., landscape statistics reflecting parcel area, shape, and contiguity are first examined to test for spatial patterns consistent with EEEs. These tests motivate the estimation of three econometric models that specify the probability of observing certified organic vs. non-certified organic agricultural parcels as a function of neighboring land uses and parcel geometry