Measuring Interactions among Urban Development, Land Use Regulations, and Public Finance

Seong-Hoon Cho* and JunJie Wu

* Corresponding author:
Department of Agricultural and Resource Economics
Oregon State University
Corvallis, OR 97331
Phone: 541-737-1451
Fax: 541-737-2563
Email: cho@ucs.orst.edu

A Selected Paper for 2001 Annual Meeting of American Agricultural Economics Association

The authors are, respectively, graduate research assistant and assistant professor, Department of Agricultural and Resource Economics, Oregon State University.

Copyright 2001 by Seong-Hoon Cho and JunJie Wu. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that his copyright notice appears on all such copies.

Measuring Interactions among Urban Development, Land Use Regulations, and Public Finance

Abstract

In this paper, a theoretical model is developed to analyze the interactions among residential development, land use regulations, and public financial impacts (public expenditure and property tax). A simultaneous equations system with self-selection and discrete dependent variables is estimated to determine the interactions for counties in the five western states (California, Idaho, Nevada, Oregon, and Washington). The results show that county governments are more likely to impose land use regulations when facing rapid land development, high public expenditure and property tax. The land use regulations, in turn, decrease land development, long-run public expenditure, and property tax at the cost of higher housing prices and property tax. During the period of 1982–1992, land use regulations reduced developed areas by 612,800 acres or 8.8 % of the developed area of five western states in 1992, but increased housing price by $5,741 per unit under "stringent" regulations and $1,319 per unit under "low" regulations. Because it costs money to develop and implement land use regulations, land use regulations increased public expenditure and property tax in the short run, during the period of 1982-1987. However, in the long-run (1982-1992), land use regulations actually reduce public expenditure and property taxes because the regulations reduce developed areas. The results also show that land use regulations, land development, public expenditure, and property tax all are significantly affected by population, geographic location, land quality, housing prices, and the risks and costs of development.

Key Words: land development, land use regulations, housing price, public expenditure, property tax

Measuring Interactions among Urban Development, Land Use Regulations, and Public Finance

The role of local land use policies has been examined in a number of studies (e.g. Fischel, 1978; Mills, 1979; Henderson, 1980; Shlay and Rossi, 1981; Epple et al., 1988; McDonald and McMillen, 1998; Levine, 1999; Phillips and Goodstein, 2000). However, little evidence is available on which factors motivate land use regulations. Because local political processes determine land use regulations, treating regulations as exogenous causes a selection bias (Pogodzinski and Sass, 1994). The endogenous nature of zoning regulation was first raised by Davis (1963). He pointed out the different preferences for zoning between the existing homeowners and developers or renters. Rolleston (1987) assessed the link between suburban fiscal environments and zoning policies. She examined the interjurisdictional determinants of restrictive zoning and the relationship between residential and nonresidential zoning decisions in suburban communities. Rolleston measured the restrictiveness of residential zoning by an ad hoc weighted average of lots in various residential zoning categories.

Erickson and Wollover (1987) estimated the effects of a number of demographic variables on the choice of zoning regulations, but did not account for the simultaneous nature of zoning decisions. Wallace (1988) treated zoning regulations as endogenous when evaluating the impact of land-use zoning. He estimated a logit model to correct for selection bias. McMillen and McDonald (1989, 1991) explored the econometric problems involving the measurement of impact of endogenous zoning decisions. They used a two-step estimation technique to derive unbiased estimates of the zoning regulations, but excluded demographic variables from consideration.

Wallace (1988) and McMillen and McDondald (1989, 1991) did not develop a political theory of zoning. Pogodzinski and Sass (1994) model the political procedure of zoning and its implications for measuring the impact of zoning regulations. They assume that zoning regulations are established by maximizing effective political support. In order to measure the effective political support, they consider whether a utility maximizing representative voter would support local land-use zoning.

There are several shortcomings in those previous studies. First, with the exception of Pogodzinski and Sass (1994), land use regulations have not been modeled explicitly. Thus, variables included in land use regulation models were chosen rather arbitrarily. Second, the linkages between land use regulations and land use, public expenditure, and property tax were not considered. These linkages are important factors affecting the choice of land use regulations. Third, previous studies have focused on a specific land use regulation. They have not considered effects of various types and degrees of land use regulations.

In this paper, a theoretical model is developed to analyze the interactions among residential development, land use regulations, and public financial impacts (public expenditure and property tax). Specifically, housing markets and socially optimal land uses are modeled to identify variables affecting land use, land use regulations, housing price, public expenditure, and property tax. The demand function for land development is modeled from a household utility maximization model. The supply function of land development is modeled using an option value approach to accommodate uncertainty and irreversibility of land development. Land use regulations are modeled from a land planner's perspective, which seeks to maximize a social welfare function. A polychotomous-choice model with self-selectivity (Lee, 1983) is used to control self-selection bias in modeling adoption of land use regulations. A simultaneous equations system is estimated to analyze the interactions between land use regulations and land use, public expenditure, and property tax.

The Theoretical Model

Demand for Land Development

Since most land use regulations are imposed at the county level, we consider land use decisions within a region. We assume each region can be divided into sub-regions that are homogenous in physical and demographic characteristics (Epple and Sieg, 1999). The households in each sub-region are assumed to have homogenous preferences and incomes. The utility of a household depends on their consumption choices and the characteristics of the sub-region. The consumption choices include residential lot size (n_i) and consumption of other goods (x_i). The characteristics of the sub-region include public expenditure (g_i), property taxes (τ_i), physical features (Ψ_i), and demographic characteristics (μ_i). The utility function of a household residing in a sub-region i is written as $U_i(n_i, x_i, g_i, \mu_i, \Psi_i)$. The household takes as given the level of public expenditure (g_i), the property tax rate (τ_i), physical features of the sub-region (Ψ_i), and demographic characteristics of the sub-region (μ_i) to maximize its utility function subject to a household budget constraint:

$$\text{Max } U_i(n_i, x_i, g_i, \mu_i, \Psi_i) \tag{1}$$

$$\text{s.t. } p^x \cdot x_i + (1+\tau_i) \cdot R_i \cdot n_i = Y_i . \tag{2}$$

where p^x is price of other goods, R_i is residential rent, and Y_i is household income. The solution of the maximization problem gives the optimal size of residential lot in the sub-region: $n_i^* = n_i(p^x, R_i, \tau_i, g_i, \mu_i, Y_i, \Psi_i)$. Thus, the total demand for land development in year t in the region equals,

$$N_t^d = \sum_{i=1}^{I} N_{it} \cdot n_{it}^* = \sum_{i=1}^{I} N_{it} \cdot n_{it}(p_{it}^x, R_{it}, \tau_{it}, g_{it}, \mu_{it}, Y_{it}, \Psi_i) = N_t^d(p_t^x, R_t, \tau_t, g_t, \mu_t, Y_t, \Psi). \quad (3)$$

where N_i is the number of households in sub-region i, and I is the number of sub-regions in the region. Assuming that individual demand functions are homogenous, $R_t, \tau_t, g_t, \mu_t, Y_t, \Psi$ are the average of residential rent, property tax, government expenditure, demographic characteristics, household income, and land quality.

Supply of Residential Areas

The supply of residential areas is determined by developers. Suppose a developer is considering converting a parcel of undeveloped land (e.g. farmland) into development. The developer develops the land to maximize the expected present value of profit from development. Suppose his decision is made in a two-period framework: a first period followed by future time horizon compressed into a single second period. The developer knows both the rents from farming (F_1) and development (R_1) in the first period, but is uncertain about the rents from farming (F_2) and development (R_2) in the second period. We assume that the net gain from development, $R_2 - F_2$, in the second period, takes a normal distribution, $\mathrm{N}[\Delta R_2, \sigma^2]$ and that the developer will develop his land in the second period only if $R_2 > F_2$. The following truncated mean values are obtained based on the theorem of moments of the truncated normal distribution (Greene, 1997 p.949-953):

$$E[R_2 - F_2 \mid R_2 > F_2] = \Delta R_2 + \frac{\sigma\phi(\alpha)}{P}, \tag{4}$$

$$E[R_2 - F_2 \mid R_2 < F_2] = \Delta R_2 - \frac{\sigma\phi(\alpha)}{1-P}, \tag{5}$$

where $\alpha = -\mu/\sigma$, ϕ is the probability distribution function of the standard normal, and P is probability that $R_2 > F_2$. If the land developer develops the land in the first period, the expected net present value is

$$NPV = (R_1 - F_1) + P[\Delta R_2 + \frac{\sigma\phi(\alpha)}{P}] + (1-P)[\Delta R_2 - \frac{\sigma\phi(\alpha)}{1-P}]. \tag{6}$$

On the other hand, if the land developer waits a period and develops only if the net gain from development, ΔR_2, turns out to be positive, the expected net gain is

$$NPV = P[\Delta R_2 + \frac{\sigma\phi(\alpha)}{P}]. \tag{7}$$

The optimal decision rule for development in the first period is obtained when (6) is set to be greater than (7):

$$R_1 > F_1 + \sigma\phi(\alpha) - (1-P)\Delta R_2. \tag{8}$$

Equation (8) implies that the area of land development in time, t, is a function of $R_t, F_t, \Delta R_{t+1}$, and σ_t: $\Delta N_t^s(R_t, F_t, \Delta R_{t+1}, \sigma_t)$, where ΔR_{t+1} is the expected net return from development in the future. In previous studies of land allocation decisions, various socioeconomic, and physical variables have been included to explain land allocations to urban, residential, and other uses. For example, land and demographic characteristics and income levels have been used as measures of development pressure in previous studies (e.g., Chicoine (1981), Hushak and Sadr (1979), Wall (1981), Alig and Healy (1987)). Hardie and Parks (1989) and Bockstael et al. (1995) found that land quality is an important determinant of land use. Based on these studies, we assume that

$\Delta R_{t+1} = \Delta R_{t+1}(R_t, F_t, \Psi, \mu_t, \varphi_t, Y_t)$ where φ_t is land use regulation. Thus, the aggregate supply of land for development equals:

$$N_t^s = N_{t-1} + \Delta N_t^s = N_t^s(N_{t-1}, R_t, F_t, \Psi, \mu_t, \varphi_t, Y_t, \sigma_t). \tag{9}$$

The equilibrium rental rate for housing is obtained when the aggregate supply is set to equal the aggregate demand:

$$R_t = R_t(p_t^x, F_t, \sigma_t, \varphi_t, \Psi, \mu_t, Y_t, \tau_t, g_t, N_{t-1}). \tag{10}$$

Land Use Regulations and the Social Welfare Function

We assume that the county government (i.e., planning commission) attempts to maximize the net value from land use by choosing the optimal level of land development in each sub-region:

$$\underset{N_i, g_i, \tau_i}{Max}\ V \equiv \sum_{i=1}^{I}(R_i(N_i) \cdot N_i) + \sum_{i=1}^{I} F_i \cdot (L_i - N_i) - D(\sum_{i=1}^{I} N_i). \tag{11}$$

$$\text{s.t. } \sum_{i=1}^{I} g_i N_i = \sum_{i=1}^{I} \tau_i R_i N_i .$$

The $\sum_{i=1}^{I} L_i$ represents total area of the county, the $N = \sum_{i=1}^{I} N_i$ represents total urban area of the county. The first term of equation (11) represents the value of urban land, the second term represents the value of farmland, and the last term $D(\sum_{i=1}^{I} N_i)$ represents the social cost of converting farmland to urban land. The first order condition for land development can be written as

$$(1 + \lambda\tau_i)\frac{\partial(R_i N_i)}{\partial N_i} - F_i - \lambda g_i = D'(N) \tag{12}$$

i = 1, 2, . . . , I.

where λ, the Lagrange multiplier for the budget balance constraint, can be interpreted as the marginal social cost of public expenditures. Equation (12) indicates that land ought to be developed where the net rent (development rent minus farmland rent and marginal cost of public goods) equals the marginal social cost of public goods.

The first order condition for optimal land use is illustrated in figure 1. The socially optimal level of land development, N^*, obtained from equation (12), is where the marginal benefit of development equals the marginal cost of development. However, the developed area under the market equilibrium can be greater or less than the socially optimal level of land development, resulting in a social welfare loss. If the developed area under the market equilibrium N_l^e is less than the socially optimal level N^*, the welfare loss is the area *abc*. If the developed area under the market equilibrium is N_h^e, the welfare loss is the area *ade*. In both cases, a county government can reduce the welfare loss by shifting the market equilibrium land use toward the socially optimal land use in the form of land use regulations. A county government can encourage development by reducing land use regulations and discourage development by imposing more stringent land use regulations. Thus, the probability that land use regulations will be imposed depends on the difference between the left and right hand sides of (12), which is

$$\mathrm{Pr}_t^* = \varphi_t(p_t^x, F_t, \sigma_t, \tau_t, \Psi, \mu_t, Y_t, g_t, D_t, N_{t-1}). \tag{13}$$

From the first order condition of the county government's maximization problem, we obtain the government expenditure and property tax functions:

$$g_t^* = g_t(p_t^x, F_t, \sigma_t, \varphi_t, \Psi, \mu_t, Y_t, \tau_t, D_t, N_{t-1}), \tag{14}$$

$$\tau_t^* = \tau_t(p_t^x, F_t, \sigma_t, \varphi_t, \Psi, \mu_t, Y_t, g_t, D_t, N_{t-1}), \tag{15}$$

which, together with the public budget constraint, determine the optimal level of public expenditure and property taxes.

The Empirical Model

In the last section, we analyzed the theoretical interrelationships between land use, land use regulations, and their fiscal impacts. In this section, we present an empirical model of these interrelationships. Specifically, the interrelationships are represented by the following simultaneous equations system with self-selection and discrete dependent variables:

$$\Pr_t^j \equiv \Pr(I = j) = \frac{\exp(X_t^{'} \cdot \Pi_j)}{\sum_{i=1}^{M} \exp(X_t^{'} \cdot \Pi_i)}, \; j = 1, 2, 3, 4, \tag{16}$$

$$N_t^{sj} = \beta_0^j + \beta_1^j \cdot R_t + \beta_2^j \cdot Z_t + \varepsilon_t^{sj}, \tag{17}$$

$$R_t^j = \gamma_0^j + \gamma_1^j \cdot \tau_t + \gamma_2^j \cdot g_t + \gamma_3^j \cdot Z_t + \varepsilon_t^{Rj}, \tag{18}$$

$$\tau_t^j = \delta_0^j + \delta_1^j \cdot g_t + \delta_2^j \cdot Z_t + \varepsilon_t^{\tau j}, \tag{19}$$

$$g_t^j = \pi_0^j + \pi_1^j \cdot \tau_t + \pi_2^j \cdot Z_t + \varepsilon_t^{gj}, \tag{20}$$

where $j = 1, 2, 3, 4$ represents the four degrees of land use regulations as defined in table 1, Z_t is a matrix of exogenous variables $(N_{t-1}, F_t, \mu_t, Y_t, \sigma_t, \Psi)$, and $\varepsilon_t^{sj}, \varepsilon_t^{Rj}, \varepsilon_t^{\tau j}, \varepsilon_t^{gj}$ are random error terms.

The degree of land use regulations is defined based on a comprehensive survey of land use regulations in each county in five western states (California, Idaho, Nevada, Oregon, and Washington). From the survey, we identified the 20 most important land use regulations. Survey respondents were asked to evaluate the level of effectiveness of each regulation on a scale of 1, 2, 3, 4, and 5 with 1 being not effective and 5 being most effective. The sum of the level of effectiveness for all regulations in a county is defined as an index of regulatory intensity. For example, a county with 20 land use regulations each with level of effectiveness of 5, would have an index of 100. Counties with indexes greater than 60 are classified as having "stringent land use regulations", counties with indexes greater than 30 and equal to or less than 60 are classified as having "moderate land use regulations", counties with indexes greater than 0 and equal to or less than 30 are classified as having "low land use regulations", and counties without any land use regulations are defined as "no land use regulations".

The equation system (16-20) is an extension of the polychotomous-choice selectivity model as described in Lee (1983) and applied to agricultural policy analysis in Wu and Babcock (1998). When any two equations of land demand, land supply, and housing price are estimated, the other one would be determined. Here we choose to estimate the land supply and housing price equations.

Maddala (1983, p. 242-245) describes a two-stage technique for estimating a simultaneous model with discrete dependent variables. In the first stage, we estimate the reduced form equations of (18), (19), and (20), using OLS:

$$R_t^j = \Pi_1^j \cdot Z_t + v_{1t}^j \tag{21}$$

$$\tau_t^j = \Pi_2^j \cdot Z_t + v_{2t}^j \tag{22}$$

$$g_t^j = \Pi_3^j \cdot Z_t + v_{3t}^j \tag{23}$$

We then use the predicted value of $\hat{R}, \hat{\tau}, \hat{g}$ to estimate the multinomial logit model in (16) and use it to predict $\hat{\Pr}_j$:

$$\hat{\Pr}_t^j = \frac{\exp(\hat{\Pi}_j \cdot X_t)}{\sum_{i=1}^{M} \exp(\hat{\Pi}_i \cdot X_t)}, \; j = 1, 2, 3, 4. \tag{24}$$

which is then used to calculate $\hat{\lambda}_t^j \equiv \phi[\Phi^{-1}(\hat{\Pr}_t^j)]/\hat{\Pr}_t^j$, j = 1, 2, 3, 4. The $\hat{\lambda}_t^j$ reflects correction of self-selection bias (Lee, 1983). It is included in the model because counties that adopt land use regulations may behave differently from a randomly selected county with the same characteristics.

In the second stage, the parameters in the structural equations are determined by estimating the following equations using OLS:

$$N_t^j = \beta_0^j + \beta_1^j \cdot \hat{R}_t + \beta_2^j \cdot Z_t - \beta_3^j \cdot \hat{\lambda}_t^j + u_{1t}^j \tag{25}$$

$$R_t^j = \gamma_0^j + \gamma_1^j \cdot \hat{\tau}_t + \gamma_2^j \cdot \hat{g}_t + \gamma_3^j \cdot Z_t - \gamma_4^j \cdot \hat{\lambda}_t^j + u_{2t}^j \tag{26}$$

$$\tau_t^j = \delta_0^j + \delta_1^j \cdot \hat{g}_t + \delta_2^j \cdot Z_t - \delta_3^j \cdot \hat{\lambda}_t^j + u_{3t}^j \tag{27}$$

$$g_t^j = \pi_0^j + \pi_1^j \cdot \hat{\tau}_t + \pi_2^j \cdot Z_t - \pi_3^j \cdot \hat{\lambda}_t^j + u_{4t}^j \tag{28}$$

Since the coefficients of the multinomial logit model are difficult to interpret, the marginal effects of explanatory variables on the degree of regulation are determined using

$$\frac{\partial \Pr^j}{\partial X} = \Pr^j (\Pi_j - \sum_{i=1}^{3} \Pr^i \cdot \Pi_i). \tag{29}$$

This model can be used to estimate the effects of alternative degrees of land use regulations on land development, housing price, public expenditure, and property tax. Consider the public expenditure of a county with and without land use regulations, the expected change in public expenditure due to the adoption of level of land use regulation j is:

$$[E(g^j \mid I = j) - E(g^4 \mid I = 4)]_{short-run} \tag{30}$$

$$= [(\pi_0^j - \pi_0^4) + \hat{R}(\pi_1^j - \pi_1^4) + Z(\pi_2^j - \pi_2^4)] + (\pi_3^4 - \pi_3^j)\hat{\lambda}^j$$

where I = 4 denotes no land use regulations in the county. The first bracket in the right hand side of equation (30) is the expected change in public expenditure resulting from adoption of level of land use regulation j. The remaining term accounts for self-selection.

The expected change in public expenditure resulting from adoption of land regulations on housing price, public expenditure, and property taxes in a single-period frame is defined as the short-run effect and is estimated using equation (30). The expected changes in public expenditure from adoption of land use regulations that take into account the effect of changes in developed area is defined as the long-run effect and it is estimated using equation (31):

$$[E(g^j \mid I = j) - E(g^4 \mid I = 4)]_{long-run} \tag{31}$$
$$= [(\pi_0^j - \pi_0^4) + \hat{R}(\pi_1^j - \pi_1^4) + Z^{'}(\pi_2^{j'} - \pi_2^{4'}) + (\pi_{2N_{t-1}}^j N_{t-1} - \pi_{2N_{t-1}}^4 N_{t-1}^*) + (\pi_3^4 - \pi_3^j)\hat{\lambda}^j],$$

where $Z_t^{'}$ is vector that includes every variable in Z_t except N_{t-1}, $\pi_2^{j'}$ and $\pi_{2N_{t-1}}^j$ are the estimated coefficients on $Z_t^{'}$ and N_{t-1}, and N_{t-1}^* is the acres of land that would be developed without any land use regulation. The expected changes in housing price, land development, and property taxes due to adoption of different degree of land use regulation can be similarly analyzed.

Data

The study area includes five western states (California, Idaho, Nevada, Oregon, and Washington) of the Unites States. The data on land use was taken from the 1982, 1987, and 1992 Natural Resource Inventories (NRI)[1]. The NRI collected land use data at 800,000 randomly selected sites across the continental United States and divided land use into twelve major categories (cultivated cropland, non-cultivated cropland, pastureland, rangeland, forestland, urban and built-up land, and six other categories). In this study, cultivated cropland, non-cultivated cropland, pastureland, and rangeland are categorized as farmland and urban and built-up land is categorized as urban land. The NRI survey assigns a weight called an expansion factor or "X" factor to each site in the sample to determine the number of acres each sample site represents. The sum of this value for all sites in a county equals the total county acreage.

The expected variances of farm profit and new housing value were used to measure the risk associated with farming and development. These variances were estimated using

$$VB_t = \frac{1}{4}\sum_{t=t-4}^{t-1}(B_t - EB_t)^2 , \tag{32}$$

where VB_t = the expected variance of farm profit or new housing value in year t, t= 1982, 1987,
B_t = the farm profit or the value of new housing units in year t,

A comprehensive land use policy survey was conducted to obtain information on county land use regulations in the five western states. The survey, conducted between August and October of 1999, was sent to all county land use planners or equivalent positions in the five states. The overall response rate was 69%. Counties of Washington had the highest response rate (87%), followed by Oregon (78%), Nevada (65 %), California (60%), and Idaho (57%).

---

[1] The 1997 NRI has not been released due to technical problems.

The survey results show that the most important land use policy goal of Nevada counties was the promotion of industrial and commercial investment, while the counties in other states were more concerned about the conservation of farmland, forestland, and natural areas. All counties expressed a serious concern about urbanization. A county comprehensive plan had been enacted in almost all of the counties in the five states when the survey was conducted, however, the timing of the initial enactment varied across counties. Extra territorial planning and zoning were popular in Idaho, urban growth boundaries were popular in Oregon and Washington. Agricultural, residential, forestry, conservation, open space, and steep slope zonings were popular throughout the states, whereas performance zoning was used only in a limited number of counties. Specification of minimum parcel sizes was popular in many counties, limits on maximum parcel sizes was not.

Developer exaction and dedication was the most popular land acquisition technique in many counties. Fee simple purchase and agricultural districts were especially popular in California. Preferential property taxation for farmland and forestland were the most popular incentive-based management techniques. Special assessments were popular in Oregon, Washington, and California.

Environmental impact assessments were popular in Washington and California. Regional fair sharing was especially popular in California. The planners predicted a high possibility of conversion from farmland to residential land, especially in Idaho and Nevada. Counties in California spent the largest amount of money on planning, while counties in Idaho spent the least amount. However, the average share of money spent on planning out of general fund for the entire county budget remained fairly close in the five states. Planners in Oregon and Washington felt that the State governments had strong influence on land use regulations, whereas planners in California, Idaho, and Nevada felt strong influences from non-government organizations.

Land quality and location variables in the empirical models, included the average land capability class and distance to the closest metropolitan center (population $\geq$ 100,000). The weighted average of land capability classes was calculated for each county using the survey records of the land capability class at each NRI site. The Natural Resources Conservation Service divided land capability into eight classes, with 1 being the best quality land and 8 being the worst quality land. Location was calculated as the distance from the geographical center of each county (defined as the cross point of the medium latitude and longitude) to the center of the closest metropolitan area (defined as a city with more than 100,000 people). The data on the latitude and longitude of the geographical center of each county and the closest metropolitan area were collected from the National Association of Counties. The website, www.indo.com/distance was used to measure the distances.

Data on the average value of new housing units, construction cost, income, population, property tax, and public expenditure were obtained from the Census Bureau's 'USA counties 1998'. Average farm profit data was obtained from the Census Bureau's 'Regional Economic Information System: 1969-1997'. Both the farm profit and the average value of new housing units are adjusted by the consumer price index from the Bureau of Labor Statistics. The summary of variables is shown in table 2.

Estimation Results and Discussion

Factors Affecting Adoption of Land Use Regulations

Parameter estimates for the multinomial logit model of land use regulations are presented in table 3. The model correctly predicts the level of land use regulation for 67 % of counties. The marginal effects of alternative variables on the intensity of land use regulations are shown in table 4. Six of twelve marginal effects are statistically significant at the 5 % level for counties with "stringent" land use regulations. Four of twelve coefficients are statistically significant at the 5 % level for counties with "moderate" and "low" land use regulation indexes. The marginal effects of all twelve variables increase with the index of land use regulations. Although the marginal effects are less significant for counties with a lower land use regulation index, their signs are not affected.

Counties with higher farm profit adopted land use regulations more frequently. This reflects the economic incentive of land use regulations against farmland development. Farmers with high farm profit are more willing to support land use regulations preserving their farmland. Population increases the pressure for adopting land use regulations. Land use regulations are also more frequently adopted by counties with higher household income under stringent and moderate levels of regulations. These population and income results are consistent with those found by Erickson and Wollover (1987), who estimated the effects of a number of demographic variables on the adoption of zoning regulations.

Counties closer to metropolitan centers are more likely to enact land use regulations. This result is expected because counties closer to metropolitan centers tend to have more land use conflicts. Land use regulations are more likely to be adopted in counties with smaller variances in farm profit and larger variances in new housing price. This suggests that the greater the risk associated with new housing price compare with the risk associated with farming, the more likely developers accept land use regulations. In addition, county governments may use regulations to reduce variations in housing prices.

Adoption rates of land use regulations are higher in counties with high public expenditures and property taxes. This provides empirical evidence that high public expenditures and property tax encourage county governments to impose land use regulations to control government expenditures. Finally, land use regulations are more frequently adopted in the counties with a large share of developed areas. This suggests that development pressure promotes county governments to take actions to control land development.

The Effects of Land Use Regulations

Tables 5-8 present the estimated parameters for the land supply equation, the housing price equation, the public expenditure equation, and the property tax equation under alternative levels of land use regulations. There is evidence that self-selection occurred in the adoption of land use regulations. The coefficient of λ^j is statistically significant at the 5 % level in the equations of land supply, housing price, public expenditure, and property tax for stringent level of regulations. It is also statistically significant at the 10 % level in those equations for counties with moderate, low, and no land use regulations. These results indicate that the land use regulations do not have the same effects on non-adopters, should they choose to adopt, as it does on adopters.

The parameter estimates for counties with stringent land use regulations are generally greater than for those with less stringent regulations in all four equations. This reflects that under stringent land use regulations, land supply, housing price, public expenditure, and property tax are more sensitive to variables affecting them.

The results in table 5 indicate that developers are more likely to develop in counties with higher land quality, higher income, and larger population. They develop more land in counties closer to metropolitan areas. Higher housing prices increase the supply of housing and thus land development; however, housing supply is negatively correlated with farm profit since farm profit is an opportunity cost of land development. The positive coefficients on variance of farm profit and negative coefficients on variance of new housing prices in the land supply equations indicate that developers are more likely to develop when facing high risks and uncertainties of farm profit and less likely to develop when facing high risks and uncertainties of housing price.

Parameter estimates for the housing price equation are shown in table 6. Seven of twelve coefficients under stringent regulation are statistically significant at the 5 % level. Only two of twelve coefficients are statistically significant at the 5 % level under no regulation. The coefficients on the distance to a metropolitan center and property taxes were not statistically significant at the 10% level under no regulation but they were statistically significant at the 5 % level under stringent regulations. This suggests that counties with stringent regulations are likely to be located near a metropolitan center where housing prices are significantly affected by both the distance to the metropolitan center and property taxes.

Housing prices tend to be higher in counties with higher land quality, higher income, larger population, and a larger variance of farm profit but tend to be lower in counties with a large variance of housing prices. Housing prices increase with the consumer price index as the prices of non-housing goods and housing prices tend to move in the same direction. Counties with higher development densities tend to have higher housing prices, but counties with higher property tax per capita tend to have lower housing prices. Housing prices tend to be higher in counties with a large public expenditure. This may reflect that counties with a large public expenditure can provide better public service.

Parameter estimates for the public expenditure equations are shown in table 7. Overall, the model fits the data well, with high R-squares. Most variables are statistically significant at the 10 % level. Public expenditure is positively correlated with income and population. Counties with high construction costs and/or high development densities tend to have higher levels of public expenditure. As expected, the higher the property tax, the larger the public expenditure.

Parameter estimates for the property tax equations are shown in table 8. The R-square and the magnitude of coefficients are consistently larger under the stringent regulations than under the other degrees of regulations. The coefficients of the variables in the property tax equation have the same signs as their coefficients in the public expenditure equations except variance of farm profit reflecting the balance budget constraint faced by county governments.

Equations (30) and (31) can be used to further explore how the intensity of land regulations affects land development, housing prices, public expenditure, and property tax. The short-run effects for period 1982-1987 and long-run effects for period 1982-1992 are shown in Tables 9 and 10, respectively. The effects of land use regulations increase with the degree of regulation. In counties with "stringent" land use regulations, the percent of developed area is reduced by 0.29 % in the five western states in the long-run. This means that for a county with 100 squares mile, the stringent regulations reduce the developed area by 0.29 squares mile. The total land area in all counties with stringent regulations in the five western states is 85,560,500 acres. By 1992, 2,909,100 acres, or 3.4 % were developed. If land use regulations had not been imposed in those counties, 3.79 % of total land area would have been developed. Thus, regulations in those counties save 248,100 acres of land from development, which is 8.5 % of developed area in 1992.

In counties with "moderate" regulations, the percent of developed area is reduced by 0.22 % in the five western states in the long run. The total land area in all counties with moderate regulations in the five western states is 113,183,300 acres. By 1992, 2,829,600 acres, or 2.5 % were developed. If land use regulations had not been imposed in those counties, 2.72 % of total land area would have been developed. Thus, regulations in those counties saved 249,000 acres of land from development, which is 8.8 % of developed area in 1992. Similarly in counties with "low" regulations, the percent of developed area is reduced by 0.13 %. The total land area in all counties with some regulations in the five western states is 89,026,500 acres. By 1992, 1,826,800 acres, or 1.7 % were developed. If land use regulations had not been imposed in those counties, 1.83 % of total land area would have been developed. Thus, regulations in those counties save 115,700 acres of land from development, which is 6.3 % of developed area in 1992.

All land use regulations in the five western states saved an estimated total of 458,000 acres (6.6 % of developed area in 1992) in the short-run and 612,800 acres (8.8 % of developed area in 1992) in the long-run. However, in counties with the most stringent land use regulations, the average new housing price increased by $5,741 per unit in the long-run. The average new housing price was $146,000 in 1982, thus the stringent land use regulations increased new housing prices by 3.9 % compared to no land use regulations.

Under stringent regulations, public expenditure increased by the largest amount ($92 per capita) in the short-run. The average public expenditure was $1,320 per capita in 1982, thus the stringent regulations increased public expenditure by 7.0 % in the short-run. However, in the long-run, land use regulations reduced public expenditure by $49 per capita under stringent regulations, a 3.7 % decrease compared to no regulations. Property tax also increased by the largest amount ($29 per capita) under the stringent regulation in the short-run. However, in the long-run, land use regulations reduced property tax by $16 per capita under stringent regulation.

The different short-run vs. long-run effects on public expenditure and property taxes suggest that in the short-run, county governments raise property taxes to cover the increased public expenditure needed to develop and implement land use regulations, whereas, in the long-run land use regulations reduce public expenditure and property taxes by reducing the extent of developed areas. In summary, in the long-run land use regulation reduced the amount of land developed, long-run public expenditure, and property tax; however, not without higher long-run housing prices, and short-run increases in public expenditure and property tax.

Conclusions

Measuring effects of land use regulations is becoming increasingly important as more communities exercise land use regulations. Previous studies on land use regulations have focused on a single land use regulation, treating all others as given and exogenously determined. They also have neglected interactions among residential development, land use regulations, and public finance (public expenditure and property tax). In this study a simultaneous equations system with self-selection and discrete dependent variables is used to estimate adoption decisions of land use regulations and their impacts on land use, public expenditure, and property tax.

The method is applied to land use regulation decisions in five western states using data from a comprehensive survey on land use regulations, the 1982, 1987, and 1992 National Resources Inventories, and other USDA publications. The results indicate that conversion of farmland and open space to development along with high public expenditure and property taxes promote county governments to impose more stringent land use regulations. More stringent land use regulations, in turn, reduce land development, long-run public expenditure, and property tax; however, not without higher long-run housing prices and short-run increases in public expenditure and property tax. The results also show that land use regulations, land development, public expenditure, and property tax all are significantly affected by population, geographic location, land quality, housing rent, and risks and costs of development.

References

Alig, R. J. and R. G. Healy. "Urban and Built-Up Land Area Changes in the United States: An Empirical Investigation of Determinants" *Land Economics* 63(1987): 215-226..

Bockstael, N., R. Costanza, I. Strand, W. Boynton, K. Bell, and L. Waigner. "Ecological Economic Modeling and Valuation of Ecosystems." *Ecological Economics* 14(1995): 143-159.

Chicoine, D. L. "Farmland Values at the Urban Fringe: An Analysis of Sales Prices." *Land Economics* 57(1981): 353-362.

Davis, O. A. "Economic Elements in Municipal Zoning Decisions." *Land Economics* 39(1963): 375-386.

Epple, D., T. Romer, and R. Filmore. "Community Development with Endogenous Land Use Controls." *Journal of Public Economics* 35(1988):133-162.

Epple, D. and H. Sieg. "Estimation Equilibrium Models of Local Jurisdictions." *Journal of Political Economics* 107(1999): 645-681.

Erickson, R. A. and D. R. Wollover. "Local Tax Burdens and the Supply of Business Sites in Suburban Municipalities." *Journal of Regional Science* 27(1987): 25-37.

Fischel, W. A. "A property Rights Approach to Municipal Zoning." *Land Economics* 54 (1978): 64-81.

Greene, W. H. *Econometric Analysis.* New Jersey: Prentice Hall, 1997.

Hardie, I. W. and P. J. Parks. "Land Use with Heterogeneous Land Quality: An Application of an Area Base Model." *American Journal of Agricultural Economics* 79 (1997): 299-310.

Henderson, V. "Community Development: The Effect of Growth and Uncertainty." *American Economic Review* 70(1980): 894-910.

Hushak, L. J. and K. Sadr. "A Spatial Model of Land Market Behavior," *American Journal of Agricultural Economics* 61(1979): 697-701.

Lee, L. F. "Generalized Econometric Models with Selectivity." *Econometrica* 51(1983): 507-512.

Levine, N. "The Effects of Local Growth Controls on Regional Housing Production and Population Redistribution in California, Urban Studies." 36(1999): 2047-2068.

Maddala, G. S. *Limited Dependent and Qualitative Variables in Econometrics.* CambrIdahoge: CambrIdahoge University Press, 1983.

McDonald, J. F. and D. P. McMillen. "Land Values, Land Use, and the First Chicago Zoning Ordinances." *Journal of Real Estate Finance and Economics* 16(1998): 135-150.

McMillen, D. P. and J. F. McDonald. "Selectivity Bias in Urban Land Value Functions." *Land Economics* 65(1989): 341-351.

McMillen, D. P. and J. F. McDonald. "Urban Land Value Function with Endogenous Zoning." *Land Economics* 29(1991): 14-27.

Mills, E. "Economic Analysis of Urban Land-Use Controls" in *Current Issues in Urban Economics.* P. Mieszkowski and M. Straszheim, Eds. Baltimore: Johns Hopkins University Press, 1979.

Phillips J. and E. Goodstein. "Growth Management and Housing Prices: The case of Portland, Oregon." *Contemporary Economic Policy* 18 (2000): 334-344.

Pogodzinski, J. M. and T. R. Sass. "The Theory and Estimation of Endogenous Zoning." *Regional Science and Urban Economics* 24(1994): 601-630.

Rolleston, B. S. "Determinants of Restrictive Suburban Zoning: An Empirical Analysis." *Journal of Urban Economics* 21(1987): 1-21.

Shlay, A. B. and P. H. Rossi. "Keeping Up the Neighborhood: Estimating Net Effects of Zoning." *American Sociological Review* 46(1981): 703-719.

Wall, B. R. "Trends in Commercial Timberland Area in the United States by State and Ownership, 1952-77, with Projections to 2030," General Technical Report, *Pacific Northwest Forest and Range Experiment Station, Portland OR*(1981).

Wallace, N.W. "The Market Effects of Zoning Undeveloped Land: Does Zoning Follow the Market?" *Journal of Urban Economics* 23(1988): 307-326.

Wu, J. and B. A. Babcock. "The Choice of Tillage, Rotation, and Soil Testing Practices: Economic and Environmental Implications." *American Journal of Agricultural Economics* 80(1998): 494-511.

Table 1. The Intensity of Land Use Regulation in the Five Western States

Category	Index of intensity of land use regulations (I)	% of Counties
Stringent	$I \geq 60$	31 %
Moderate	$30 \leq I < 60$	33 %
Low	$0 < I < 30$	25 %
No Regulations	0	11 %

Table 2. Definition of Variables

Variables	Mean	Standard Deviation	Definition
Endogenous Variables:			
Percent of total land developed	1.87	0.22	Percent of total land developed (%)
New housing price	159.0	91.5	Value of private new housing units ($1,000)
Property tax	436.0	67.0	Property tax per capita ($)
Public expenditure	1859.0	616.0	Public expenditure per capita ($)
Exogenous Variables:			
Farm profit	8.2	15.9	Farm profit per acre ($)
Population	0.2	0.9	Population per acre
Income	15.6	4.0	Income per capita ($ 1,000)
Land capability class	5.2	0.9	Weighted average of land capability class with 1 being the best land and 8 being the worst land
Distance to the closest metropolitan center	80.0	52.6	Distance from the geographic center of a county to the closest metropolitan center (population ≥ 100,000) (mile)
Construction cost	75.0	28.8	Construction cost as recorded on the building permit ($1,000)
Consumer price index	127.0	13.0	Consumer price index
Variance of farm profit	169.3	1,006.1	Variance of farm profit at the beginning of the period
Variance of new housing value	353.5	1,949.1	Variance of housing value at the beginning of the period

Table 3. Parameter Estimates for the Multinomial Logit Model of Land Use Regulation Intensity

Variable	Stringent	Moderate	Low
Constant	-1.554** (0.127)	-1.075** (0.343)	-1.395* (0.631)
Farm profit	0.034* (0.016)	0.026* (0.012)	0.010* (0.004)
Population	0.005* (0.003)	0.005* (0.002)	0.003 (0.002)
Income	0.004* (0.002)	0.002* (0.001)	-0.003 (0.015)
Land capability class	-0.017** (0.003)	-0.126** (0.021)	-0.114* (0.062)
Distance to the closest metropolitan center	-0.007* (0.004)	-0.001 (0.003)	-0.011* (0.005)
Construction cost	0.108** (0.026)	0.149** (0.019)	0.132* (0.066)
Consumer price index	-0.012* (0.005)	-0.010* (0.003)	-0.012 (0.009)
Variance of farm profit	-0.026* (0.017)	-0.043* (0.025)	0.017 (0.034)
Variance of new housing value	0.024** (0.007)	0.047* (0.020)	0.028* (0.013)
Public expenditure	0.207** (0.030)	0.183** (0.018)	0.193* (0.085)
Property tax	1.520** (0.317)	1.952** (0.224)	1.826* (0.639)
Percent of developed area in previous period	1.826** (0.429)	1.524** (0.264)	1.113 (0.653)
Pseudo R^2			0.86
Likelihood ratio test statistic			231
Correct predictions of land use regulation			67%

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 4. The Marginal Effects of Alternative Variables on the Intensity of Land Use Regulation

Variable	Stringent	Moderate	Low
Farm profit	0.0043* (0.0022)	0.0039* (0.0017)	0.0031* (0.0012)
Population	0.0013* (0.0005)	0.0010* (0.0006)	0.0006 (0.0005)
Income	0.0007* (0.0003)	0.0005 (0.0009)	-0.0003 (0.0024)
Land capability class	0.0053* (0.0038)	0.0045* (0.0021)	0.0038* (0.0015)
Distance to the closest metropolitan center	-0.0008** (0.0002)	-0.0007* (0.0004)	-0.0001 (0.0018)
Construction cost	0.0275** (0.0041)	0.0175* (0.0084)	0.0098** (0.0010)
Consumer price index	0.0012 (0.0007)	0.0010* (0.0004)	0.0001 (0.0007)
Variance of farm profit	-0.0109* (0.0061)	-0.0088** (0.0026)	-0.0069* (0.0025)
Variance of new housing value	0.0033** (0.0008)	0.0032* (0.0018)	0.0025 (0.0016)
Public expenditure	0.0142** (0.0031)	0.0135** (0.0027)	0.0105** (0.0031)
Property tax	0.1126** (0.0210)	0.1105** (0.0184)	0.1021** (0.0223)
Percent of developed area in previous period	0.1942** (0.0031)	0.1935** (0.0046)	0.1654** (0.0109)

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 5. Parameter Estimates for the Supply Equation of Land Development under Different Levels of Land Use Regulation Intensity

Variable	Stringent	Moderate	Low	None
Constant	0.193** (0.018)	0.156** (0.035)	0.103** (0.029)	0.056* (0.020)
Land quality	-0.013** (0.002)	-0.008* (0.004)	-0.007 (0.009)	-0.002 (0.031)
Farm profit	-0.216** (0.061)	-0.185** (0.043)	-0.029 (0.033)	-0.019** (0.002)
Variance of farm profit	0.014* (0.005)	0.008* (0.004)	0.006** (0.001)	0.001 (0.025)
Variance of new housing value	-0.002* (0.001)	-0.002* (0.001)	-0.001 (0.004)	-0.001* (0.001)
Income	0.012** (0.003)	0.007* (0.004)	0.002* (0.001)	0.001 (0.018)
Population	0.0005** (0.0001)	0.0006** (0.0001)	0.0004 (0.0012)	0.0002* (0.0001)
Distance to the closest metropolitan center	-0.0015* (0.0008)	-0.0011* (0.0004)	-0.0008* (0.0003)	-0.0005* (0.0002)
New housing price	0.0006** (0.0002)	0.0005* (0.0003)	0.0001 (0.0010)	0.0001 (0.0022)
λ^j	-0.128** (0.024)	-0.095** (0.013)	-0.0045** (0.0009)	-0.0029* (0.0016)
R^2	0.89	0.86	0.84	0.77

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 6. Parameter Estimates for the Housing Price Equation under Different Levels of Land Use Regulation Intensity

	Stringent	Moderate	Some	None
Constant	14.365** (3.652)	13.362 (9.439)	11.226 (11.669)	14.629* (7.012)
Property tax	-0.011** (0.003)	-0.008* (0.004)	0.002 (0.017)	0.002 (0.029)
Public expenditure	0.055* (0.024)	0.041* (0.028)	0.128 (0.106)	0.194 (0.181)
Percent of developed area in previous period	0.184** (0.031)	0.173** (0.056)	0.123** (0.042)	0.106* (0.071)
Land quality	-1.846** (0.295)	-0.725** (0.078)	-0.652** (0.060)	-0.548** (0.081)
Farm profit	-0.088** (0.023)	-0.053** (0.014)	-0.049** (0.015)	-0.030 (0.051)
Income	0.065 (0.085)	0.123* (0.092)	0.104 (0.063)	0.093* (0.050)
Population	0.296** (0.070)	0.240** (0.051)	0.177* (0.048)	0.295 (0.516)
Variance of farm profit	0.023 (0.051)	0.019 (0.063)	0.022 (0.081)	0.018 (0.049)
Variance of new housing value	-0.057* (0.024)	-0.041* (0.028)	-0.052 (0.057)	-0.037* (0.015)
Distance to the closest metropolitan center	-0.020** (0.005)	-0.015 (0.016)	-0.007* (0.004)	-0.002 (0.004)
Consumer price index	1.224** (0.175)	0.843* (0.481)	0.784* (0.361)	0.448* (0.302)
λ^j	-4.409** (0.468)	-4.882** (1.193)	-2.194* (0.871)	1.944** (0.499)
R^2	0.79	0.71	0.69	0.67

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 7. Parameter Estimates for the Public Expenditure Equation under Different Levels of Land Use Regulation Intensity

Variable	Stringent	Moderate	Low	None
Constant	14.529* (6.712)	20.133** (3.219)	10.190* (3.971)	8.839** (2.653)
Percent of developed area in previous period	0.0012** (0.0002)	0.0008* (0.0004)	0.0005* (0.0003)	0.0003* (0.0002)
Property tax	1.145** (0.033)	1.165** (0.031)	1.120** (0.026)	0.902** (0.180)
Land quality	-0.389** (0.105)	-0.284** (0.044)	-0.251** (0.045)	-0.106* (0.048)
Farm profit	-0.368** (0.036)	-0.254** (0.059)	-0.094** (0.031)	-0.056* (0.031)
Income	0.569** (0.177)	0.219* (0.131)	0.115* (0.055)	0.093** (0.029)
Population	0.005** (0.001)	0.003 (0.007)	0.012** (0.003)	0.008* (0.005)
Variance of farm profit	-0.309* (0.210)	-0.299* (0.128)	-0.165* (0.092)	0.060* (0.031)
Variance of new housing value	-0.583** (0.199)	-0.395** (0.031)	-0.254** (0.064)	-0.762** (0.041)
Consumer price index	0.017 (0.023)	0.025** (0.007)	0.015 (0.023)	0.011* (0.005)
Construction cost	1.407* (0.781)	1.257** (0.441)	1.109* (0.427)	1.093** (0.270)
λ^j	-0.612** (0.051)	-0.674** (0.017)	-0.324* (0.159)	-0.218* (0.115)
R^2	0.99	0.95	0.93	0.92

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 8. Parameter Estimates for the Property Tax Equation under Different Levels of Land Use Regulation Intensity

Variable	Stringent	Moderate	Low	None
Constant	-35.921* (17.316)	12.228** (4.190)	10.258* (5.013)	12.259** (3.710)
Percent of developed area in previous period	0.165* (0.085)	0.117 (0.219)	0.097** (0.014)	0.055 (0.060)
Public expenditure	0.274** (0.069)	0.195** (0.037)	0.164** (0.024)	0.078* (0.033)
Land quality	-1.543* (0.774)	-0.761* (0.365)	-0.329** (0.092)	-0.106 (0.108)
Farm profit	-0.024** (0.006)	-0.012** (0.004)	-0.007* (0.003)	-0.003* (0.001)
Income	0.031 (0.062)	0.029* (0.014)	0.016 (0.032)	0.007 (0.036)
Population	0.120** (0.028)	0.052** (0.014)	0.030** (0.009)	0.042** (0.010)
Variance of farm profit	0.127 (0.122)	0.073 (0.114)	0.066** (0.016)	0.032** (0.008)
Variance of new housing value	-0.199** (0.038)	-0.078* (0.042)	-0.021 (0.013)	-0.010 (0.024)
Consumer price index	0.082** (0.025)	0.090** (0.014)	0.051* (0.027)	0.025* (0.010)
Construction cost	0.259 (0.368)	0.195 (0.171)	0.060** (0.014)	0.071* (0.035)
λ^j	-7.620** (0.776)	-2.914* (1.198)	-0.162* (0.182)	-0.073** (0.017)
R^2	0.90	0.81	0.79	0.73

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 9. The Estimated Short-Run Effects of Land Use Regulation Intensity on Land Development, Housing Price, Public Expenditure, and Property Tax between 1982 and 1987

Regulation intensity	Percent of total land developed	Housing price ($/unit/year)	Public expenditure ($/capita/year)	Property tax ($/capita/year)
Stringent	-0.23** (0.09)	5,512** (124.2)	92* (33.5)	29** (8.9)
Moderate	-0.16* (0.05)	2,391** (196.4)	51** (8.4)	12* (3.7)
Low	-0.09 (0.20)	701** (116.3)	26 (41.9)	7 (15.6)

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

Table 10. The Estimated Long-Run Effects of Land Use Regulation Intensity on Land Development, Housing Price, Public Expenditure, and Property Tax between 1982 and 1992

Regulation intensity	Percent of total land developed	Housing price ($/unit)	Public expenditure ($/capita/year)	Property tax ($/capita/year)
Stringent	-0.29* (0.11)	5,741** (188.9)	-49 (41.0)	-16* (9.5)
Moderate	-0.22 (0.18)	3,013** (290.1)	-31* (16.1)	-13** (2.1)
Low	-0.13 (0.14)	1,319 (1,910)	22 (54.1)	2 (10.8)

Note: The numbers in parenthesis are standard errors; * indicates statistical significance at the 10 % level; ** indicates statistical significance at the 5 % level.

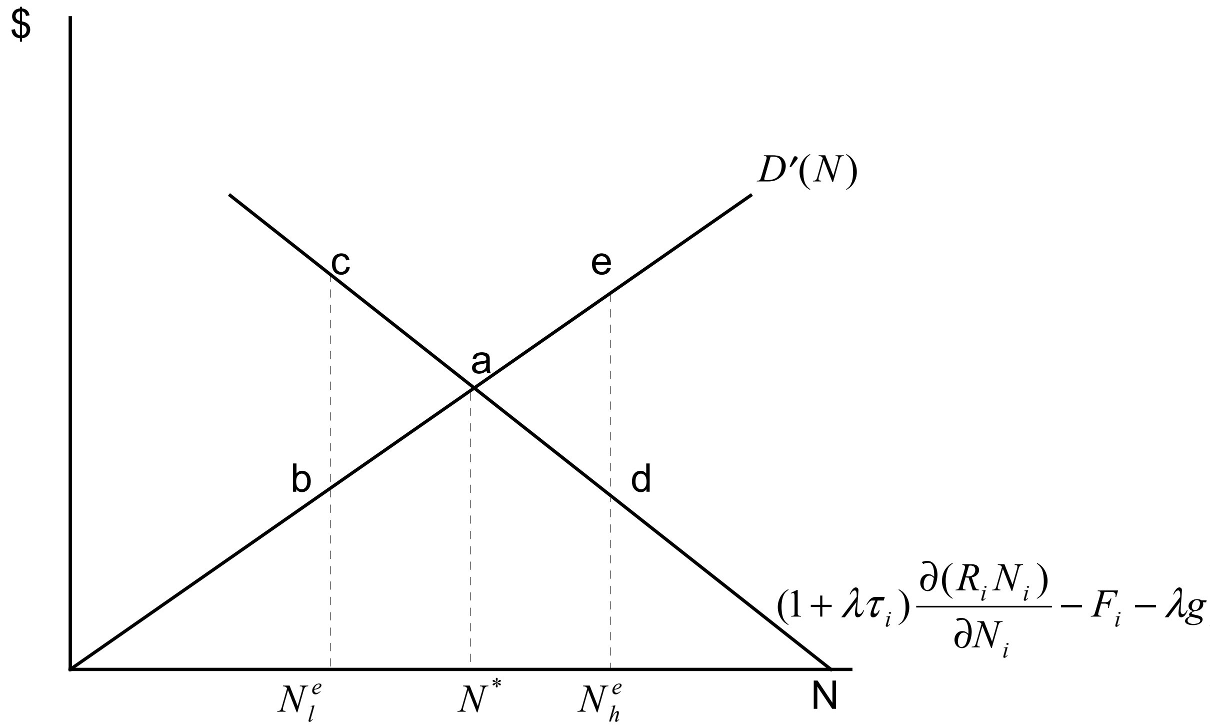

Figure 1. Socially Optimal and Market Equilibrium Land Use