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LAND USE PLANNING AS INFORMATION PRODUCTION AND EXCHANGE: AN EMPIRICAL ANALYSIS OF THE UNCERTAINTY REDUCTION EFFECT

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ABSTRACT: Land use planning practices have been economically justified as an efficient means of producing and distributing valuable information relevant to property markets and further reducing the intrinsic uncertainties and transaction costs involved in land development processes. However, although this method of justification, in addition to traditional welfare-economics-based rationales, has been adopted to support government interventions in land use, not much empirical evidence for the claim has been reported. In order to fill this gap, this study attempts to empirically validate the claim by focusing on a particular case, namely urban fringe land markets where farmland owners make decisions under uncertainties regarding the timing of potential land development for urban uses. First, through the exploration of land use data in Oregon, distinct farmland use patterns are found, consistent with the expectation that land use planning for the fringe areas reduces the uncertainties and therefore helps farmland owners make informed decisions. Furthermore, through cross-sectional regression analysis using 82 single-county MSAs' data, a positive effect of the presence of land use planning efforts on agricultural investment levels is detected; this may indicate planning's real contribution to uncertainty reduction. The effect is found to be statistically significant in MSAs with relatively larger shares of livestock and fruit production (as opposed to crops), which generally require a greater amount of sunk costs and a longer period of operation to result in profits.

KEY WORDS: Land Use Planning; Uncertainty; Transaction Cost; Land Market

1. INTRODUCTION

Government interventions in land use planning have been traditionally justified from an economic perspective as well as by political theories and environmental rationales. In particular, welfare economic theory, combined with the demonstration of some market failures has been mainly used for the justification. As explained by Kim (2009), for example, Bailey (1959) noted that the welfare level of land owners can be raised by appropriate land use controls that eliminate existing and/or potential negative externalities. He argued that this welfare increase is a major benefit of government interventions in land use. Davis (1963) also considered the ideal zoning restriction as a state "under which external diseconomies are simply eliminated" (p.383), so that land use becomes more economically efficient. In addition to these early studies, many others have justified government actions in the form of land use planning and regulation, in a similar way – i.e., using welfare economics per se. The studies include Gardner (1977) and Moore (1978)'s work that focus on the issue of public goods problems under a free market system as well as Lee's (1981) article, *Land Use Planning as a Response to Market Failure*. Furthermore, the welfare-economics-based claims have been supported by many empirical studies that demonstrate the virtual existence of negative externalities in the context of uncontrolled land use (see e.g., Stull 1975; Lafferty & Frech 1978: Burnell 1985) or show the benefits of environmental amenities, preserved by the regulations (see e.g., Correll *et al.* 1978; Spalatro & Provencher 2001).

However, there are some critical shortcomings of the justification on the basis of welfare economic theory and the existence of typical market failures. First, because it is a static framework, the welfare economics approach has limited usefulness in dealing with land use and development issues, which are dynamic and irreversible in nature (see e.g., Ohls & Pines 1975; Arnott & Lewis 1979; Capozza & Helsley 1990). In addition, based on the government vs. market dichotomy, this approach only considers the possible benefits of land use regulations, which are just an end-product from a series of land use planning practices, in addressing market failures and, consequently, achieving a higher level of the efficiency in land allocation among various uses.[1] It neglects the other potential benefits of the entire land use planning processes, particularly the aspect of information production and exchange. Land use planning practices produce information relevant to land use, facilitate the exchange of information, and improve the efficiency of land markets (Friend & Jessop 1969; Schaeffer & Hopkins 1987; Knaap *et al.* 1998). In other words, land use planning practices could bring some economic benefits, even if the final decision – that may or may not be a regulatory action – does not achieve a higher level of the efficiency in allocation.

The importance of this contribution of land use planning (i.e., information production and exchange) has been emphasized by studies that draw on transaction-cost economic (TCE) theory. For instance, Alexander (1992, 1994, and 2001) claimed that land markets generally bear substantial uncertainties and unnecessary transaction costs, thus requiring government interventions which can reduce those costs by providing valuable information more efficiently. Dawkins (2000) also highlighted this point by arguing that land use planning practices or regulatory interventions can effectively lower uncertainties and transaction costs, and thus help the decision-making of various actors involved in the processes of land development.

Notwithstanding these important theoretical discussions, empirical studies that validate the theoretical suppositions are scarce, so that little is known about the real-world effect of land use planning on uncertainties and transaction costs.[2] The present study attempts to fill this gap. Here, an examination is made to see whether or not land use planning actually contributes to reducing the level of uncertainties in land markets as suggested by the TCE-based studies. Rather than considering various kinds of uncertainties in multi-stage land development and land use processes, the focus will be on a particular case, namely the urban fringe land markets where farmland owners are faced with uncertainties regarding the timing

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[1] Land use planning should be thought of as a series of plan making processes, different from land use regulation. Hopkins (2001) explains this point by noting that "Regulations [are] … enforceable assignment and reassignment of rights. Regulations affect the scope of permissible actions. Plans … provide information about interdependent decisions in relation to expected outcomes but these plans do not determine directly the scope of permissible actions" (p.9-10).

[2] There are a few empirical studies which examine whether plans or information contained in the plans, as opposed to the regulatory actions, have effects on decision-making of economic agents (see e.g., Talen 1996a and 1996b; Knaap *et al.* 2001). But they do not test the validity of the TCE-based justification of land use planning.

of potential land development for urban uses. Based on an understanding of the strategic behavior of farmland owners under uncertainties, the validity of the TCE-based justification is tested by conducting an exploratory spatial data analysis, followed by a MSA-level statistical analysis.

The remainder of this paper is structured as follows. Section 2 briefly discusses the choice problems and decision making of farmland owners and the potential economic contribution of land use planning, particularly the urban growth boundary (UGB). In section 3, the farmland use pattern in Oregon is explored as an example to see how farmland owners may exploit or respond to the information, produced and exchanged through land use planning processes. Section 4 presents a regression analysis designed to measure the effect of the land use planning practices (i.e., UGB or similar land use planning efforts) on uncertainty reduction, by using the data of 82 single-county MSAs across states. A concluding section, where the findings are summarized and discussed, completes the paper.

2. BEHAVIORS OF FARMLAND OWNERS & UGB ESTABLISHMENT

Farmland conversion to developed land is a general trend across the states. According to the 1997 National Resources Inventory prepared by USDA Natural Resources Conservation Service (NRCS), approximately 15 million acres of cropland, pastureland, and rangeland had been developed for urban uses between 1982 and 1997 (table 1). In particular, the farmland areas at the urban fringe have been the main target of the new development.

Table 1. Land Use Change between 1982 and 1997 in the United States (Unit: 1000 acres)

Land cover/use in 1982	**Land cover/use in 1997**								**1982 total**
	Cropland	CRP land	Pasture-land	Range-land	Forest land	Other rural land	Developed land	Water areas & federal land	
Cropland	350,265	30,412	19,269	3,659	5,607	3,159	7,098	1,485	420,954
Pasture-land	15,347	1,330	92,088	2,568	14,091	1,619	4,230	733	132,006
Rangeland	6,968	729	3,037	394,617	3,022	1,703	3,281	3,383	416,739
Forest land	2,037	129	4,168	2,099	380,343	1,755	10,279	2,528	403,338
Other rural land	1,387	93	1,014	719	2,768	42,713	727	228	49,648
Developed Land	197	1	79	111	227	12	72,619	1	73,246
Water areas & federal land	798	3	337	2,204	898	181	18	443,761	448,198
1997 total	376,998	32,696	119,992	405,977	406,955	51,142	98,252	452,118	1,944, 130

Source: Table 5, 1997 National Resources Inventory, USDA NRCS

Under this situation with a high pressure or probability of conversion, the farmland owners at the urban fringe are facing two types of important decision-making every year. The first decision to be made is a discrete choice on whether to subdivide their lots and convert them for urban uses right now or keep using the land for agricultural production at least for the current year.[3] The farmland owners, who seek to maximize their profits, may develop their land, if and only if they conclude that the conversion at this time brings a greater value in terms of the future stream of returns than all other alternatives (i.e., no conversion or conversion at all other time points), considering the profitability of continuing agricultural production activities and the expected returns of the development in future.[4]

The second decision-making option comes when the farmland owners do not convert their land at this time. If this is the case, a set of decisions need to be made on how to use the land without development, until the time comes for them to opt for development. In other words, the farmland owners need to decide the items of production, the number of workers to be hired, and the level of capital investment in order to maximize the profits while using their land for the agricultural production.[5]

These decisions, particularly production item choice and capital investment, are highly affected by the farmland owners' prediction of the timing of land development in the future. Because cultivating certain items requires a longer period of operation or a larger amount of sunk costs to make an acceptable amount of profit, they are reluctant to choose those items if there is an enhanced probability of development of his/her parcels within the next few years. Also, since capital investment is generally irreversible, they are less likely to put capital in agricultural production if they think the invested capital may not be fully utilized in terms of the return on investment. In this case, they may give up the improvement of irrigation or other supporting system, and may use existing machinery and equipment rather than buying new ones, even if new investment is required for the optimal agricultural production from a long-term perspective.

These influences of development timing have been investigated by some studies on agricultural production, although consideration has not been given to the role of land use planning. For example, Lopez *et al.* (1988) conducted a longitudinal analysis to examine how agricultural production in New Jersey is affected by the degree of suburbanization, measured by population in nonurban counties, and found that fruit and livestock production is discouraged by suburbanization. Their analysis outcomes also suggest that agricultural production tends to become more labor intensive (i.e., declining capital and land inputs), as the region is more suburbanized.

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[3] This (first) decision-making process has been discussed more intensively by many studies on land use changes, such as Bockstael (1996), Irwin & Geoghegan (2001), and Segerson *et al.* (2006).

[4] The assumption of farmland owners' profit maximization does not mean the homogeneity of the owners. There is a significant amount of variance by individuals in this decision making, as reported by Barnard & Butcher (1989) and many others.

[5] It is possible not to use the land for any purposes. However, since there is a considerable amount of financial advantages os using land for agricultural activities in the U.S., the owners may tend to use or pretend to use the land for agricultural production.

The Farm & Ranch Irrigation Survey, conducted by the USDA National Agricultural Statistics Service (NASS), also provides some evidence of this behavioral pattern. As a part of the survey, the farmers were asked about the "barriers to making improvements to reduce energy use or conserve water". According to the survey, 5~8 percent of respondents in the entire U.S. answered "will not be farming this operation long enough to justify improvements" in response to the question, "why not invest in improvements?" (table 2).

Table 2. Farm & Ranch Irrigation Survey Outcomes: Barriers to the System Improvements

	2008 Survey		2003 Survey	
	Farms	%	Farms	%
1."Investigating improvements not a priority"	46,825	21.7%	9,055	8.0%
2. "Risk of reduced yield or poor crop quality"	18,578	8.6%	9,818	8.7%
3. "Physical field/crop condition limit system improvements"	20,888	9.7%	8,951	7.9%
4. "Improvements will not reduce costs enough to cover installation costs"	33,725	15.7%	21,304	18.8%
5. "Cannot finance improvements"	37,512	17.4%	20,122	17.7%
6. "Landlord will not share in cost"	6,815	3.2%	8,194	7.2%
7. "Uncertainty about future availability of water"	19,536	9.1%	13,790	12.2%
8. "Will not be farming this operation long enough to justify improvements"	17,280	8.0%	6,204	5.5%
9. "Other"	14,272	6.6%	15,995	14.1%
Total	215,431	100.0%	113,433	100.0%

Source: Table 41, 2008 Farm & Ranch Irrigation Survey Report
Note: Respondents are allowed to choose more than one barrier to improvement. Here, "Total" is the number of all responses, as opposed to the number of respondents.

In the real world, the farmland owners' prediction of development timing and the following decisions are made with uncertainties. Under a higher level of the uncertainties, the owners cannot predict the exact timing of land development and attach low values of confidence in their predictions. This may raise the risk of over-investment and alter the item choices and capital investment decision-making for the agricultural production (i.e., the farmland owners are less likely to grow the items with a greater amount of sunk costs and are less likely to increase or continue irreversible investment).

According to the TCE-based justification of planning, these kinds of uncertainties can be reduced with relevant information, produced and exchanged through effective land use planning practices. Particularly, the uncertainties in the urban fringe land markets could be lowered by an UGB, a widely used land use planning practice related to such fringe areas.[6] Although the practice qualitatively and administratively differs across regions (see e.g., Gale 1992; Innes 1992), in order to develop an UGB, local and regional government bodies typically 1) conduct population projections, 2) determine the future demand of new development, 3) investigate suitable or desirable locations for new development, and then 4)

[6] In the United States, an UGB was first adopted by Lexington, Kentucky in 1958 (Nelson & Duncan 1995). As of 1998, more than a hundred regions establish UGBs (Staley *et al.* 1999). Furthermore, Oregon, Washington, and Tennessee enacted state-level legislation that mandates local and regional government to do this work and to incorporate the UGBs into their comprehensive plans.

draw the boundary, as a proposal (Anderson 1999). In addition, like many other planning processes, the proposed boundary is publicized and reviewed by various actors at public hearings or some other forms of public engagement where the ideas and information related to future development are exchanged. In the end, an UGB, as a final product that reveals the expected expansion of developed areas for upcoming 20 years or some other periods of time, is established.

From the perspective of farming, the UGB is not a regulation binding item choice, investment, or detailed operation. Rather, the boundary is valuable information that helps individual farmland owners obtain a better sense about the probable timing for development of their land, as characterized by Knaap (1985). In addition to the UGB itself, population projection, new development demand estimation, site investigation, and opinions of other actors at the place of collaborative planning may also inform the farmland owners.

3. SPATIAL DATA ANALYSIS

Do uncertainties exist in urban fringe land markets? Do UGBs or other similar land use planning practices really inform farmland owners in the sense of reducing uncertainties and thus transactions costs? In this section, a data analysis will be conducted using the case of Oregon, in order to explore 1) whether or not there are any notable relationships between farmland use patterns and the UGBs and 2) whether the demonstrable relationships suggest a real contribution of the UGBs to uncertainty reduction.

Given that disaggregated-level investment data or other metrics for the uncertainty level are not available, it would be meaningful to analyze the farmland use pattern (i.e., what items are grown at certain location points) with some knowledge about the characteristics of various items, such as the minimum period of operation for the profit and the required level of sunk costs for production. Although farmland use is determined by many other factors, such as physical characteristics, the farmer's capabilities and preferences, and so on, certain types of agricultural production, with greater time and sunk cost requirements, may be less likely to appear where land development is expected to happen soon.

3.1. Method & Data

The main task of this spatial analysis is to explore how the farmland use patterns vary across space. To do this, above all, the urban fringe areas of interest are divided according to the distance to the cities. This is accomplished by using the boundaries of the Census's Urbanized Area and Urban Cluster, which well represent the borders of the densely developed territories, rather than using the administrative city limits. In other words, the fringe areas are first classified into six categories: 1) between the border and 0.5 mile buffer, 2) 0.5~1.0 mile area, 3) 1.0~1.5 mile area, 4) 1.5~2.0 mile area, 5) 2.0~2.5 mile area, and 6) 2.5~3.0 mile area. Although this way of space division is useful for capturing the relationship between the farmland use pattern and the proximity to the cities that had been well discussed in the land use analysis of von Thunen (1826), the buffer width (i.e., 0.5 mile) may be too large to consider the uncertainties and thus the impact of the UGB. Therefore, the first category (i.e. between the border and 0.5 mile buffer) is sub-divided to 0.1 mile buffer zones: i.e. 1-a) between the borders and 0.1 mile buffers, 1-b) 0.1~0.2 mile area, 1-c) 0.2~0.3 mile area, 1-d) 0.3~0.4mile area, and 1-e) 0.4~0.5 mile area (figure 1). Then, the zones are further classified by overlaying the UGBs. As a result, the areas Within vs. Outside of the UGBs are differentiated, even though the areas have the same distance to the cities. Finally, by using the Tabulate Area function in ArcGIS as well as high-resolution land use data, the farmland use patterns in each type of zones are measured in terms of the land use mix.

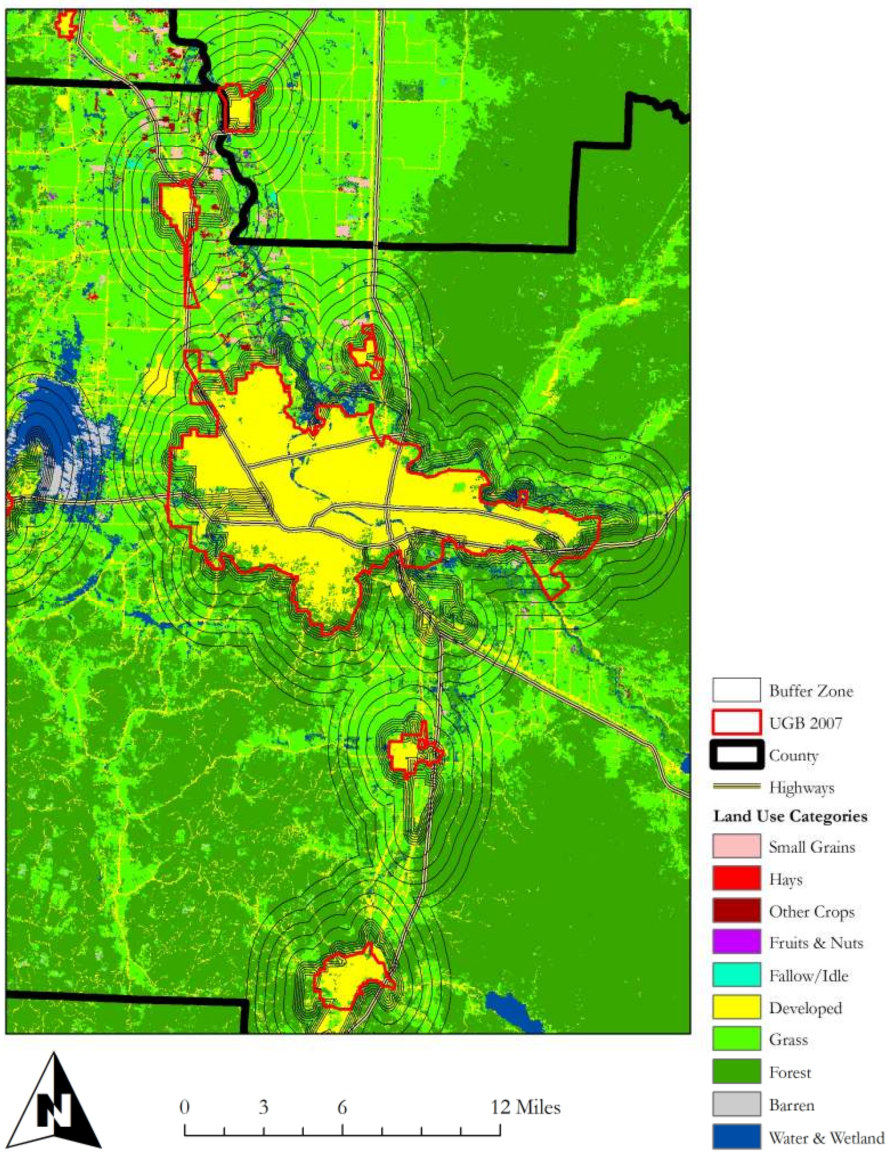

Figure 1. Space Division and Land Uses: The Case of Eugene-Springfield MSA (Lane County, OR)

This method of analysis is applied to the state of Oregon where the UGBs have long been implemented. The availability of GIS data for the analysis is another reason of the choice. The Oregon Geospatial Enterprise Office provides the UGB shapefiles for recent years; 2007 version is used for this analysis. For the land use information, the 2007 Cropland Data Layer (CDL) for Oregon made by USDA NASS is employed. Because the original CDL adopts a very detailed land use type classification, the land uses are aggregated into ten categories for the analysis, as presented in figure 1. For the boundaries of Census's Urbanized Area and Urban Cluster, the Census TIGER (Topologically Integrated Geographic Encoding and Referencing) data are employed.

3.2. Analysis Outcomes

Table 3 shows how the land use mixes differ across 0.5-mile buffer zones from the urbanized area borders in Oregon. Also, the varying farmland patterns are graphically demonstrated in figure 2, where each item's share of the sum of all croplands is plotted over the distance to the cities.

Table 3. Land Use Patterns by 0.5-Mile Buffer Zones in Oregon

	Borders ~0.5mile	0.5~1.0 mile	1.0~1.5 mile	1.5~2.0 mile	2.0~2.5 mile	2.5~3.0 mile
Percentage to total						
Small grains, including corn, rice, barley, wheat, etc	1.7%	2.4%	2.6%	2.7%	2.7%	2.8%
Hays, including rye, oats, canola, etc	1.2%	1.5%	1.7%	1.7%	1.8%	1.6%
Other crops, including potatoes, onions, peas, etc	1.6%	2.0%	1.7%	1.7%	1.9%	1.6%
Tree fruits and tree nuts	0.6%	0.6%	0.7%	0.6%	0.5%	0.5%
Fallow/Idle cropland	0.4%	0.5%	0.6%	0.8%	0.7%	0.8%
Developed	21.0%	12.2%	10.2%	9.1%	8.4%	7.4%
Grassland, including seed/sod grass, herbs, clover/wildflowers, etc	28.2%	30.2%	29.8%	28.7%	28.1%	27.2%
Forest, woodland, and shrubland	32.4%	40.4%	43.3%	46.7%	49.2%	51.8%
Barren	0.9%	0.9%	0.9%	0.8%	0.7%	0.8%
Water and wetlands	12.0%	9.2%	8.4%	7.2%	6.1%	5.6%
Percentage to the sum of croplands						
Small grains, including corn, rice, barley, wheat, etc	30.8%	34.0%	35.3%	36.0%	35.7%	38.2%
Hays, including rye, oats, canola, etc	21.7%	21.5%	23.7%	22.8%	23.4%	21.5%
Other crops, including potatoes, onions, peas, etc	30.0%	27.9%	23.6%	23.0%	24.6%	22.3%
Tree fruits and tree nuts	10.9%	8.9%	9.2%	8.2%	6.3%	6.2%
Fallow/Idle cropland	6.6%	7.7%	8.1%	10.0%	10.0%	11.7%

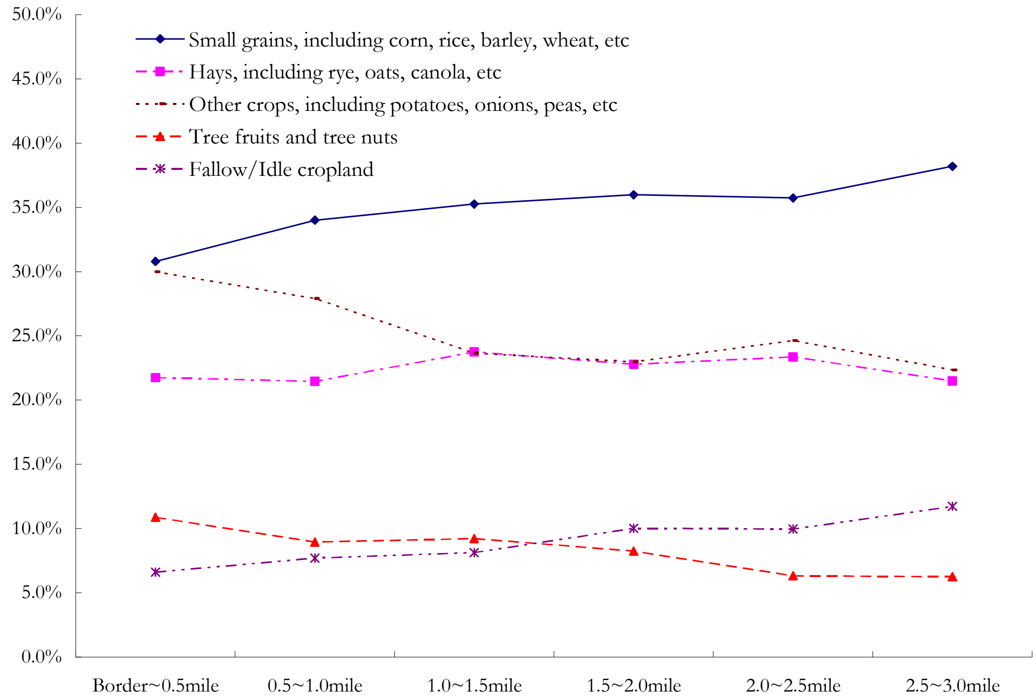

Figure 2. Farmland Use Patterns in Oregon's Urban Fringe Areas

The general trends of farmland use across space are well revealed here. Small grains, such as corn, rice, and wheat, are more likely to be grown, as the distance to the cities goes up. In contrast, consistent with our intuition based upon the lessons from von Thunen, tree fruits and nuts as well as potatoes, onions, peas, and so on, bearing larger per distance transportation costs, tend to be grown more in the areas with higher accessibility to the cities. The pattern of Fallow/Idle Cropland (i.e., declining share over distance) is interesting. One possible explanation could be traced to the farmland owner's strategic behavior, that is they are less likely to improve the soil quality by letting their land lie fallow near city edges, because they feel that the land will be developed soon, so that agricultural production will not continue long enough.[7]

The farmland land use patterns within the 0.5 mile buffer, where a higher level of uncertainties may exist, are investigated in detail by using the 0.1 mile buffer zones and UGBs. Table 4 presents the patterns over distance with respect to UGBs in terms of percentage to the total cropland area.

[7] Alternatively, this may happen, because this type of land use (i.e. Fallow / Idle Cropland) is highly associated with small grains, showing the same declining pattern over distance, rather than other items.

Table 4. Land Use Patterns within 0.5-Mile Buffer in Oregon

	Borders ~0.1mile	0.1~0.2 mile	0.2~0.3 mile	0.3~0.4 mile	0.4~0.5 mile
Percentage to the sum of croplands (Within UGBs)					
Small grains, including corn, rice, barley, wheat, etc	23.8%	27.8%	36.4%	37.9%	43.7%
Hays, including rye, oats, canola, etc	20.6%	17.7%	16.1%	14.4%	11.7%
Other crops, including potatoes, onions, peas, etc	37.5%	35.0%	32.1%	31.9%	29.5%
Tree fruits and tree nuts	9.1%	9.9%	7.6%	7.3%	6.1%
Fallow/Idle cropland	9.1%	9.5%	7.9%	8.5%	9.0%
Percentage to the sum of croplands (Out of UGBs)					
Small grains, including corn, rice, barley, wheat, etc	28.3%	28.8%	30.1%	30.7%	32.9%
Hays, including rye, oats, canola, etc	19.8%	22.3%	23.7%	23.3%	22.4%
Other crops, including potatoes, onions, peas, etc	30.9%	30.3%	30.0%	29.6%	27.3%
Tree fruits and tree nuts	14.3%	12.3%	10.6%	10.5%	10.5%
Fallow/Idle cropland	6.8%	6.2%	5.7%	5.9%	6.8%

Above all, attention needs to be paid to the pattern of tree fruits and tree nuts. As found in the previous analysis, generally this item is more likely to occupy the areas close to the cities. However, since it bears a larger amount of sunk costs, thereby profitable when the operation continues for a certain period of time, the item may be less likely to appear where development is expected to occur in few years or development timing is very uncertain. If the UGBs really inform the farmland owners and support their decision-making as argued by the TCE-based justification of land use planning practices, we will find the distinct difference in this land use type between Within-UGBs zones and Out-of-UGBs zones, although the difference does not necessarily mean the TCE-based argument is valid.[8]

The outcomes of the detailed investigation suggest this is the case. It is apparent that tree fruits and tree nuts is much important in the farmlands outside of the UGBs (table 4 and figure 3). One could interpret this finding as one that can be traced to the uncertainty

[8] It needs to be noted that the item choice in reality is path-dependent, thus more complicated than the description here. Suppose a farmland owner who has grown tree fruits in his land a long time before the emergence of development pressure. Because the trees and other structures for the operation are sunk costs, he may continue to cultivate the fruits rather than changing the item with a certain (probably low) level of investment in maintenance, even if his land will be developed soon. This results in the production of the tree fruits even in the farms with high development probability or uncertainties. However, new fruit production may be less likely to locate in these farms. It may tend to go to the sites where the need for accessibility and the required operation period for profits are satisfied. If an UGB functions as anticipated, it provides valuable information for this site selection. As a result, the fruit items will be more likely to appear outside of the UGB, *ceteris paribus*.

reduction effect of UGB establishment: i.e., setting UGBs makes it more probable that large acres of farmland outside of the UGBs are not going to be developed soon even though they are close to city edges, so that the farmland owners do not need to give up the option of tree fruits and tree nuts. This results in a more efficient use of land.

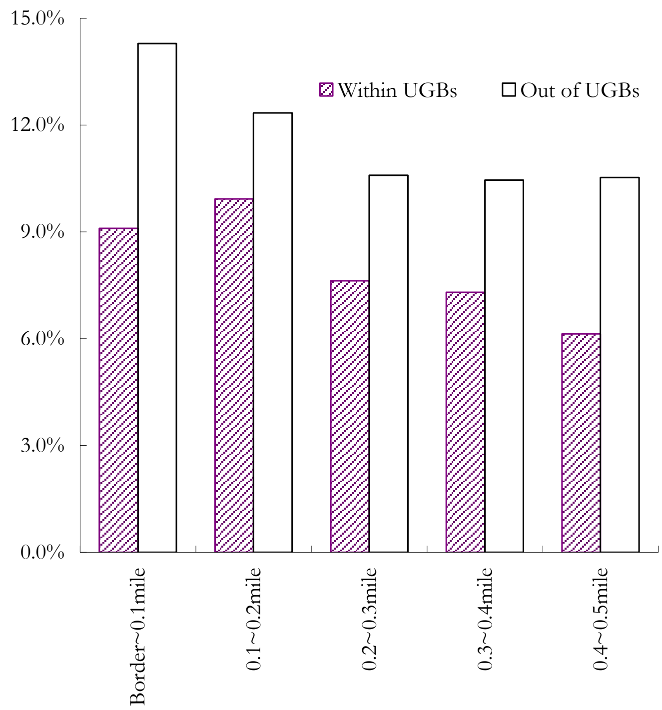

Figure 3. The Land Use Share of Tree Fruits and Tree Nuts in Oregon

The case of Fallow/Idle cropland also needs to be noted. According to the analysis outcomes, this type of land use tends to appear within UGBs more (figure 4). More specifically, the share of Fallow/Idle cropland within UGBs exceeds its value at 1.5 miles from the cities. At first glance, this seems counter-intuitive. Why do the farmland owners tend to let their farmlands lie fallow, even though the areas are included in UGBs that indicates development in near future? This cannot be explained if the soil quality improvements were the only motivation of this type of land use. To elucidate this, consideration may need to be given to the possibility of farmland owners not growing anything in their farmlands while waiting development, so that the land use is recognized as Fallow/Idle cropland. If this is the case, it can be argued that a larger part of the urban fringe lands (i.e., the areas outside of the UGBs) is more intensively used as a direct consequence of the UGB that informs the farmland owners that their properties are not going to be developed soon.

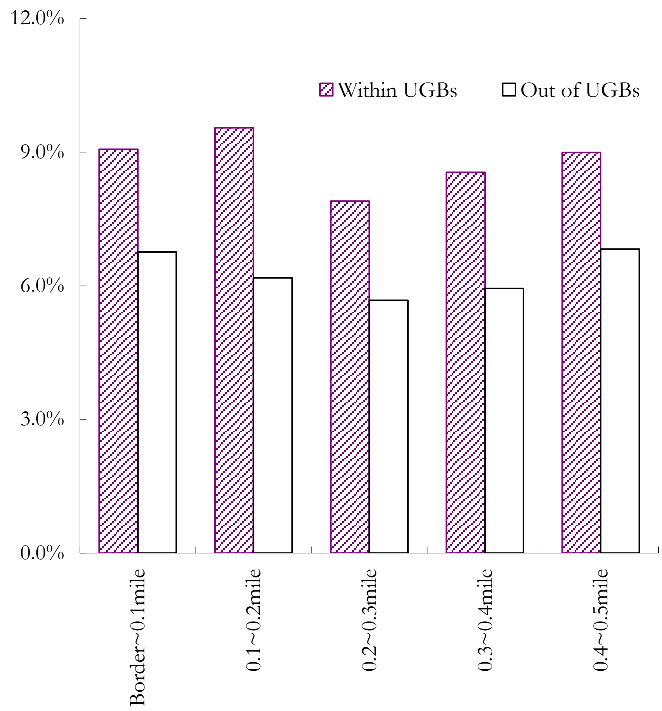

Figure 4. The Land Use Share of Fallow / Idle Cropland in Oregon

4. REGRESSION ANALYSIS

The previous section explored the UGB's effect in the urban fringe land markets by using high-resolution land use data. In this section, a regression analysis will be conducted to derive a more generalized conclusion on the validity of TCE-based justification, with single-county MSAs as units of analysis. The idea, explained in section 2, is that the farmland owners may tend to increase the value of investments if the level of the uncertainties associated with the timing of development of their farmlands is reduced, as they would then be faced with a lower risk metric with respect to wasting irreversible investments. In other words, the value of investments may to some extent represents the uncertainty level. If the UGB really reduces the uncertainties consistent with TCE-based arguments, then there should be a positive effect of UGBs on agricultural investment when other factors are properly controlled for.

4.1. Model

For the simplicity, suppose that the agricultural production exhibits constant returns to scale with a Cobb-Douglas form.

$$X = \phi \cdot S^{\alpha} \cdot K^{\beta} \cdot L^{\gamma} \qquad (1)$$

$$\alpha + \beta + \gamma = 1$$

where X is the output of agricultural production, S is land input, K is capital investment, and L is labor force employed for the production. Coefficient ϕ is the technology parameter, which represents the efficiency level in production. α, β, and γ are cost share parameters for land, capital, and labor force, respectively.

In this setting, the optimal levels of land and capital input, that minimizes the production cost for a certain amount of production, are

$$S^* = \frac{\alpha \cdot p \cdot X}{p_S} \qquad (2)$$

$$K^* = \frac{\beta \cdot p \cdot X}{p_K} \qquad (3)$$

where p, p_S, and p_K indicate the prices of final farm product, land, and capital, respectively.

From the equation (2) and (3), the optimal level of per acre capital investment can be derived, as below.

$$\left(\frac{K}{S}\right)^* = \frac{K^*}{S^*} = \frac{\beta \cdot p \cdot X \big/ p_K}{\alpha \cdot p \cdot X \big/ p_S} = \frac{\beta \cdot p_S}{\alpha \cdot p_K} \qquad (4)$$

Then, by taking log on both sides of the equation (4), a log linear formula, which is a basis of the model development, can be obtained.

$$\log\left(K/S\right)^* = \log(p_S) - \log(p_K) - \log(\alpha) + \log(\beta) \qquad (5)$$

The equation (5) implies that per acre capital investment is a function of land price (p_S), capital price (p_K), and the two cost share parameters (α and β), in the assumed situation of agricultural production. Among the four determinants in this equation, land price is the most important factor to explain the level of per acre capital investment in an empirical analysis using cross sectional data like this study, since it varies significantly across regions. The two cost share parameters, representing the character of agricultural production in each region, are also influential ones. Because these parameters are item- and region-specific, this study tries to capture the influence of these factors on per acre capital investment by including additional explanatory variables, such as item composition metrics and the regional control dummies. Unlike land price and the two cost share parameters, capital price is assumed to be a constant, since its variance across regions in the U.S. is neglectable.

In addition to the above variables, several more factors should be included to precisely explain the real per acre capital investment and correctly examine the effect of UGB on investment level. Since the farmland owners are able to adjust the level of capital investment responding to the relative prices of other inputs (i.e., they can substitute capital with other inputs and vice versa) for their cost minimization as well, here, the price of labor (i.e., wage level of hired farm labor) is included in the list of the independent variables. Also, because the economies of scale may exist in the real-world agricultural production and supporting industries, total acre of farmland in each single-county MSA is included as an explanatory variable in the model.[9]

Moreover, as noted, the actual level of per acre capital investment may be affected by the probable development timing of individual farmland properties and uncertainty level. As a MSA is growing more rapidly, a larger share of farmland is expected to be developed soon with a higher uncertainty level. Therefore, in this model, each MSA's population growth rate is used to reflect the influences of the development timing and uncertainty. Finally and the most importantly, a dummy variable, indicating if a region has implemented an UGB or similar land use planning practice, is included in the model to examine the effectiveness of such land use planning work in reducing the uncertainties. As noted in following sections, interactive dummy variables, derived by multiplying the UGB dummy and other item-related dummies, are also used, because the UGB's effect on investment may significantly depend on what items (i.e., one requiring large sunk costs vs. the others) are mainly cultivated.

4.2. Samples & Data

To conduct an empirical analysis using the model presented above, this study selects the single-county metropolitan statistical areas (MSAs) in the U.S. with year 2000 population ranging between 100,000 and 500,000, except for Anchorage MSA, Alaska (see table 5 and figure 5).[10] Here, the MSAs that consist of multiple counties or county equivalent areas, are excluded to identify the presence of the UGB more accurately.[11] Also, by limiting the range of population, this sample selection tries to use a set of homogeneous MSAs in size and, eventually, to minimize the possible unexpected variances and disturbance.

Table 5. List of the Samples

No	MSA	State	County	Pop in 2000
1	Lakeland--Winter Haven	FL	Polk County	483,924
2	Melbourne--Titusville--Palm Bay	FL	Brevard County	476,230
3	Lancaster	PA	Lancaster County	470,658
4	Modesto	CA	Stanislaus County	446,997
5	Fort Myers--Cape Coral	FL	Lee County	440,888
6	Madison	WI	Dane County	426,526
7	Spokane	WA	Spokane County	417,939

9 This is relevant to the "critical mass", suggested and investigated by many studies on agricultural sector and farmland loss, such as Dhillon & Derr (1974) and Lynch & Carpenter (2003). Because the level of critical mass threshold is uncertain and may not constant across state, total acre of farmland in each county, as opposed to a dummy variable based on a threshold, is used in the estimation.

10 The geographical delineation of the MSAs follows 1999 definition of U.S. Office of Management and Budget, which is used for Census 2000, found at http://www.census.gov/population/estimates/metro-city/99mfips.txt.

11 Since an UGB is usually established by municipalities or counties, the identification of UGB for such MSAs consisting of a number of counties and municipalities is more likely to generate a larger error than the single-county MSAs.

8	Salinas	CA	Monterey County	401,762
9	Santa Barbara--Santa Maria--Lompoc	CA	Santa Barbara County	399,347
10	York	PA	York County	381,751
11	Reading	PA	Berks County	373,638
12	Provo--Orem	UT	Utah County	368,536
13	Visalia--Tulare--Porterville	CA	Tulare County	368,021
14	Reno	NV	Washoe County	339,486
15	Brownsville--Harlingen--San Benito	TX	Cameron County	335,227
16	Eugene--Springfield	OR	Lane County	322,959
17	Fayetteville	NC	Cumberland County	302,963
18	Erie	PA	Erie County	280,843
19	South Bend	IN	St. Joseph County	265,559
20	Ocala	FL	Marion County	258,916
21	Fort Collins--Loveland	CO	Larimer County	251,494
22	Naples	FL	Collier County	251,377
23	Lincoln	NE	Lancaster County	250,291
24	San Luis Obispo--Atascadero--Paso Robles	CA	San Luis Obispo County	246,681
25	Lubbock	TX	Lubbock County	242,628
26	Green Bay	WI	Brown County	226,778
27	Yakima	WA	Yakima County	222,581
28	Gainesville	FL	Alachua County	217,955
29	Waco	TX	McLennan County	213,517
30	Merced	CA	Merced County	210,554
31	Chico--Paradise	CA	Butte County	203,171
32	Myrtle Beach	SC	Horry County	196,629
33	Laredo	TX	Webb County	193,117
34	Cedar Rapids	IA	Linn County	191,701
35	Lake Charles	LA	Calcasieu Parish	183,577
36	Elkhart--Goshen	IN	Elkhart County	182,791
37	Medford--Ashland	OR	Jackson County	181,269
38	Champaign--Urbana	IL	Champaign County	179,669
39	Tyler	TX	Smith County	174,706
40	Las Cruces	NM	Dona Ana County	174,682
41	Fort Walton Beach	FL	Okaloosa County	170,498
42	Topeka	KS	Shawnee County	169,871
43	Bellingham	WA	Whatcom County	166,814
44	Tuscaloosa	AL	Tuscaloosa County	164,875
45	Redding	CA	Shasta County	163,256
46	Benton Harbor	MI	Berrien County	162,453

47	Yuma	AZ	Yuma County	160,026
48	Jackson	MI	Jackson County	158,422
49	Bryan--College Station	TX	Brazos County	152,415
50	Janesville--Beloit	WI	Rock County	152,307
51	Bloomington--Normal	IL	McLean County	150,433
52	Jacksonville	NC	Onslow County	150,355
53	Panama City	FL	Bay County	148,217
54	Monroe	LA	Ouachita	147,250
55	Punta Gorda	FL	Charlotte County	141,627
56	Pueblo	CO	Pueblo County	141,472
57	Jamestown	NY	Chautauqua County	139,750
58	Columbia	MO	Boone County	135,454
59	Greenville	NC	Pitt County	133,798
60	Billings	MT	Yellowstone County	129,352
61	Altoona	PA	Blair County	129,144
62	Waterloo--Cedar Falls	IA	Black Hawk County	128,012
63	Dover	DE	Kent County	126,697
64	Abilene	TX	Taylor County	126,555
65	Alexandria	LA	Rapides Parish	126,337
66	Wausau	WI	Marathon County	125,834
67	Florence	SC	Florence County	125,761
68	Rochester	MN	Olmsted County	124,277
69	Bloomington	IN	Monroe County	120,563
70	Sharon	PA	Mercer County	120,293
71	Muncie	IN	Delaware County	118,769
72	Grand Junction	CO	Mesa County	116,255
73	Auburn--Opelika	AL	Lee County	115,092
74	Lawton	OK	Comanche County	114,996
75	Decatur	IL	Macon County	114,706
76	Goldsboro	NC	Wayne County	113,329
77	Sheboygan	WI	Sheboygan County	112,646
78	Iowa City	IA	Johnson County	111,006
79	Sherman--Denison	TX	Grayson County	110,595
80	Sumter	SC	Sumter County	104,646
81	San Angelo	TX	Tom Green County	104,010
82	Gadsden	AL	Etowah County	103,459

Note: “Pop in 2000” is each MSA’s population by Summary File 1, Census 2000, U.S. Census Bureau.

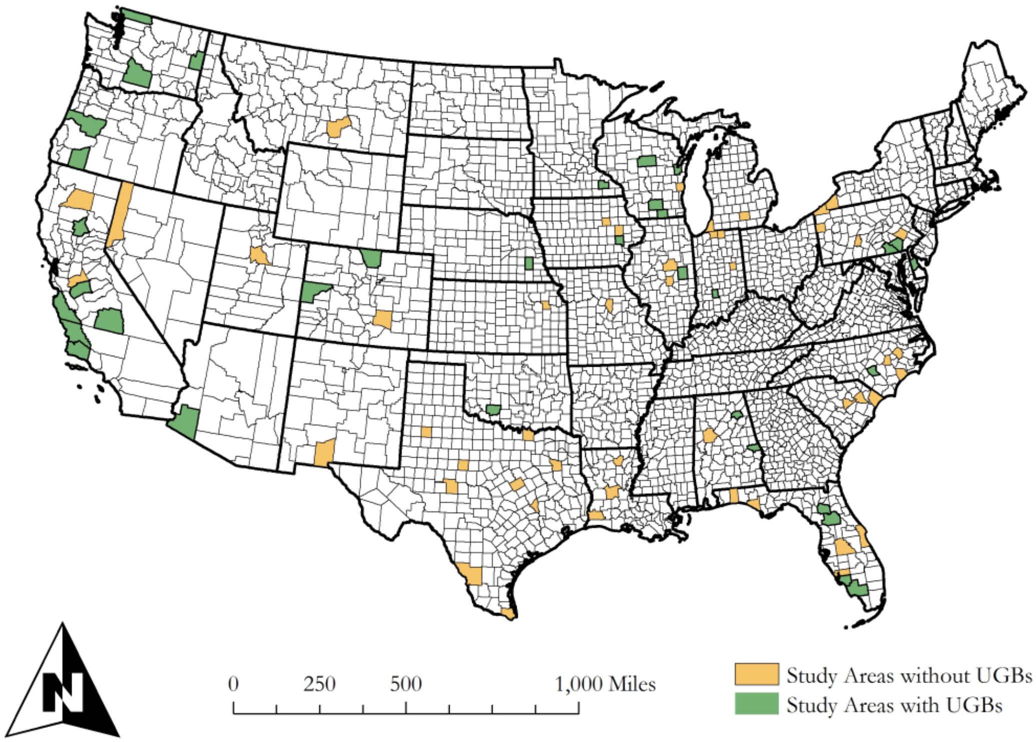

Figure 5. Study Areas: 82 Single-County MSAs in the U.S.

The necessary agricultural and economic data are collected from the National Agricultural Statistics Service (NASS), U.S. Department of Agriculture (USDA), namely 2002 Census of Agriculture data, and Regional Economic Information System (REIS), U.S. Bureau of Economic Analysis (BEA). In addition, the presence of an UGB in each MSA is identified by using other surveys, particularly Burby *et al.* (2001), and verifying the survey results through an investigation on the official web-sites of the municipalities and county of the MSA. Table 6 lists the measurements and the data sources for the variables. In table 7, the statistics of the collected input data for the 82 MSAs are summarized.

Table 6. Measurements & Data Sources

Variable	Measurement	Data Sources
Dependent Variable		
Log of per acre capital investment	*LPACI = log [(Value of machinery and equipment in 2002) / (Land in Farm in 2002)]*	NASS, USDA
Independent Variables		
Log of land price	*LLP = log [(Estimated market value of land and buildings in 2002) / (Land in Farm in 2002)]*	NASS, USDA
Log of labor force price	*LLFP = log [(Hired Farm Labor Expenses in 2002) / (Number of Non-proprietors Employment in 2002)]*	REIS, BEA
Total acre of farmland	*TAF = Land in Farms in 2002*	NASC, USDA
Share of fruits, tree nuts, and berries in terms of sales [1]	*SFTB = (Sales of Fruits, Tree Nuts, and Berries in 2002) / (Total Sales in 2002)*	NASS, USDA
Share of the crops (except fruits, tree nuts, and berries) in terms of sales	*SNFC = (Sales of Crops except Fruits, Tree Nuts, and Berries in 2002) / (Total Sales in 2002)*	NASS, USDA
Dummy for the regions showing high shares of non-fruit crop production [2]	*If the MSA's SNFC > 0.4, HSNFC1 =1* *Otherwise, HSNFC = 0*	NASS, USDA
Dummy for the regions showing low shares of non-fruit crop production [2]	*If the MSA's SNFC =< 0.4, LSNFC1 =1* *Otherwise, LSNFC = 0*	NASS, USDA
Regional control dummies for Midwest, South, & West	*If the MSA is in the Census Region, MIDWEST, SOUTH, or WEST = 1; Otherwise, MIDWEST, SOUTH, or WEST = 0*	U.S. Census Bureau
Population growth rate	*PGR = [(Pop in 2001) – (Pop in 1991)] / (Pop in 1991)*	REIS, BEA
Presence of the UGB establishment practice	*If the MSA has the UGB establishment practice, UGB=1* *Otherwise, UGB=0*	Anderson (1999) GOP&R (1999) Burby *et al.* (2001)

[1] The data of Sales of Fruits, Tree Nuts, and Berries in 2002 for some MSAs are suppressed. In these cases, the suppressed values are estimated using 1997 data for the MSAs or state-level data.
[2] *HSNFC* and *LSNFC* are multiplied by *UGB* and used as interactive terms, in order to capture the potential difference in UGB's effect under different contexts. It is expected that the UGB effect may be greater in the regions having relatively lower *SNFC* (i.e. where NSNFC = 1) thereby having relatively larger shares of live stocks or fruit production which require greater amount of irreversible investments.

Table 7. Statistics of the Input-data

Variable	Description	Mean	Variance	Min	Max
LPACI	Log of per acre capital investment	-1.424	0.531	-4.704	0.001
LLP	Log of land price	0.827	0.309	-0.798	2.060
LLFP	Log of labor force price	3.428	0.151	2.410	4.615
TAF	Total acre of farmland	411,883	1.510E+11	10,863	2,042,680
SFTP	Share of fruits, tree nuts, and berries in terms of sales	0.104	0.029	0.0003	0.764
SNFC	Share of crops, except fruits, tree nuts, and berries	0.403	0.058	0.947	0.038
HSNFC	Dummy for the regions with higher *SNFC*	Number of samples with 1 = 39			
LSNFC	Dummy for the regions with lower *SNFC*	Number of samples with 1 = 43			
MIDWEST	Regional control dummy for Midwest	Number of samples with 1 = 21			
SOUTH	Regional control dummy for South	Number of samples with 1 = 33			
WEST	Regional control dummy for West	Number of samples with 1 = 21			
PGR	Population growth rate	0.143	0.015	-0.040	0.613
UGB	Presence of the UGB establishment practice	Number of samples with 1 = 34			

From the estimation, it is anticipated to have a positive estimated coefficient for log of land price (*LLP*), as presented in the equation (5), because the farmland owners may use expensive land more intensively by making a greater amount of investment per area. A positive coefficient is also expected for log of labor force price (*LLFP*), since the farmland owners' dependence on capital will increase as the price of labor force, which can substitute for capital or be substituted by capital to some extent, goes up. In contrast, the coefficients for the Share of fruits, tree nuts, and berries (*SFTP*) and Total acre of farmland (*TAF*) may show negative signs, due to the high labor-intensity (i.e., relatively low dependence on capital) of the production of *FTP* items and the benefit of the scale effect in saving expenditures, respectively. The expected sign for population growth rate (*PGR*) is negative, which implies that a larger share of total farmland is under the situation of being developed soon with a higher level of uncertainties, so that investment level may be generally low in a more rapidly growing MSA. Finally, the *UGB* dummy variable will exhibit a positive coefficient, if the land use planning efforts really reduce uncertainties, consistent with the TCE-based claim.

4.3. Analysis Outcomes

Using the data of the 82 MSAs, the models with different settings are estimated by employing the ordinary least square estimation method. Table 8 presents the estimation outcomes of two model types showing the highest R-squared. In the first one, *UGB*, the dummy variable of interest, is included as it stands, whereas the second model uses the interactive dummy variables, derived by multiplying it by *HSNFC* and *LSNFC*, to capture the UGB effects in the relatively higher- and lower-crop-share MSAs separately.

Table 8. Estimation Outcomes of the Regression Analysis

Variable	Description	Model 1	Model 2
C	Intercept	-2.221 ****	-2.265 ****
LLP	Log of land price	0.771 ****	0.762 ****
LLFP	Log of labor force price	0.218 *	0.226 *
TAF	Total acre of farmland	-0.510E-06 ****	-0.510E-06 ****
SFTP	Share of fruits, tree nuts, and berries to total sales	-0.552 **	-0.520 *
MIDWEST	Regional control dummy for Midwest	-0.170	-0.131
SOUTH	Regional control dummy for South	-0.229	-0.212
WEST	Regional control dummy for West	-0.159	-0.165
PGR	Population growth rate	-1.434 ****	-1.411 ****
UGB	Presence of the UGB establishment practice	0.150	-
UGB HSNFC*	UGB in the regions with higher crop shares	-	0.045
UGB LSNFC*	UGB in the regions with lower crop shares	-	0.233 **
R-squared | Adjusted R-squared		0.764 | 0.734	0.770 | 0.738

Note: **** 0.1% level | *** 1% level | ** 5% level of significance | * 10% level of significance.

The overall models' explanatory powers seem moderately high, considering the adjusted R-squared, 0.734 and 0.738. Most control variables, except the three regional control dummies (*MIDWEST, SOUTH,* and *WEST*), show high-level statistical significances as well as the expected signs in both models. More specifically, the positive estimated coefficients are found for log of land price (*LLP*), which indicates the farmland owners' extensive use of expensive land. The positive coefficients for log of labor force price (*LLFP*) are also the expected finding, because of the substitution effect between labor and capital as explained above. The negative effects of Share of fruits, tree nuts, and berries (*SFTP*) and Total acre of farmland (*TAF*) on capital investment also correspond to the intuition noted above (i.e., the *FTP* items' labor-intensive character and the economies of scale in agricultural production and supporting activities).

Population growth rate (*PGR*), that is included in the model to capture the influences of development timing and uncertainty level, also exhibits the expected sign with 0.1% level of significance in both models. The negative sign of *PGR*'s estimated outcome may suggest that rapid (mostly urban) population growth expands the area of farmlands under the situation of being developed soon with a higher level of uncertainties and, consequently, has a negative effect on the average per acre investment level in the region.

Of considerable interest are the estimated coefficients of Presence of the UGB (*UGB*) in the first model and the UGB-based interactive dummy variables in the second one. In both models, the signs of these experimental variables' coefficients are positive which indicate that the MSAs having UGBs or other similar land use planning practices are more likely to have a higher level of per acre capital investment. As discussed above, this regression analysis outcome may suggest that the land use planning relevant to the fringe areas actually reduces the uncertainties regarding development timing of the farmlands at urban fringe and thus increases the per acre capital investment in the area.

It should be stressed that only *UGB* LSNFC* in the second model shows a statistically significant (5%-level) estimation outcome. On one hand, this implies that the UGB has a strong effect on per acre capital investment in the MSAs having larger shares of live stock and fruit production that require greater amount of sunk costs and a longer period of operation for profits to be realized, in contrast to crop production. More specifically, the magnitude of the coefficient, 0.233, indicates that the UGB establishment raises the per acre capital investment by about $55.1 [$2.1~$233.1], which is approximately $22.7 million in a medium size single-county MSA (figure 6).[12] On the other hand, the result suggests that the UGB's effect is weak or neglectable in the MSAs where crop production is dominant. However, this does not necessarily mean that the UGB contributes to uncertainty reduction only in the limited number of regions. Rather, this can be attributable to the fact that the per capita investment is not much dependent on the level of uncertainties in the crop-oriented areas, because generally crop production can be made on a short-term basis rather than requiring a substantial amount of long-term investments. For example, certain types of crop production can continue right before the physical development begins.

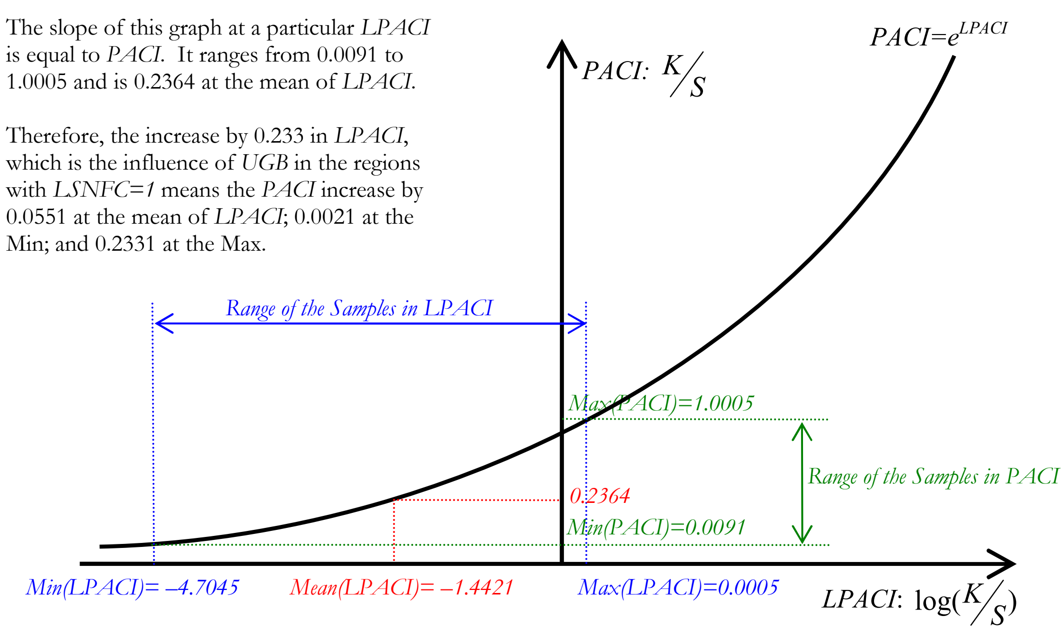

Figure 6. Interpretation of the Magnitude of UGB's Estimated Coefficient

[12] The unit of *PACI* in this study is $1000/acre. Therefore, the 0.0551 increase in *PACI* is interpreted as $55.1 additional investment per acre.

5. CONCLUSION

The present study attempts to test the empirical validity of the TCE-based justification of land use planning. More specifically, this study examines whether or not land use planning practices relevant to urban fringe areas really support the farmland owners' informed decision-making and eventually contribute to a more efficient use of land by reducing the level of uncertainties regarding the timing of potential farmland development.

Testing this proposition was accomplished by conducting an explorative analysis of high-resolution farmland use data in Oregon and a statistical analysis using 82 single-county MSAs' data with a log-linear regression model. The exploration of farmland use data in Oregon revealed that:

1) Tree fruits and tree nuts, which generally require a larger amount of sunk costs and a longer period of operation for the profits, is more likely to be grown outside of UGBs rather than within UGBs, when the distance to the cities is controlled for. This may suggest that the farmland owners exploit the information contained in UGB plans in their decision-making, become more certain about the timing of potential land development, and enjoy a wider range of item choice options if their land is not included in the growth boundaries (i.e., information is available that the area will not be developed soon.)
2) Fallow/Idle cropland, which may indicate inactive use of farmland while waiting development rather than soil quality improvements for a long-term agricultural purpose in this case, is less likely to appear outside of UGBs, compared to the areas within UGBs. This may also be evidence of the UGB's effect, thereby offering support for the TCE-based arguments. In other words, the UGB informs many farmland owners (having the areas outside of the UGBs) that their parcels are not going to be developed soon and, consequently, induces a more intensive and efficient use of land.

According to the MSA-level statistical analysis, regressing available independent variables on log of per acre capital investment (*LPACI*),

1) For Population growth rate (*PGR*), negative estimated coefficients are found with a very high level (0.1%) of statistical significance. This may suggest that the farmland owners' decision making is indeed a forward-looking strategic choice and that the uncertainties, which could be represented by the variable, do matter, as argued by TCE-based studies.
2) For the variable indicating the Presence of an UGB (*UGB*), positive coefficients were found; and this may suggest that the land use planning efforts reduce the uncertainty and further facilitate capital investment for agricultural production. However, the estimated coefficient is statistically significant (5%-level) only in the MSAs having relatively larger shares of livestock and fruit production that generally require a greater amount of sunk costs as well as a longer operation period to be profitable. The insignificance of the estimates for other MSAs may need to be explained by the weak connection between the uncertainty and capital investment, rather than no or weaker UGB's effect on uncertainty reduction.

Overall, this study empirically validates the TCE-based justification of land use planning. It is suggested that uncertainties exist in land markets and prevent economically efficient use of land. Furthermore, land use planning practices seem to help land-owners make better land use-related decisions by proving valuable information and reducing the level of uncertainties. In this sense, governments' involvement in land use and development may be warranted, because is can be a more efficient form of information production and exchange.

Finally, it should be stressed that this contribution of land use planning may not be trivial. The UGB's effect on agricultural investment estimated in this study (i.e., 22.7 million dollars in the case of a medium size single-county MSA) may be a very small portion of the full potential contribution. Land use planning practices may inform not only the farmland owners in urban fringe areas but also land developers and many other actors involved in various land use and development processes. More generally, a larger amount of benefits may arise in urban areas where various kinds of uncertainties along with dramatic internal changes exist, which in turn cause a greater amount of transaction costs and a greater demand for the systematic management of land use.

REFERENCES

Alexander, E.R. 1992. A transaction cost theory of planning. *Journal of the American Planning Association* 58 (2):190–200.

Alexander, E.R. 1994. To plan or not to plan, that is the question: Transaction cost theory and its implications for planning. *Environment and Planning B: Planning and Design* 21 (3): 341–352.

Alexander, E.R. 2001. Why planning vs. markets is an oxymoron: Asking the right question. *Planning and Markets* 4: 1–6. http://www-pam.usc.edu/volume4/v4i1a2print.html

Anderson, H.A. 1999. *Use and Implementation of Urban Growth Boundaries*, Center for Regional and Neighborhood Action, Denver at http://www.colorado.edu/conflict/5010/CRNA-UGBReport.pdf

Arnott, R.J. and F.D. Lewis. 1979. The transition of land to urban use, *Journal of Political Economy* 87 (1): 161-169.

Bailey, M.J. 1959. Note on the economics of residential zoning and urban renewal. *Land Economics* 35 (3): 288-292.

Barnard, C.H. and W.R. Butcher. 1989. Landowner characteristics: A basis for locational decisions in the urban fringe. *American Journal of Agricultural Economics* 71 (3): 679-684.

Bockstael, N.E. 1996. Modeling economics and ecology: The importance of a spatial perspective. *American Journal of Agricultural Economics* 78 (5): 1168-1180.

Burby, R.J., A.C. Nelson, D. Parker, and J. Handmer. 2001. Urban containment policy and exposure to natural hazards: Is there a connection? *Journal of Environmental Planning and Management* 44 (4): 475-490.

Burnell, J.D. 1985. Industrial land use, externalities, and residential location. *Urban Studies* 22 (5): 399–408.

Capozza, D.R. and R.W. Helsley. 1990. The stochastic city. *Journal of Urban Economics* 28 (2): 187-203.

Correll, M.R., J.H. Lillydahl, and L.D. Singell. 1978. The effects of greenbelts on residential property values: Some findings on the political economy of open space. *Land Economics* 54 (2): 207–217.
Davis, O.A. 1963. Economic elements in municipal zoning decisions. *Land Economics* 39 (4): 375–386.
Dawkins, C.J. 2000. Transaction costs and the land use planning process. *Journal of Planning Literature* 14 (4): 507–518.
Dhillon, P. S. and D. A. Derr. 1974. Critical mass of agriculture and the maintenance of productive open space. *Journal of the Northeastern Agricultural Economics Council* 3 (1): 23-34.
Friend, J.K. and W.N. Jessop. 1969. *Local Government and Strategic Choice: An Operational Research Approach to the Processes of Public Planning*, Beverly Hills: Sage Publications.
Gale, D.E. 1992. Eight state-sponsored growth management programs: A comparative analysis. *Journal of the American Planning Association* 58 (4): 425-439.
Gardner, B.D. 1977. The economics of agricultural land preservation. *American Journal of Agricultural Economics* 59 (5): 1027–1036.
Governor's Office of Planning and Research (GOP&R), State of California. 1999. *The California Planners' Book of Lists 1999* at http://ceres.ca.gov/planning/bol/1999/
Hopkins, L.D. 2001. *Urban Development: The Logic of Making Plans*, Washington: Island Press.
Innes, J.E. 1992. Group processes and the social construction of growth management. *Journal of the American Planning Association* 58 (4): 440-453.
Irwin, E.G. and J. Geoghegan. 2001. Theory, data, methods: Developing spatially explicit economic models of land use change. *Agriculture, Ecosystems, and Environment* 85 (1-3), 7-23.
Kim, J.H. 2009. Linking land use planning and regulation to economic development: A literature review. Regional Economics Applications Laboratory Discussion Paper 09-T-5. http://www.real.illinois.edu/d-paper/09/09-T-5.pdf
Knaap, G. J. 1985. The price effects of urban growth boundaries in metropolitan Portland, Oregon. *Land Economics* 61 (1), 26-35.
Knaap, G. J., C. Ding, and L.D. Hopkins. 2001. Do plans matter? The effects of light rail plans on land values in station areas. *Journal of Planning Education and Research* 21 (1): 32–39.
Lafferty, R.N. and H.E. Frech. 1978. Community environment and the market value of single family homes: The effect of the dispersion of land uses. *Journal of Law and Economics 21 (2)*, 381–394.
Lee, D.B. Jr. 1981. Land use planning as a response to market failure. In *The Land Use Policy Debate in the United States*, ed. J. I. de Neufville, 149–164. New York: Plenum Press.
Lopez, R. A., A. O. Adelaja, and M. S. Andrews. 1988. The effects of suburbanization on agriculture. *American Journal of Agricultural Economics* 70 (2), 346-358.
Lynch, L. and J. Carpenter. 2003. Is there evidence of a critical mass in the Mid-Atlantic agriculture sector Between 1949 and 1997? *Agricultural and Resource Economics Review* 32 (1): 116-128
Moore, T. 1978. Why allow planners to do what they do?: A justification from economic theory. *Journal of the American Institute of Planners* 44 (4): 387-398.
Nelson, A.C. and J.B. Duncan. 1995. *Growth Management: Principles and Practice*, Chicago: Planners Press.

Ohls, J.C. and D.P. Pines. 1975. Discontinuous urban development and economic efficiency. *Land Economics* 51 (3): 224-234.

Segerson, K., A.J. Plantinga, and E.G. Irwin. 2006. PART II: Determinants of land use change – Theoretical background. In *Economics of Rural Land Use Change*. Ed. K. P. Bell, K. J. Boyle, and J. Rubin, 77-112. Aldershot: Ashgate.

Schaeffer, P.V. and L.D. Hopkins. 1987. Behavior of land developers: Planning and the economics of information. *Environment and Planning A* 19 (9): 1221–1232.

Spalatro, F. and B. Provencher. 2001. An analysis of minimum frontage zoning to preserve lakefront amenities. *Land Economics* 77 (4): 469–481.

Staley, S. R.., J. G. Edgens, and G. C. S. Mildner. 1999. *A Line in the Land: Urban Growth Boundaries, Smart Growth, and Housing Affordability*, Policy Study No. 263, Reason Public Policy Institute.

Stull, W. J. 1975. Community environment, zoning, and the market value of single family homes. *Journal of Law and Economics* 18 (2): 535–558.

Talen, E. 1996a. Do plans get implemented? A review of evaluation in planning. *Journal of Planning Literature* 10 (3): 248–259.

Talen, E. 1996b. After the plans: Methods to evaluate the implementation success of plans. *Journal of Planning Education and Research 16* (2): 79–91.

von Thunen, J. 1826. *The Isolated State*. London: Pergamon.