AN ABSTRACT OF THE DISSERTATION OF

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Title: Land Use Policy and Property Value

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Andrew J. Plantinga William K. Jaeger

A plethora of land use policies are implemented at the local, state, and federal levels to influence the manner in which land is utilized. The distribution of the costs and benefits associated with implementing such land use policies always has been, and will continue to be, a source of contention. The three essays presented in this dissertation explore two types of land use policies: state and local-level land use regulations that restrict the use of land and incentives for voluntary conservation.

The first essay addresses the economic issues that arise from the adoption of state-level compensation legislation, which requires a government entity to pay compensation to a property owner when the value of his property has been reduced by the enactment of a land use regulation. An assumption implicit to the idea of compensation is that effect of a land use regulation on a property's value is observable and can be accurately estimated. This assumption is problematic due to the complex interaction of land use

regulations and land use decisions, and the market's anticipation of both future regulation and potential payments of compensation. Supposing that the price effects of regulation could be accurately estimated, the scope of compensation statutes is too narrow to consistently identify and appropriately compensate landowners who have been most heavily burdened by land use regulation.

Economists investigating the effect of land use regulation on property value have typically estimated hedonic property value models with regulations included as exogenous regressors. This approach is likely to be invalid if parcel characteristics that determine property values also influence the government's decision about how to implement regulations. The second essay uses Regression Discontinuity Design (RDD) to study the effect of the Portland, Oregon, Urban Growth Boundary (UGB) on property values. RDD provides an unbiased estimate of the treatment effect under relatively mild conditions and is well-suited to our application because the UGB defines a sharp treatment threshold. We find a price differential on the western and southern sides of the Portland metropolitan area ranging from $30,000 to at least $140,000, but no price differential on the eastern side. Voter support for Measure 37, a compensation statute approved by Oregon voters in 2004, was fueled by price differences such as these among parcels subject to different regulations, but one must be careful not to view current price differentials as evidence that regulations have reduced property values.

The third essay considers an incentive mechanism designed to encourage spatially coordinated land conservation: the agglomeration bonus. The primary weakness of the agglomeration bonus as it has been represented in the literature is that it requires landowners to coordinate land use decisions amongst each other, potentially resulting in coordination failure. The functionality of the agglomeration bonus is improved by allowing landowners' enrollment decisions to be conditional on surrounding patterns of enrollment. Under a conditional agglomeration bonus, a landowner's enrollment decision is determined entirely by his own private costs and benefits, eliminating the potential for coordination failure.

Land Use Policy and Property Value

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APPROVED:

_____

Co-Major Professor, representing Agricultural and Resource Economics

_____

Co-Major Professor, representing Agricultural and Resource Economics

_____

Head of the Department of Agricultural and Resource Economics

_____

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University Libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Cyrus A. Grout, Author

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Chapter 1 - General Introduction

The status of the Nation's natural resources is inextricably tied to condition of the lands on which they exist and how the land is used. Changes in land-use can affect the livability of urban spaces, environmental benefits such as wildlife habitat, ecosystem services, and recreation opportunities, as well as the productivity and quality of agricultural and forest resource lands. As such, a plethora of land use policies are implemented at the local, state, and federal levels to influence the manner in which land is utilized.

An aspect of land that differentiates it from other capital assets is that its utilization typically generates externalities. Consequently, land use policies are often designed to influence private land uses for the public benefit, by encouraging land use patterns that generate positive externalities while limiting negative externalities. The distribution of the costs and benefits associated with implementing such land use policies always has been, and will continue to be, a source of contention. From the perspective of property owners, there is a great deal of concern about how land use policies affect property values, particularly when policies restrict the use of private property. From the perspective of budget constrained policy makers, the design of mechanisms that maximize the production of public benefits is of great interest. The three essays presented in this dissertation explore two types of land use policies: state and local-level land use regulations that restrict the use of land and incentives for voluntary conservation.

The first essay (Chapter 2), *Regulatory Takings and Compensation Legislation*, considers compensation statutes, which are on one hand a reaction to land use policy, and on the other hand a land use policy in and of themselves. The statutes, which advance the argument that too often, land use regulations unfairly burden some property owners, have been adopted in six states. Recent years have seen a proliferation of compensation legislation on the ballots of Western states. Compensation statutes require a government entity to compensate a property owner when the fair market value of his property has been reduced by the enactment of a land use regulation.

The idea of compensating a property owner for the diminution in fair market value resulting from the enactment of a land use regulation raises a number of economic issues. This essay addresses some of the most prominent of these issues in two parts. The first part considers an assumption implicit to the idea of compensating a property owner: that the effect of a land use regulation on the fair market value of a property is observable and can be accurately estimated. I find that accurately estimating this effect is problematic, and that efforts to do so are likely to be contentious and costly. A jurisdiction subject to a compensation statute is likely to face a great deal of uncertainty about the liability associated the enactment of any new regulation.

The second part considers the scope of the question posed by the compensation statutes (What is the effect of a particular regulation on a particular property?) and analyzes whether it is sufficient to consistently identify and appropriately compensate unfairly burdened property owners. I find that the compensation statutes will not, in general, do so because they do not account for many of the indirect effects of land use regulations.

The second essay (Chapter 3), *Land Use Regulations and Property Values in Portland, Oregon: A Regression Discontinuity Design Approach*, studies the effect of Portland's urban growth boundary (UGB) on property values. Oregon's land-use planning system is regarding by many as the most comprehensive in the nation. UGBs are a central feature of Oregon's land use planning system, and the source of much controversy. When Oregon voters approved compensation legislation in 2004 (Measure 37), a large share of the ensuing claims filed for compensation were made on agricultural and forest lands just outside the Portland UGB.

The central economic question behind Measure 37 and other compensation statutes is, what is the effect of land-use regulations on land values? A related question, which has also received much attention in the context of Oregon is, does growth management increase housing prices? Identifying the causal effect of land use regulation on property value is difficult due to endogeneity of land value and land use regulation. Economists investigating these issues have mostly relied on hedonic price models, which assume that land use regulations are exogenous. In this paper, we adopt an alternative identification strategy, regression discontinuity design (RDD), to study the effects of

Portland's UGB on property values. RDDs involve a dichotomous treatment that depends on an observable and continuous score variable. The average effect of the treatment is measured as the difference in the outcome of interest above and below the threshold. An unbiased estimate of the average treatment effect is obtained under relatively mild continuity assumptions.

We find a price differential on the western and southern sides of the Portland metropolitan area ranging from $30,000 to at least $140,000, but no price differential on the eastern side. Voter support for Measure 37, a compensation statute approved by Oregon voters in 2004, was fueled by price differences such as these among parcels subject to different regulations, but one must be careful not to view current price differentials as evidence that regulations have reduced property values.

The third essay (Chapter 4), *Incentives for Spatially Coordinated Land Conservation: A Conditional Agglomeration Bonus*, considers the design of an incentive to encourage spatially coordinated land conservation. Land conservation is a tool extensively used by governments and environmental organizations to obtain a multitude of environmental benefits. In some cases, the marginal benefit of conservation effort is small until some threshold level of conservation has been reached. For example, the population of a species may not be viable when its contiguous habitat is below some minimum amount of acreage.

An incentive mechanism proposed in the literature to encourage spatially coordinated conservation is the agglomeration bonus. It awards landowners bonus payments for the conservation of adjacent portions of land. Real world applications of the agglomeration bonus are rare, and its implementation is hampered by limits on the amount of information neighboring landowners have about each other's opportunity costs of participating in a conservation program. The modification to the agglomeration bonus mechanism proposed in this paper improves its applicability by limiting landowners' information requirements to knowledge of their own opportunity costs and eliminating the need for landowners to coordinate their enrollment decisions.

Chapter 2 – Regulatory Takings and Compensation Legislation

> …nor shall private property be taken for public use, without just compensation.
>
> ■ The "takings clause" of the Fifth Amendment of the U.S. Constitution

> As Justice Holmes warned in Mahon, "[g]overnment hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law." A rule that required compensation for every delay in the use of property would render routine government processes prohibitively expensive or encourage hasty decision making. Such an important change in the law should be the product of legislative rulemaking rather than adjudication.
>
> ■ U.S. Supreme Court Justice Stevens, majority opinion of Tahoe v. Tahoe, 2002

> If a public entity enacts or enforces a new land use regulation or enforces a land use regulation enacted prior to the effective date of this amendment that restricts the use of private real property or any interest therein and has the effect of reducing the fair market value of the property, or any interest therein, then the owner of the property shall be paid just compensation…Just compensation shall be equal to the reduction in the fair market value of the affected property interest.
>
> ■ State Ballot Measure 37, Oregon, 2004

> We all buy home insurance to protect our property from floods, fires, and other natural disasters. But you can't buy insurance to protect your home from unexpected changes in property regulations. Measure 37 fills that gap, and doesn't cost a dime!
>
> ■ Argument presented in favor of Measure 37, Oregon Homeowner's Association, November 2004 Oregon Voter's Pamphlet

Introduction and Background

Property rights advocates have consistently argued for greater protections of private property rights under the "takings clause" of the Fifth Amendment of the Constitution; the Supreme Court has consistently disappointed, providing no more than a limited baseline of protection against government takings. Over a series of rulings, the Court has defined a categorical taking as limited to either the physical invasion of a property or actions resulting in the total loss of a property's economic viability (Lucas v. South Carolina 1992, Palazzolo v. Rhode Island 2001, Penn. Coal v. Mahon 1922, Tahoe

v. Tahoe 2002). While awarding compensation is not ruled out in the case of a partial taking (e.g., a diminution in property value caused by the enactment of a land use regulation), the Court has tended to rule against non-categorical takings claims. The Court has also refused to adopt any *per se* rule, such as a particular diminution in value, that would categorically define partial takings (Cordes, 1997). Ultimately, as suggested by Justice Stevens in *Tahoe v. Tahoe* (2002) (see quote above), the Court indicated that any further protections against regulatory takings should be the product of legislative rule making.

In response, the fight for stronger property rights has been taken to the state level in the form of legislation that seeks to protect landowners from governmental restrictions on the use of their property. Since 1992, some form of legislation supporting fewer restrictions on property rights has been introduced in every state and passed in at least 26 states (Jacobs, 2003). The majority of this legislation consists of "assessment" or "look-before-you-leap" statutes, the impact of which has been largely symbolic.[1]

Since 1995, more substantial legislation consisting of "compensation" statutes has been introduced in at least 20 states (Cordes, 1997) and passed in six states.[2] Compensation statutes give a landowner the right to seek compensation when a government action (typically a land use regulation) reduces the market value of his or her property. However, the statutes allow governments to grant exemptions to landowners in lieu of paying compensation. Recent years have seen a proliferation of this type of "pay or waive" compensation legislation on ballot initiatives in the western U.S. Oregon passed compensation statutes in 2004 and 2007 after rejecting a similar initiative in 2000. In 2006, compensation legislation was passed in Arizona, rejected in California, Idaho and Washington, and blocked from ballots by courts in Montana and Nevada.

To say that compensation legislation adopted by states strengthens the protections of private property provided by the Constitution would be an understatement. Each

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[1] "Assessment" or "look-before you leap" statutes essentially ask governments to formally consider the impact of land-use regulations on private property values without restricting a government's underlying authority to impose and enforce regulation.

[2] States that have passed compensation legislation are Florida, Louisiana, Mississippi, and Texas (1995); Oregon (2004); Arizona (2006); Oregon (2007).

compensation statute adopted into law redefines categorical takings in a manner that represents an enormous departure from existing case law and legal tradition. In particular, each statute effectively adopts a *per se* rule to define a partial taking. The farthest reaching statutes, adopted in Arizona, Florida, and Oregon, ignore Justice Holmes' warning in *Pennsylvania Coal v. Mahon* that "government could hardly go on," and consider *any* diminution in the value of a property caused by a land use regulation to be a compensable taking.

Legal arguments aside, from an economic standpoint the effect of a land use regulation on property value is theoretically ambiguous. A land use regulation potentially has (often simultaneously) three different kinds of effects on a parcel of land: restriction effects, scarcity effects, and amenity effects (Jaeger, 2006). A restriction effect, which is negative, is the result of the most profitable use of a parcel of land (e.g. industrial development) being restricted. A scarcity effect, which is positive, results from a restriction on the supply of land available for a particular use (e.g. residential development). An amenity effect, which is positive, is the result of positive externalities produced by the enforcement of a land use regulation (e.g. compatible neighboring land uses). Depending on the magnitude of each of these effects, the net effect of a land use regulation on property value may be positive or negative.

This theoretical ambiguity is reflected in the empirical literature. In a survey of 28 studies on the effects of municipal zoning Pogodzinski and Sass (1991) found little agreement on the net effect of municipal zoning. More recent empirical studies produce mixed results, identifying restriction effects (Anderson and Weinhold, 2005, Beaton and Pollock, 1992, Ihlanfeldt, 2007, Nickerson and Lynch, 2001), amenity effects (Mahan, et al., 2000, Netusil, 2005, Ready and Abdalla, 2005, Spalatro and Provencher, 2001, Thorsnes, 2002), and scarcity effects (Phillips and Goodstein, 2000, Quigley and Raphael, 2005). The empirical evidence on the net effect of development restrictions, which are likely to produce both restriction and amenity effects on the regulated properties, is also mixed (for example, see Anderson and Weinhold, 2005, Henneberry and Barrows, 1990).

The traditional justification of land use planning is to prevent the negative externalities that result from unfettered land use. And in spite of what theoretical and

empirical economics has to say on the matter, a popular perception is that development restrictions unambiguously depress vacant land values. That many hold this perception is understandable. Land use planning decisions have the effect of allocating and reallocating property rights and lead to differential effects that benefit some landowners more than others. Even if the great majority of property owners are better off with, rather than without, a land use planning system, observed disparities between differentially regulated properties are often interpreted as evidence of a diminution in value caused by the planning system.

Where there are land use regulations, there are likely to be tensions over the differential effects of those land use regulations on land value. Of the states that passed the farthest reaching compensation statutes (AZ, FL, and OR), two (FL and OR) had adopted comprehensive land-use planning systems in the 1970s and 1980s featuring restrictions on development and the protection of resource lands.[3] Although the benefits of these land use planning systems appear to be appreciated by residents of Oregon and Florida (for example, see Gray and Shriver, 2006), the degree to which the use of private property is restricted by these planning systems had clearly become a source of discomfort for many property owners. Compensation statutes, which effectively redistribute the costs and benefits of land use planning, represent an attempt to manage this discomfort.

The idea of compensating a property owner for the diminution in fair market value resulting from the enactment of a land use regulation raises a number of economic issues. Preceded by a description of the compensation statutes adopted into law and a brief discussion of land value, this essay addresses some of the most prominent of these issues in two parts. The first part considers an assumption implicit to the idea of compensating a property owner: that the effect of a land use regulation on the fair market value of a property is observable and can be accurately estimated. I argue that this price effect is not generally observable, and that attempts to estimate it are likely to be contentious, costly, and loaded with uncertainty. The second part considers the scope of

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[3] The Florida Legislature adopted The Local Government Comprehensive Planning and Land Development Regulation Act in 1985. The Oregon Legislature approved Senate Bill 100 in 1973, creating the Department of Land Conservation and Development.

the question posed by the compensation statutes: what is the effect of a particular regulation on a particular property? The application of a particular regulation to a property is one of many government actions that may positively or negatively affect a property's value (including the application of other land use regulations to other properties). I argue that the scope of compensation statutes is too narrow to consistently identify, and appropriately compensate, those property owners who have been most heavily burdened by land use regulation.

The Compensation Statutes

The six compensation statutes adopted into law are described in the subsections below. The features that are of particular interest to this essay are (1) the definition of a compensable action, (2) the definition of "just compensation" and how it is to be measured, and (3) in what manner governments may exercise the option to waive or modify an offending action in lieu of paying compensation.

Florida

In 1995 the Florida legislature passed the Bert Harris Private Property Rights Protection Act (1995). It was a legislative response to widespread discomfort with limits the state's land use planning system imposed on landowners' ability to use their property as they desired. The stated purpose of the Act is to protect the interest of property owners from unfair burdens by expanding the protections provided to property owners under the U.S. and Florida constitutions. The Act establishes a detailed legal process by which landowners may seek this protection.

Definition of a compensable action

A landowner may seek financial compensation or other relief when a "specific action of a governmental entity has inordinately burdened an existing use of real property." "Real property" means land and includes any appurtenances and improvements to the land. An "existing use" is defined to include current *and proposed* uses of the real property. The property owner may demonstrate that a government action has "inordinately burdened" him by demonstrating that he is (1) "permanently unable to attain the reasonable, investment-backed expectation for the existing use of the real

property," or (2) "left with existing or vested uses that are unreasonable such that the property owner bears permanently a disproportionate share of a burden imposed for the good of the public, which in fairness should be borne by the public at large." To establish an inordinate burden under condition (1), a landowner must submit as part of his claim a valid appraisal that demonstrates a loss in fair market value to the real property.

The inordinate burden criterion is an ambiguous standard, but the important point is that it is expansive. Under condition (1), the imposition of virtually any new land use regulation that restricts a potential use of a property is arguably imposing an "inordinate burden" upon the landowner. Apparently, no Florida court has rejected a claim on the grounds that it failed to meet the inordinate burden criterion (Echeverria and Hansen-Young, 2008).

The Act does not apply to any government action prior to its adoption in 1995, and no claim for compensation or other relief may be filed more than 1 year after any future government action.

Definition and measurement of "just compensation"

"Just compensation" is intended to account for the actual loss to the fair market value of the real property caused by the specific government action in question, as of the date of the action. The Act directs the court considering the claim to impanel a jury to determine the award of compensation. The award of compensation is to be calculated as the difference in the fair market value of the property with and without the government action in question, at the point in time when the government action occurred.

Waivers or modifications in lieu of compensation

Prior to entering the compensation stage of the legal process, the government is entitled to make a settlement offer, which may consist of any combination of modifications to the government action in question and financial compensation. It is only after the claimant rejects a settlement offer that a claim for compensation is filed in circuit court. If the court finds that the claimant rejected a bona fide settlement offer in his pursuit of compensation, the government is entitled to recover reasonable costs and fees from the claimant. Likewise, the claimant is entitled to recover costs and fees from the government if the settlement is not found to represent a bona fide offer. The key

point is that any waiver or modification in lieu of compensation is made prior to the determination of "just compensation" by the court.

Oregon – Measure 37

In 2004, Oregon voters overwhelming approved Ballot Measure 37, titled "Governments Must Pay Owners, or Forego Enforcement, when Certain Land Use Restrictions Reduce Property Value." The stated purpose of the Measure is to expand the protections provided to landowners by the Oregon Constitution, which requires the government to pay "just compensation" when condemning private property or taking it by other action, including laws precluding all economically viable use. The Measure expanded these protections by requiring the government to pay "just compensation" whenever it enacts or enforces a land use regulation that precludes essentially *any* economically viable use.

In comparison to the other compensation statutes considered in this essay, Measure 37 is brief and ambiguous (the entire Measure is all of three pages). Much of its interpretation was left up to courts and local jurisdictions, which responded to claims in a variety of ways.

<u>Definition of a compensable action</u>

Under Measure 37, a landowner may seek relief in the form of compensation or a waiver whenever a public entity enacts or enforces a new land use regulation or enforces an existing land use regulation that restricts the use of private real property and has the effect of reducing the fair market value of the property. "Land use regulation" is defined to include any statute regulating the use of land, local government comprehensive plans and zoning ordinances, and regional planning goals. The statute's application to existing land use regulations is unique among the compensation statutes adopted into law.

While the Measure does apply to both new and existing land use regulations, it does not apply to regulations enacted prior to the date of acquisition of a property by its owner. Claims arising from land use regulations enacted prior to Measure 37 must be filed within two years of its adoption. Claims related to a new land use regulation must be filed within two years of its enactment, or the date on which the landowner submits a

land use application where the land use regulation is an approval criterion, whichever is later.

Definition and measurement of "just compensation"

"Just compensation" is to be equal to the reduction in the fair market value of the affected property interest resulting from enactment of the land use regulation in question as of the date the landowner files a claim for compensation. The Measure does not proscribe any specific methods for measuring the reduction in fair market value caused by a land use regulation.

Waivers or modifications in lieu of compensation

A government entity may modify, remove, or not apply a land use regulation in lieu of payment of just compensation. If a land use regulation continues to apply to a property more than 180 days after its owner has made a written demand for compensation, the owner shall have a cause of action for compensation in circuit court and be entitled to reasonable attorney fees and costs.[4] If a claim has not been paid within two years, the owner shall be allowed to use his property as permitted at the time he acquired it. A waiver or modification of a land use regulation made in response to a claim for compensation is not considered a compensable land use decision.

Oregon - Measure 49

In 2007, Oregon voters approved Measure 49, titled "Modifies Measure 37; Clarifies Right to Build Homes; Limits Large Developments; Protects Farms, Forests, Groundwater." In comparison to Measure 37, Measure 49 is detailed and precise. Measure 49 eliminates many of Measure 37's most controversial features and establishes specific procedures for processing and settling claims. However, the central premise of Measure 37, that land use regulations unfairly burden some landowners, is maintained. Measure 49 also maintains that, to address this situation, unfairly burdened landowners are entitled to just compensation based on the reduction in fair market value resulting from the enactment of a land use regulation.

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[4] The liability for legal fees under Measure 37 extends only to the government. This stands in contrast to Florida's Bert Harris Act.

Definition of a compensable action

A landowner is eligible to file a claim if his desired use of the property is residential, farming or forest practice, the desired use is restricted by one or more land use regulations, and the regulation or regulations have reduced the fair market value of the property. Furthermore, "relief may not be granted…if the highest and best use of the property at the time the land use regulation was enacted was not the use that was restricted by the land use regulation." A claim for compensation must be filed within five years of the enactment of the land use regulation at issue.

Measure 49 applies to existing regulations only to the extent that it establishes detailed procedures for the resolution of Measure 37 claims filed prior to the effective date of the new Measure. Measure 37 claimants could elect one of two processes to resolve a claim. The first option, outlined in Section 6 of the Measure, allows the claimant to create no more than three parcels, lots, or dwellings. The claimant does not have the burden of demonstrating a diminution in fair market value, but must show that the creation of the desired parcel, lot, or dwelling is prohibited by a land use regulation. The second option, outlined in Section 7, potentially awards a more extensive waiver or financial compensation. The claimant must in this case establish a reduction in fair market value as described below.

Definition and measurement of "just compensation"

Just compensation is to be equal to the reduction in fair market value caused by the land use regulation(s) at issue. The reduction in fair market value is defined as the difference in the fair market value of the property from the date that is one year before the enactment of the land use regulation to the date that is one year after the enactment, plus interest compounded to the present. Fair market value is defined as the amount of money that the property would bring if the property were offered for sale by a willing seller and purchased by a willing buyer.

The claimant must provide an appraisal that shows the fair market value of the property one year before and after the enactment of the regulation at issue and demonstrates the highest and best use of the property at the time of enactment. Section 21b of the Statute states that the fair market value of the property "does not include any

prospective value, speculative value or possible value based upon future expenditures and improvements."

Waivers or modifications in lieu of compensation

If the claimant is able to establish a reduction in fair market value cause by a land use regulation, the responsible government entity must either: (a) compensate the claimant for the reduction in fair market value, or (b) authorize the claimant to use the property without application of the land use regulation to the extent necessary to offset the reduction in fair market value.

Arizona

In 2006 Arizona voters passed Proposition 207, titled the "Private Property Rights Protection Act" (2006). The proposition is modeled after Oregon's Measure 37 with the important distinction that it only applies to land use regulations enacted after its adoption. The Act finds that in spite of existing constitutional protections against takings, "the state and municipal governments of Arizona consistently encroach on the rights of private citizens to own and use their property." The stated intent of the act is to establish procedures by which a landowner will receive just compensation when state or local governments take or diminish the value of private property.

Definition of a compensable action

A property owner is entitled to seek just compensation "if the existing rights to use, divide, sell or possess private real property are reduced by the enactment or applicability of any land use law…and such action reduces the fair market value of the property." "Land use law" is defined to include any statute, rule, ordinance or law that regulates the use or division of land or accepted farming or forest practices. The Act applies only to land use laws enacted after the passage of the Act that apply directly to a property, and a landowner may not seek compensation for the effect of a government action taken prior to his acquisition of property. A claim for compensation must be made within three years of the enactment of the land use law at issue.

Definition and measurement of "just compensation"

Just compensation is defined as the diminution in value resulting from the enactment of the land use law at issue, as of the date its enactment. Fair market value is defined as the most likely price a property would bring if exposed for sale in the open market. The purchaser is assumed to buy with knowledge of all the uses and purposes to which the property is adapted and for which it is capable.

Waivers or modifications in lieu of compensation

If a land use law continues to apply to a property more than 90 days after the owner makes a written demand for compensation the owner has a cause of action for just compensation in court. The government can avoid court if it reaches an agreement on the amount of compensation to be paid, or it amends, appeals, or issues a binding waiver of enforcement of the land use law at issue and the owner's *specific* parcel. The Act only applies to government actions that *directly regulate* a property. Hence, liability does not extend to a reduction in fair market value caused by an action taken to resolve a landowner claim for just compensation under the Act.

The claimant is never liable to the government for attorney fees and costs. A claimant prevailing in a case for just compensation may be awarded reasonable fees and costs.

Louisiana, Mississippi, and Texas

In 1995, Louisiana, Mississippi, and Texas adopted compensation statutes that are more narrowly construed than the legislation presented above. Apparently, no lawsuit seeking compensation for a diminution in property has been filed in either Louisiana or Mississippi. In Texas, landowners rarely invoke the Private Real Property Rights Preservation Act and when they have, they have rarely if ever succeeded in winning relief (Echeverria and Hansen-Young, 2008).

Under these compensation statutes, the range of government actions subject to potential claims for compensation is relatively limited. The statutes adopted in Louisiana and Mississippi apply only to regulations restricting forestry or agricultural activities. In Texas, the statutes generally exempt actions taken by municipalities and actions "reasonably taken" to comply with state or federal laws (Echeverria and Hansen-Young,

2008). A major difference between these statutes and those passed in Florida, Arizona and Oregon is that claimants seeking "just compensation" must establish more substantial diminutions of value than *any* diminution in value. A landowner is entitled to seek compensation if a land use law causes a diminution in value of more than 20% (LA), 40% (MS), or 25% (TX).

The Value of Land

The concept of fair market value is central to each piece of compensation legislation. From a theoretical standpoint, the value of a parcel of land is equal to the sum total of the future incomes it will generate discounted back to the present (Barlowe, 1958). Assuming perfect competition and risk neutrality, the present value of a parcel of land can be formulated as

(1) $PV_{t=0} = \sum_{t=0}^{T} \frac{I_t}{(1+r)^t}$,

where $PV_{t=0}$ is the present value of the property in time period zero, I_t is the expected income in time period t, and r is the discount rate. If expected income $I_t = I$ in each year and is earned into perpetuity, the calculation simplifies to $PV = \frac{I}{r}$.

The fair market value of a parcel of land is typically defined as the price that willing and well-informed buyers and sellers would agree upon for the exchange of the property. In a competitive market, market forces will push the price of a property at time $t = 0$ towards the value $PV_{t=0}$ as represented in equation (1).[5]

While the expression of land value in equation (1) is simple, it is important to recognize that the sequence of values $I_0,\ I_1,\ I_2, \ldots$, incorporates a great deal of complexity and uncertainty. Underlying each I_t are expectations about a host of variables including input and output prices, development patterns, government policies (including future land use regulations), and regional demographics (Alig and Plantinga, 2004, Plantinga, et al., 2002).

Because future incomes are unknown, the value of a particular parcel of land as an income-earning asset is uncertain. Individuals forecasting the stream of income that

[5] This assumes risk neutrality on the part of buyers and sellers in the market. The formula in equation (1) would require modification to accommodate risk preferences.

will be generated by a property are likely to form a variety of opinions about the expected value of a property. Observations of market prices tend to be preferred by economists to inform an accurate estimate of an asset's value. The basic reasoning underlying this preference is that a market price captures the information and knowledge that forms the expectations of many individuals (i.e., all potential buyers and sellers in the market). The following discussion presumes that a sales comparison (as opposed to income or cost) approach is the suitable method to appraising the effect of a regulation on a property's fair market value.

Observability

Stated in various terms, each compensation statute declares that just compensation shall be equal to the diminution of a property's fair market value resulting from the enactment of a land use regulation. Arizona and Florida's statutes measure the diminution in value as of the date the land use regulation is enacted. Oregon's Measure 37 measures diminution in value as of the date a claim is filed, and Measure 49 compares the fair market value of a property one year before and one year after the land use regulation in question was enacted. What each statute ostensibly assumes, is that the diminution in fair market value resulting from the enactment of a land use regulation is observable or can be reliably estimated.

From an economic standpoint, the causal effect of a land use regulation on the fair market value of a property is the difference in what the property would sell for given that the land use regulation was enacted and what the property would sell for had the regulation never been enacted. For reasons discussed in the following subsections, identifying this effect in the context of the compensation statutes presented above may be impossible or at the very least, challenging.

Existing Land Use Regulations

Oregon's Measure 37 is the only compensation statute that applies to land use regulations enacted prior to the statute's adoption into law.[6] It states that just

[6] Oregon's Measure 49 establishes procedures to resolve Measure 37 claims, including claims made against land use regulations that were enacted prior to the adoption of Measure 37 in 2004. However, by the time

compensation is to be equal to the reduction in the fair market value of the affected property resulting from enactment of the land use regulation, as of the date the landowner files a claim for compensation. Applying this definition of just compensation to a property with an existing land use regulation is problematic because its calculation involves a hypothetical value. Just compensation for the effect of an existing land use regulation is equal to the fair market value of the property as it exists minus the fair market value of the property as it would have existed had the land use regulation in question never been enacted. We do observe the value of the property as it exists subject to the regulation, but we do not at the same time observe the value of the property had the regulation never been enacted. That is, we do not observe the counterfactual.

It is tempting to infer a counterfactual by comparing the value of the regulated property to the value of a similar property that is not subject to the regulation, and this was standard practice under Measure 37 (see, for example, Martin and Shriver, 2006). However, to do so would ignore the fact that over time, the enactment of the regulation may have interacted with other variables that are determinants of land value. Consider a hypothetical example: suppose that Property A has been subject to a regulation restricting development for the past 10 years, Property B has not been, and that the properties are otherwise the same. Currently, the value of Property A is $100 and the value of Property B is $200: a disparity of $100. A comparison of these current land values might be construed (incorrectly) as implying a $100 diminution in Property A's value resulting from the regulation. Suppose also that had the land use regulation not been enacted 10 years in the past, there would have been a larger supply of developable land (lowering land prices) and fewer people would have been drawn to the region due to undesirable land use patterns (decreasing demand and pushing prices downward). In this world without the land use regulation, the value of both Property A and Property B is $110. Hence, enactment of the land use regulation diminished the value of Property A by $10. Ultimately, the value of the regulated property in this example was affected by both

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Measure 49 was adopted in 2007, the two-year deadline had passed to file claims against existing land use regulations under Measure 37. Therefore, no new claims against existing land use regulations will be filed under Measure 49.

restriction (negative) and amenity (positive) effects, while the unregulated property benefited from scarcity effects.

Identifying the differential effect of a land use regulation must not be confused with identifying the effect of a land use regulation on a property's value. In the above example, the disparity between the values of Property A and Property B of $100 is the differential effect of the land use regulation. The effect that Measure 37 defines as the "just compensation" that should be awarded to the owner of Property A is $10. Particularly when a regulation has been in place for a significant amount of time, estimations of diminution in value based on comparisons of regulated and unregulated properties are likely to be misleading. In the example above, Property B benefited from the regulation which restricted supply and produced amenity benefits. Most of the disparity between the values of Property A and Property B is in fact due to an increase in Property B's value, not a decrease in Property A's value.

In attempting to determine the effect of a real-world land use regulation, we do not have the luxury of observing both regulated and unregulated outcomes. Measure 37 puts whichever party has the burden of proof into a very difficult position, because one cannot establish diminution in value based on observable data. A claimant is put into the position of having to engage in retrospective fortune telling. Measure 49, which clarifies Measure 37, redefines just compensation as the diminution in value resulting from a regulation one year before and after its enactment. In its use of estimates of land value close to the point in time that the regulation was enacted, Measure 49 acknowledges the lack of a counterfactual. The assumption underlying this approach is that any change in land value during the two year period surrounding the enactment of the regulation is attributable to the regulation. That is, it assumes other determinants of land value did not change independently of the enactment of the land use restriction. As discussed below, this approach has pitfalls of its own.

Anticipation of Land Use Regulation

While only Measure 37 applies to land use regulations existing at the time of its adoption, each compensation statute applies to the enactment of new compensation statutes. Estimating the diminution in a property's value resulting from the enactment of

a new regulation as of the date it is enacted would appear to be a straightforward exercise: observe the fair market value of the property immediately before and after the enactment of the regulation. However, identifying the effect of a regulation on property value is complicated by the fact that land values incorporate expectations about the future, including the enactment of new land use regulations. Hence, the present value of a property may reflect the effect of a new land use regulation *prior* to its enactment.

The compensation statutes adopted in Florida and Arizona seek to identify the diminution in value resulting from the enactment of a land use regulation *as of* the date of its enactment. This quantity must be distinguished from the diminution in value resulting from a land use regulation *on* the date of its enactment. "As of" implies a cumulative change in value, while "on" implies a change that occurs at a specific point in time.[7] When the enactment of a regulation is anticipated by the market, these changes in value are not equivalent.

To illustrate this point, consider a simple example where a parcel of land in a competitive market earns an annual income of $100 into perpetuity and that the discount rate is 5%. The present value of the property in each year is then $\frac{\$100}{.05} = \$2{,}000$. If a land use regulation restricts the use of the property and reduces its annual income to $50, the present value of the restricted property is $\frac{\$50}{.05} = \$1{,}000$. From an economic standpoint, the effect of the land use regulation on the fair market value of the property is $\$2{,}000 - \$1{,}000 = \$1{,}000$: the difference in the value of the property when its use is restricted into perpetuity and its value had its use never been restricted.

Regardless of how the market anticipates the regulation, the cumulative change in value resulting from the regulation *as of* the date of its enactment will be $1,000. However, when and by how much the property's market value changes depends on how the market anticipates the enactment of the new regulation. If the market has absolutely no foresight of the regulation, the change in the value of the property *on* the date it is enacted is $1,000. On the other hand, if the market anticipates the regulation and its effect on the annual income earned by the property at any time prior to its enactment, the

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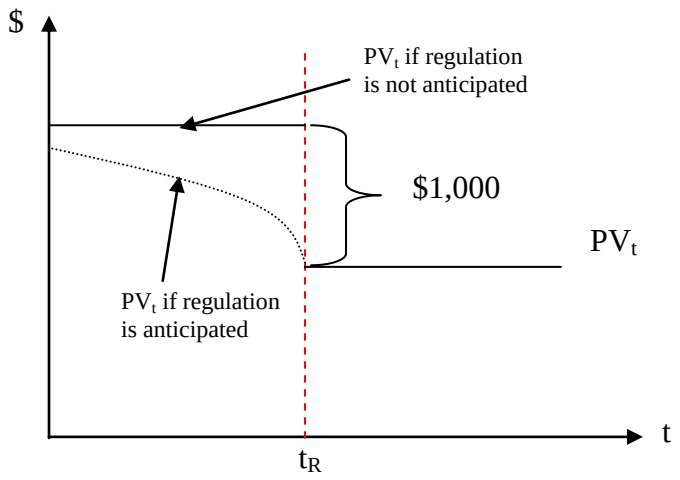
[7] For example, suppose a person has been dieting for the past month. He weighed 160 lbs one month ago and now weighs 150 lbs. *As of* today he has lost 10 lbs. *On* this date, he lost 0 lbs.

market value of the property will reflect the future losses of income and change gradually (see Figure 1). For example, the expected stream of income from the property one year prior to the anticipated regulation is $\{\$100, 50, 50, 50, ...\}$ and its present value is $1,050, which is close to its value after the enactment of the regulation.

Figure 2.1 The Change in Property Value in Response to a Land use Regulation



Estimates of fair market value based on market transactions occurring soon before the enactment of a regulation may be misleading if the regulation is anticipated by the market. The graph in Figure 1 considers two extreme cases: (1) there is absolutely no anticipation of the regulation, and (2) there is perfect anticipation of the regulation and its effect on property value. Realistically, the anticipation of a regulation is likely to be somewhere in between, where the enactment of a new regulation and its effect on property value are both uncertain. To the extent that new land use regulations are anticipated, observations of market transactions before and after the enactment of a regulation will tend to reflect less than the total effect of the regulation on property values.

The extent to which land use regulations are anticipated by the market will depend on the transparency of regulatory agencies and how well long term planning objectives are expressed. In most jurisdictions, the enactment of new regulation is a long process involving public input and new regulation will tend to be anticipated to some degree. In Oregon for example, the legislation authorizing statewide land-use planning was passed in 1973, but was not fully implemented until a decade later. The same

Oregon legislation created the Department of Land Conservation and Development which adopted 19 state-wide planning goals, the first of which is Citizen Involvement.

Anticipation of Compensation or a Waiver

The discussion of observability has to this point ignored the effect of compensation itself on property value. If the market anticipates the enactment of a new regulation and an accompanying reduction in property value, it will also anticipate potentially receiving compensation (or a waiver in lieu of compensation) for that reduction in value. The compensation (or the value of a waiver) is then an expected future income and has the effect of increasing the market value of a property prior to the enactment of a regulation.

To continue with the example above, suppose that the effect of an impending regulation on property value is known to be $1,000 and that owners of properties subject to the regulation will be compensated accordingly when the regulation is enacted. The market value of such a property one year before the enactment of the regulation is $2,000 because the present value of a perpetual stream of $50 less income is equivalent to the compensation of $1,000:

(2) $$PV = 100 + \frac{50+1{,}000}{(1+0.05)^1} + \frac{50}{(1+0.05)^2} + \frac{50}{(1+0.05)^3} + \cdots + \frac{50}{(1+0.05)^n} = \$2{,}000.$$

In this simple example the actual effect of the regulation is known and a specific amount of compensation is certain to be awarded. More realistically, the market will form expectations about the effect of the land use regulation on property value and the amount of compensation to be awarded, both of which are uncertain.

The interaction between an expectation of future compensation and the market value of land is potentially complex. If estimates of the diminution in fair market value resulting from the enactment of a regulation are based on observations of market transactions before and after its enactment (as opposed to certain compensation of $1,000), the effect of compensation on market value becomes indeterminate because compensation and market value are determined simultaneously. That is, expected compensation is a function of market value, and market value is a function of expected compensation. If a buyer expects to be compensated for any losses resulting from an impending land use regulation, he may be willing to pay more for a property than what its

present value (as unregulated) would normally justify.[8] The important point is that compensation may be incorporated into a property's value prior to the enactment of a new regulation, complicating the estimation of the effect of the regulation on fair market value.

The estimation of diminution in value is also complicated by the effect of expected compensation on a property's value *after* the enactment of regulation. Consider a population of properties that are subject to a new regulation restricting their use, where the perceived effect of the regulation is to lower each property's value. Ideally, one would like to base estimates of the fair market value of a regulated property on observations of market transactions of these properties. However, particularly if the perceived diminution in value is large, a property owner may be unlikely to sell his property prior to filing a claim for compensation because his property rights are left in an uncertain state. An important feature of each compensation statute is that a property owner is entitled to file a claim if and only if he or she owned the property prior to the enactment of the regulation in question. Hence, the value of the property to the regulated owner (who has recourse for compensation) is higher than the value of the property to a potential buyer (who has no recourse for compensation), and a transaction is unlikely. The owner of a regulated property could file a claim and sell the property prior to the resolution of the claim, but the value of the resolved claim to the buyer and seller would depend on whether compensation is awarded (benefitting the seller) or a waiver is granted (benefitting the buyer).

The incentive not to sell a newly regulated property prior to resolving a claim for compensation may result in a paucity of data upon which to base an accurate estimate of fair market value. Furthermore, even when a property is sold prior to the resolution of a claim, the property rights associated with it are uncertain: will it be regulated (compensation paid) or unregulated (waiver granted)? In general, the potential award of compensation (or a waiver) creates a situation where the rights associated with newly (or

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[8] The effect of anticipated compensation on fair market value has been discussed under the context compensation for eminent domain actions. For example, see Blume et al. (1984).

soon to be) regulated properties are uncertain.[9] Until those rights are resolved, it is unclear from a theoretical standpoint how the market will value those properties.

The Compensation Statutes and Diminution in Fair Market Value

The basic question posed by each compensation statute is, what is the diminution in value resulting from the enactment of a land use regulation? The preceding subsections argue that it may be difficult to answer this question. In the case of an existing regulation, we do not observe a counterfactual. In the case of a new regulation, estimating its effect on property value is complicated by the fact that markets may anticipate the enactment of new regulation as well as the payment of compensation. In general, estimates of diminution in market value based on observations of actual market transactions may be misleading.

Income and Sales Comparison Approaches to Appraisal

The language in the statutes regarding just compensation focuses on "fair market value," and a sales comparison approach to appraising the value of a property would ostensibly be the appropriate approach. That said, even putting aside the issues raised in this section, a sales comparison approach to appraisal is vulnerable to data limitations. There may not be a sufficient number of comparable transactions upon which to base an estimate. For example, large commercial and agricultural properties do not tend to be frequently transacted. Furthermore, real estate transactions are often combined with the sale of other goods (such as buildings and equipment) or property rights (such as easements), and an appraiser must be able to identify which sales are arms length transactions.

In reviewing claims for just compensation, claimants appear to be amenable to adopting an income approach (i.e. discounted cash flow analysis) to determining fair market value.[10] An income approach to market value is based on the anticipation of future benefits. In principle, the market value of a property is equivalent to the future

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[9] For reasons discussed in the second part of this essay, the value of a waiver is likely to differ from the value of just compensation.

[10] For example, some claims made in Florida and Oregon are expressed in terms of lost development opportunities, which may or may not have been profitable or even carried out, rather than observable changes in market prices.

stream of benefits it will generate, discounted to the present as represented in Equation (1). However, market values derived using income approaches are an inherently subjective product: an appraiser must make assumptions about future incomes, costs, and market conditions. The Uniform Standards of Professional Appraisal Practice (2010) manual notes the following about discounted cash flow (DCF) analysis: "Because DCF analysis is profit oriented and dependent on the analysis of uncertain future events, it is vulnerable to misuse." When the level of compensation is directly related to the market value of a property, claimants have a strong incentive to inflate estimates of the income a property is expected to generate in the future.

Compensation for Existing Land Use Regulations

Measure 37's guidelines for determining just compensation did not go beyond stating that it shall be equal to the reduction in fair market value resulting from the enactment or enforcement of the land use regulation in question. The statute did not require the preparation of a certified appraisal, nor specific forms of evidence supporting the claim.[11] Measure 37 claimants tended to adopt two approaches to calculating just compensation: (1) a sales comparison based on the differential effect of the land use regulation, or (2) an income approach forecasting the cash flow that a proposed land use would generate. Rather than answer the question of how much a regulation has reduced a property's value, these approaches answer the question of how much more a property would be worth if the existing regulation in question was removed from the property. This is essentially the value of the waiver, not diminution in value.

For example, a claim submitted to Clackamas County in December 2004 by Charles Hoff sought $9.6 million in just compensation for the reduction in value caused by development restrictions on a 53 acre property bordering Portland's urban growth boundary. The claimant wished to subdivide the property, which was allowed by the zoning in place at the time of purchase in 1977. In 1979, the County rezoned the property for exclusive farm use (EFU), which requires a minimum of 80 acres for new lots. In his claim, Mr. Hoff states that he had been offered over $10 million for his

[11] Though should a claim proceed to circuit court, its success would certainly benefit from an expertly prepared appraisal.

property if the zoning were changed to accommodate 2-acre subdivision (Martin and Shriver, 2006). Mr. Hoff based his estimate of just compensation on the differential effect of the land use regulation rather than the effect of the regulation on his property, by comparing the value of his property to the value of less stringently regulated properties.

In some cases, the courts appear to confuse the diminution in value resulting from the enactment of a land use regulation with its differential effects. In Fred Hall v. Multnomah County, Oregon, the plaintiff sued for damages related to regulations that restricted the land to rural uses (e.g., agriculture or forestry). Mr. Hall's desired use of his property was to develop a high density residential area with 65 to 70 lots. The plaintiff failed to meet his burden of proving that regulation had reduced the fair market value of his property. The court sought an appraisal showing the following: "…what is the market value of the property as-is in 2005, and secondly the market value of the property without the minimum 160-acre lot size [in 2005]." That is, the current value of the property, and what the property would be worth if the regulations in question were removed. Ultimately, Mr. Hall's claim failed because the court found the appraisal work to be inadequate, not because the appraiser was asking the wrong question (which, as previously discussed, would be very difficult to answer).

Many Measure 37 claims were found to successfully demonstrate a diminution in value resulting from the enactment of land use regulation(s). However, in all but one case, the government responded by waiving regulations rather than paying just compensation (Echeverria and Hansen-Young, 2008). There are a number of reasons why governments may have favored waivers over compensation, including the fact that payments for compensation would have been drawn from the general funds of cash strapped agencies. Regarding the observability of diminution in value, because the effect of an existing regulation on property value is not observable, its exact size is likely to be contentious. Engaging in a court battle to determine just compensation is likely to be unattractive to a local government, particularly when the claimant is entitled to reasonable attorney fees incurred to collect the compensation (however small).[12]

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[12] In the state's highest profile Measure 37 case, Dorothy English v. Multnomah County, the County was ordered to pay $195,000 of attorneys' fees to English in addition to $1.15 million in just compensation.

Measure 37 was the only compensation statute passed into law that applied to existing land use regulations, and it was subsequently replaced by ballot Measure 49 which was overwhelmingly approved by voters. One reason states have avoided adopting such retrospective compensation statutes is that they essentially ask appraisers to know the unknowable: what would the world look like if a regulation had not been enacted X years ago? Due to the unobservable effects of land use regulations over time, it wouldn't appear that Measure 37 could ever be practically implemented.

Compensation for New Land Use Regulations

The preceding discussion of observing the effect of a new land use regulation on property value focused on the complications arising from the market's anticipation of new regulation and compensation. It is not clear how or whether market anticipation has affected property values before and after the enactment of a regulation. However, anecdotal evidence suggests that developers and governments are incorporating expectations about the price effects of new regulation and the consequences of just compensation into their decision making.

In Florida, Echeverria and Hansen-Young (2008) cite the example of a developer, who in anticipation of a voter approved referendum reducing allowable building height from 15 to 5 stories, filed an application to develop two 15-story buildings. The referendum was enacted and when the City denied the application, the developer filed suit and prevailed in obtaining permitting to construct the 15 story buildings. In a similar case cited by the authors, a developer filed a $38 million Bert Harris Act Claim in response to a voter approved restriction on the height of new ocean-front development. The developer filed building plans with the City a few days before the election and was successful in obtaining a waiver from the City, which feared that the developer had a potentially valid claim.

At the same time developers are anticipating the future benefit of compensation, whether in the form of cash or a waiver, governments are anticipating the potential liability associated with adopting new regulations. The number of lawsuits filed under the Bert Harris Act has been relatively limited since its adoption in 1995. However, use of the Act to threaten litigation has been widespread in order to influence regulatory

decision making. Some communities have responded by deciding against the adoption of new regulations, and others have relaxed or withdrawn existing regulations (Echeverria and Hansen-Young, 2008).

In Arizona, governments have anticipated the potential liability associated with new land use regulations and have adopted a number of strategies to avoid exposure to claims for just compensation. These strategies include asking property owners affected by a new land use law to sign waivers indemnifying the government from future claims for just compensation in response to the law, and the establishment of review committees that assess potential claims and risks associated with land use actions (Stephenson and Lane, 2008). It is not clear how many communities have avoided the adoption of new land use regulations due to the liabilities created by the Private Property Rights Protection Act, but the Act has to date generated very little litigation.

In Oregon, it is unclear how Measure 49 has affected market expectations of regulatory decisions. To date, the few claims that have been filed against new regulations have all been withdrawn.[13] Several aspects of Measure 49 and Oregon's land use planning system make the prospect of successfully demonstrating a diminution in fair market value less likely. First, Measure 49 compares the fair market value of a property one year before and after the enactment of the regulation in question. If enactment of the regulation is well anticipated, one would expect little diminution in value to occur during that time period. Oregon's land use planning system is relatively transparent, and regulators may make an effort to inform citizens of future regulatory changes with Measure 49 in mind.

Second, the claimant is required to establish that the desired use of property being restricted by the regulation in question was the highest and best use of the property at the time the regulation was enacted. It has been empirically demonstrated that future development incomes are capitalized into property value when the current use of a property continues to be an undeveloped use such as forestry or agriculture (Kilgore and Mackay, 2007, Plantinga, et al., 2002, Wear and Newman, 2004). If a new regulation restricted future development when the current highest and best use is forestry or

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[13] http://www.oregon.gov/LCD/MEASURE49/docs/general/m49_new_claims_received.pdf

agriculture, the property owner would have no recourse under Measure 49 because its definition of fair market value does not include value based upon future expenditures and improvements.

Observability and Compensation Statutes

In summary, the difficulty of using observations of market transactions as a basis to estimate just compensation raises questions about the ability of states to implement compensation statutes in a fair and consistent manner. Because transaction based estimates of just compensation are difficult or problematic, claimants are likely to rely on an income approaches to estimating fair market value that are inherently subjective and prone to misuse. In general, the effect of a regulation on the fair market value of a property is contentiousness, and the transaction costs associated with determining just compensation (i.e. legal fees) are likely to be large. Furthermore, because the price effect of a regulation is difficult to pin down, governments are likely to face a great deal of uncertainty about the financial liability associated with the enactment of new regulations. Hence, the finding that actual payments of compensation for regulatory takings have been rare in states adopting compensation statutes is not surprising (Echeverria and Hansen-Young, 2008).

The Narrow Scope of Compensation Statutes

The underlying theme motivating each of the compensation statutes is one of fairness. The statutes each advance the argument that too often, land use regulations unfairly burden some landowners. To address such inequities the statutes establish procedures to identify unfairly burdened property owners (those experiencing a diminution in fair market value) and justly compensate them (in the amount of said reduction, or a waiver in lieu of compensation). The preceding section of this essay addresses the practical difficulty of accurately answering the question posed by compensation statutes: What is the effect of a particular land use regulation on a property's fair market value? This section addresses whether, in asking this question, compensation statutes are likely to consistently identify and appropriately compensate landowners who have been unfairly burdened by land use regulation.

The following discussion sets aside the arguments advanced in the first part of this essay and assumes that the effect of a land use regulation on a property's value can in fact be determined.

Direct and Indirect Effects of Land Use Regulations

An age old axiom of real estate is the oft repeated phrase, "Location, location, location," which emphasizes how important the features of a property's surroundings are to its value. In the economics literature, it is well established that the value of a parcel of land is a function of both on-site attributes (e.g., soil quality, viewshed, and slope) and off-site attributes (e.g., proximity to infrastructure and surrounding land use patterns). By extension, the fair market value of a parcel of land is affected by land use regulations that are applied to it directly, as well as by regulations that are applied to other parcels of land in the extent of its market.[14]

Consider the ways in which a bundle of regulations may potentially affect the value of some parcel of land, Property X. Suppose that a land use regulation applied to Property X *directly* affects its value by restricting potential development opportunities (a restriction effect). That same regulation applied to other properties *indirectly* affects the value of Property X by ensuring that compatible land uses surround Property X (an amenity effect). Additionally, a variety of other land use regulations applied to other properties *indirectly* affect the value of Property X by influencing the pattern of land use throughout the geographic region (potentially producing amenity and scarcity effects). The key point is that the bundle of regulations that affect the value of Property X is not limited to those regulations that specifically restrict its use. In addition to land use regulation, many other government decisions related to land use may affect property value. For example, decisions such as where to build a road or extend sewer service may confer large benefits to some landowners.

In spite of the wide array of government actions that may positively or negatively affect property value, the scope of the compensation statutes is decidedly narrow. The compensation statutes exclusively consider regulations that are applied directly to a

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[14] For the purposes of this discussion, the extent of the market is considered broadly, such that its participants include all types of land in a geographic region.

property, and ignore any positive effects resulting from the application of other regulations to other properties. Measure 49 and Arizona's Property Rights Act subtly acknowledge the indirect effects of land use regulation. In defining a "compensable government action," these statutes explicitly exclude government actions taken in response to claims by property owners for just compensation. Hence, the statutes appear to recognize the fact that a government action applied to one property, such as a granting a waiver to an existing regulation, may negatively affect the value of another property.

The narrow scope with which the compensation statutes consider the effects of regulation on property value is neither discussed nor justified, and was presumably adopted for practical reasons. Under a broadened scope, a government action applied to one property could potentially result in numerous claims for compensation by neighboring properties. And as Justice Holmes commented in *Pennsylvania Coal vs. Mahon*, "government hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law."

Identifying Unfairly Burdened Property Owners

The narrow scope of the compensation statutes has important implications for how unfairly burdened property owners are identified.

How do the Compensation Statutes Identify Unfairly Burdened Property Owners?

In general, the compensation statutes enacted in Florida, Oregon, and Arizona identify a property owner as unfairly burdened if the enactment of a land use regulation results in a diminution of the fair market value of his property. The language in Florida's Bert Harris Act and Oregon's Measure 37 does not explicitly state whether a property owner can be unfairly burdened by a regulation applied to other properties, but the statutes have generally been interpreted as applying only to regulations directly restricting a property. Arizona's Property Rights Act and Oregon's Measure 49 explicitly apply only to a regulation that directly regulates the use of a property.

A property owner is considered by the compensation statutes to be unfairly burdened if the fair market value of his property had a regulation never been enacted is greater than the fair market value of his property as it exists with the regulation. The compensation statutes measure this difference at different points in time, but the key

point is that the compensation statutes explicitly ignore the effect of other land use regulations and government actions on the value of a property.

Are the Compensation Statutes Rules Consistent?

For the sake of simplifying the following discussion, I make the two following assumptions: 1) Every property owner purchased his or her property at the same time, such that each invested into the same regulatory landscape, and 2) For each property, the diminution in fair market value resulting from land use regulation is known.

Precisely defining who has and who has not been unfairly burdened is beyond the scope of this essay, and arguably beyond the scope of economics. That said, it is reasonable to expect a rule for identifying unfairly burdened property owners to exhibit some degree of consistency. Consider the following definition of consistency where the net effect of *all* land use regulation (enacted after landowners have acquired property) on the value of Property i is NE_i: an identification rule is consistent if whenever NE_A is less than NE_B and Property B is identified as unfairly burdened, Property A is also identified as unfairly burdened.

By this definition, the compensation statutes do not, in general, consistently identify unfairly burdened property owners. To illustrate this point consider the following example represented in Table 2.1. Two groups of otherwise identical properties (Group A and Group B) are subject to two different regulations (Regulation A and Regulation B). The fair market value of each property in Group A is diminished by $25 as a result of the enactment of Regulation A (due to restriction effects) and increased by $100 as a result of the enactment of Regulation B (due to amenity and scarcity effects). The fair market value of each property in Group B is increased by $50 as a result of the Enactment of Regulation A (due to amenity effects) and not affected by the enactment of Regulation B (due to amenity and restriction effects balancing out. The net effect of regulation is positive for properties in both groups, but greater in Group A: $NE_A = \$75$ and $NE_B = \$50$.

Table 2.1 Identification of Unfairly Burdened Property Owners

	Properties in Group A	Properties in Group B
Effect of Regulation A	-$25	+$50
Effect of Regulation B	+$100	+$0
Net Effect of regulations A and B	+$75	+$50

The compensation statutes would identify properties in Group A, but not Group B as unfairly burdened. The effect of the regulation directly applied to each property in Group A is a reduction of $25 in value, which is a compensable action. The effect of the regulation directly applied to each property in Group B is no reduction in value, which is not a compensable action. The indirect effects of each regulation are not accounted for.

Payment of just compensation of $25 to properties in Group A would exacerbate the existing disparity between NE_A and NE_B. The net benefit of a regulation that explicitly restricts the use of a property is likely to be negative, while the net benefit of another regulation that explicitly restricts the use of other properties is likely to be positive. By focusing only on the effects of regulations that directly regulate a property, compensation statutes generally ignore any benefits resulting from the application of other regulations to other properties and potentially identify landowners who have fared relatively well overall as being inordinately burdened.

The compensation statutes put land use planners and regulators in a curious position. Government actions that increase the value of a property by generating positive amenity and scarcity effects may also have the effect of increasing the liability associated with restricting the use that property may be put to in the future. A property owner that disproportionately benefits from amenity and scarcity effects produced by government actions in general may experience a relatively large reduction in fair market value as a result of a regulation restricting the use of his property. For example, a county may decide to build a road next to a parcel of agricultural land with the result of increasing its value as farmland and making it suitable for residential development. A subsequent restriction on residential development would substantially decrease the value of the land. The compensation statutes consider only the second action. The property owner would

have a valid claim for compensation in spite of the fact that on net, he benefitted from government actions.

Waivers in Lieu of Compensation

Claims filed under compensation statutes have rarely resulted in the payment of actual compensation (Echeverria and Hansen-Young, 2008), and in the great majority of cases governments have granted waivers to offending land use regulations in lieu of compensation. While waivers are presented in the compensation statutes as an option equivalent to payment of just compensation, a waiver is fundamentally different than compensation. A payment of just compensation represents a transfer of wealth to a property owner, while a waiver essentially redefines the bundle of property rights held by the property owner. Two important implications of this difference are that (1) the value of a waiver is likely to exceed the value of payment of just compensation, and (2) a waiver is likely to negatively affect the value of other properties.

The Value of a Waiver

Each compensation statute allows the government to modify, remove, or not apply a land use regulation in lieu of paying compensation. In whatever form the waiver is granted, the compensation statutes (with the exception of Measure 49) state that a waiver should restore the uses available to the property owner prior to the enactment of the regulation in question.[15] This may be accomplished by removing the regulation in general, including its application to other parcels, or by granting waivers to the regulation on a parcel-by-parcel basis. Governments have tended to adopt the latter approach.

Granting waivers on a parcel-by-parcel basis further narrows the scope with which land use regulation is considered. Because a land use regulation affects a property's value directly and indirectly, waivers granted to a subgroup of the properties subject to the regulation will tend to over compensate those property owners. Such waivers remove the direct effect of the regulation (which tends to be negative) while leaving the indirect effects of the regulation in place (which tend to be positive). The

[15] Measure 49 states that the value of a waiver should be commensurate to the reduction in fair market value resulting from the enactment of the regulation in question.

ultimate value of a waiver is likely to depend on the number of other properties owners who successfully obtain waivers.

Consider, for example, a claim filed by a developer under the Bert Harris Act in Florida. Voters approved a city referendum that reduced permitted building height in the city from 15 stories to 5 stories. One developer, having submitted an application to build two 15-story buildings prior to the approval of the referendum, filed a claim for compensation when the city denied the application. The developer was then allowed to build the two 15-story buildings, while the new height restriction continued to apply to the rest of the city (Echeverria and Hansen-Young, 2008). The developer is clearly better off than before the adoption of the building height restriction, benefitting from both amenity and scarcity effects.

Waivers and Negative Externalities

Just as waivers are likely to leave a claimant better off than he was before the enactment of a regulation, a property owner who does not receive a waiver is likely to be worse off. A property owner who does not receive a waiver remains subject to the direct effect of the regulation (which tends to be negative) without fully benefitting from the indirect effects of the regulation (which tend to be positive). As mentioned above, Oregon's Measure 49 and Arizona's Property Rights Act recognize this possibility and explicitly deny such property owners the right to file a claim for compensation.

Under Oregon's Measure 37, which did not deny the right to file a compensation claim for a diminution in value resulting from a waiver, numerous claims against waivers were filed by property owners. These included a lawsuit filed by a farming family protesting a waiver allowing the subdivision of a neighboring 54-acre property into half-acre residential lots (Echeverria and Hansen-Young, 2008). The claimants argued that the incompatibility of agricultural and residential land uses would impede their operations. In addition to lawsuits, landowners wrote over 85,000 letters to the state in response to being notified of claims filed by neighboring property owners. Clearly, property owners were concerned about waivers granted to neighboring properties affect their own property values.

Conclusion

Compensation statutes rest on the premise that some property owners are unfairly burdened by land use regulations.[16] While this premise is almost certainly true, the assumptions underlying each statute's proposed remedy to this situation (to compensate a property owner for the reduction in fair market value resulting from a land use regulation restricting the use of his property) are problematic.

Payment of compensation for a diminution in fair market value resulting from the enactment of a land use regulation assumes that this price effect is observable and can be accurately estimated. However, such a price effect is not generally observable and is problematic or challenging to estimate. In the case of existing regulations, we simply do not observe a counterfactual. Particularly where a regulation has been in effect for an extended period of time, it is impossible to say with any certainty what a property's value would currently be had the regulation never been enacted. In recognition of this, Oregon's Measure 49 measures the diminution in value resulting from a land use regulation from the time one year before and one year after its enactment. However, before and after comparisons also face complications.

Estimating the effect of a land use regulation as of the date it is enacted is complicated by the market's anticipation of new regulation and potential compensation for diminutions in value resulting from new regulation. The market value of a property is likely to incorporate the effect of a new regulation prior to its enactment, as well as the effect of potentially receiving compensation (or a waiver in lieu of compensation) for any diminution in value caused by that regulation. Furthermore, the different property rights associated with potentially receiving compensation or a waiver may make the purchase and sale of a property unattractive, resulting in a dearth of market transactions upon which to base estimates of fair market value. In general, determining just compensation is likely to be contentious and costly for both property owners and governments (i.e. taxpayers).

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[16] For example, the Florida's Property Rights Act describes its intent as providing "relief, or payment of compensation, when a new law, rule, regulation, or ordinance of the state or a political entity in the state, as applied, unfairly affects real property."

The compensation statutes also assume that when a property's fair market value is reduced by a particular land use regulation, its owner has been unfairly burdened. This assumption is problematic because land use regulations are only one of many types of government decisions that may positively or negatively affect property value. In adopting an approach judging the fairness of regulation that is very narrow in scope, the compensation statutes risk increasing the disparity between landowners who have generally benefitted from government actions and those landowners who have not.[17]

The narrow scope of compensation statutes does not appear to stem ignorance of the indirect effects of regulations on other properties and other government decisions that affect property value. It is more likely that the prospect of simultaneously accounting for every regulation and government action is simply too daunting. But if asking the right question in regards to just compensation (Has a property owner benefited from and been burdened by government actions in general?) is too daunting or impractical, can asking the wrong question (How has a landowner benefitted from and been burdened by a particular regulation?) be justified?

[17] This should not be construed as a general argument against the analysis of the effect of an individual land use regulation on property value. In many contexts, an analysis of the effect of a regulation will provide accurate and useful information.

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Chapter 3 – Land Use Regulations and Property Values in Portland, Oregon: A Regression Discontinuity Design Approach

Introduction

Over the past two decades, the tension between public and private interests in the use of land has given rise to state-level legislation seeking to limit government controls on private property. Since 1992, some form of property rights legislation has been introduced in every state in the U.S. and passed in 26 (Jacobs, 2003). The majority of this legislation consists of largely symbolic "look-before-you-leap" statutes that require legislators to consider the effects of new laws on private property values. However, since 1995, more substantive "compensation" statutes have been introduced in 20 states (Cordes, 1997) and passed in six.[18] Compensation statutes require payments to landowners when the value of their property is reduced by government actions. Because of its comprehensive land-use planning system, the Oregon case is perhaps the best known. In 2004, voters approved Measure 37 with a 61 percent majority.[19] The new law required state, county, and local governments to compensate private landowners for negative effects of existing land-use regulations or, in lieu of payments, to waive the regulations. Measure 37, the text of which came to fewer than 3 pages, raised, by did not clarify, a multitude of legal and economic issues.[20] Partly because of these ambiguities, Oregon voters approved Measure 49 in 2007, which significantly scaled back the provisions of Measure 37.

The central economic question behind Measure 37 and other compensation statutes is, what is the effect of land-use regulations on land values? A related question, which has also received much attention in the Oregon context is, does growth management increase housing prices? Economists investigating these issues have mostly relied on hedonic price models that include regulatory variables as right-hand side

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[18] States that have passed compensation legislation are Florida, Louisiana, Mississippi, and Texas (1995); Oregon (2004); Arizona (2006); Oregon (2007).

[19] Prior to the passage of Measure 37, there had been numerous other ballot initiatives in Oregon designed to limit land-use regulations.

[20] See the issue of *Environmental Law* (vol. 36, issue 1) devoted to legal and economic aspects of Measure 37 and Jaeger and Plantinga (2007a, 2007b).

determinants of property value (Cervero and Duncan, 2004, Henneberry and Barrows, 1990, Knaap, 1985, Netusil, 2005, Nickerson and Lynch, 2001, Shultz and Taff, 2004, Spalatro and Provencher, 2001).[21] For example, Knapp (1985) estimates a hedonic model of prices for vacant home sites in the Portland, Oregon metropolitan area and includes a dummy variable to distinguish parcels inside and outside the Urban Growth Boundary (UGB). In Knapp, as in most other hedonic studies, land-use regulations are assumed to be exogenous attributes of land parcels. However, many parcel characteristics that determine property values also plausibly influence the government's decision about how to implement regulations. In the case of Portland, it is clear that the regional planning authority (Metro) considers factors such as soil quality, slope, and proximity to existing infrastructure when it specifies the location of the UGB. Failure to control for these variables in a hedonic regression can bias estimates of the effects of regulations. A few earlier studies have recognized this problem and used instrumental variables or matching methods to address the endogeneity of regulations (Lynch, et al., 2007, McMillen and McDonald, 2002).

In this paper, we adopt an alternative identification strategy, regression discontinuity design (RDD), to study the effects of Portland's UGB on property values. RDDs involve a dichotomous treatment that depends on an observable and continuous score variable. The average effect of the treatment is measured as the difference in the outcome of interest above and below the threshold. An unbiased estimate of the average treatment effect is obtain under relatively mild continuity assumptions. Because the UGB sharply defines a treatment threshold, our problem is naturally suited to RDD analysis. RDD has been applied in a number of recent economic studies (see, for example, Imbens and Lemieux, 2008) but has not, to our knowledge, been used to study land-use regulations.

UGBs are a central feature of Oregon's land use planning system, and the source of much controversy. The UGB controls the location of urban development by dividing

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[21] These studies use data on prices and attributes of individual properties. In contrast, Malpezzi (1996) and Phillips and Goodstein (2000) estimate hedonic housing price models using aggregate data on U.S. cities. With this approach, one gains more variation in regulations but loses precision in terms of prices, regulations, and other variables that must be represented as city aggregates. Both studies treat regulations as exogenous determinants of median house prices.

land parcels into two groups, each of which is subject to different sets of rules regulating use. For instance, parcels within the boundary are zoned for intensive uses, such as high-density residential housing, whereas those outside are zoned for less intensive uses such as agriculture, forestry, and in limited cases low-density residential development. Portland's UGB is of particular interest. Portland is the largest city in Oregon. The metropolitan area population exceeds 2 million and increased by 26% between 1990 and 2000. A large share of the Measure 37 claims were made on agricultural and forest lands just outside the Portland UGB. Figure 3.1 depicts the Portland UGB along with Measure 37 claims (in orange) drawn to scale. In almost all cases, claimants sought the right to develop land for residential housing.

Before proceeding, it is important to clarify what one measures with an RDD, propensity score matching, or a correctly specified hedonic property value model. In a study with cross-sectional data, these approaches estimate the average price differential between parcels inside and outside the UGB. Parcels within the boundary face less stringent controls with respect to urban development and subdivision, which should have a weakly positive effect on the parcel's value. The effect will be strictly positive if, on a metropolitan area scale, the UGB increases the scarcity of developable land. There is also a net difference in neighborhood amenity values that can be positive or negative. Outside the UGB, zoning for agricultural and forest uses minimizes negative externalities from the mixing of incompatible uses (e.g., farms located next to residential subdivisions). Inside the UGB, urban planning can produce attractive and livable residential neighborhoods that raise the value of development rights. Netusil (2005) finds evidence that housing prices are higher in areas of Portland with stricter environmental zoning. What none of the approaches measure is the effect of the UGB relative to the case in which the UGB was never established.[22] The counterfactual is needed to identify the total (or with/without) effect of land-use regulations on property values, but is very difficult, if not impossible, to identify for regulations that have been in place for long periods of time.

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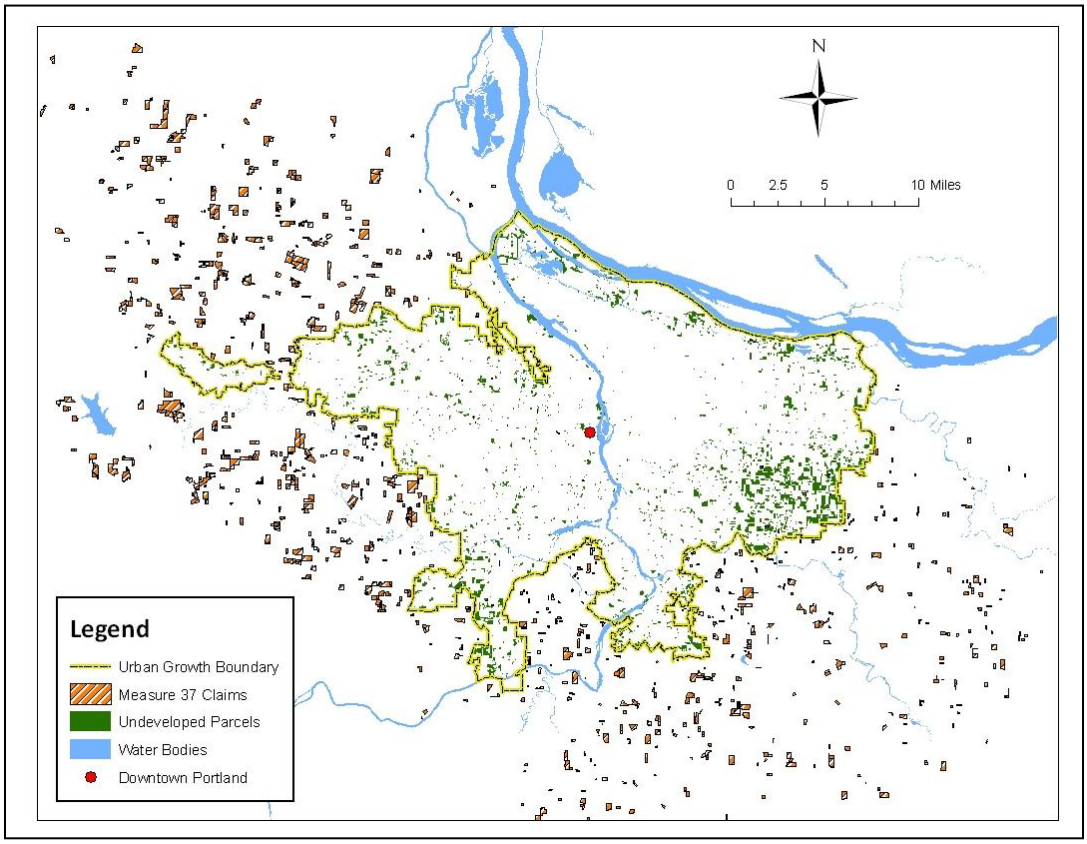
[22] The studies, mentioned above, using aggregate data can, in principle, measure the counterfactual if there is sufficient variation in regulations within the sample of cities. Identifying the effects of regulations in these models is especially challenging with aggregate data.

In the next section, the institutional features of Oregon's land-use planning system are summarized and further information is given about Portland's UGB. We then motivate and present our identification strategy, discuss the data used in the study and, present the RDD results, along with a series of robustness tests. Discussion and conclusions are found in a final section.

Figure 3.1 Measure 37 Claims Outside and Vacant Land Inside of Portland's UGB



Background

Oregon's landmark statewide land-use planning system was established in 1974 with the adoption of 14 (now 19) statewide planning goals that provide guidance on how cities and counties should plan future urban development and uses of rural lands. The goals relate to agriculture, the environment, housing, transportation, energy, and recreation. Goal 14, in particular, requires local governments to establish UGBs to "identify and separate urbanizable land from rural land." The amount of land contained within each UGB must be based on long-range population forecasts and related needs for

housing, employment opportunities, livability and uses such as public facilities, streets and roads, schools, and parks or open space. In determining needs for land, local governments may specify characteristics, such as topography or proximity, necessary for land to be suitable for an identified need. Thus, we see that factors that logically affect property values may also influence the government's decision about where to locate the UGB. At regular intervals governments are required to reassess the adequacy of their UGB, and to ensure there is a 20-year supply of developable land within the boundary based on population forecasts and anticipated demands.

Once a parcel is brought inside the UGB, its status changes with respect to permissible land uses, subdivision, access to city services, and taxes. Inside the UGB, parcels can be developed for high-density residential, commercial, and industrial uses. If land is incorporated into a city, it typically gains access to city sewer, water, and other services. Property taxes are likely to be higher inside the UGB because assessed values rise with development rights and parcels lose eligibility for preferential tax assessment available to agricultural and forest lands outside of UGBs. Thus, the location of a parcel with respect to the UGB is a summary measure of the rights and obligations of the landowner.

The Portland UGB was designated in 1979 and currently contains portions of three counties, 24 cities, and approximately 256 thousand acres of land. The UGB is managed by a regional planning authority referred to as Metro. To satisfy the requirement for a 20-year supply of developable land, Metro has expanded the UGB many times, in most cases by amounts less than 20 acres. However, larger expansions have occurred three times: in 1998 (3,500 acres), in 2002 (18, 867 acres) and in 2004-05 (2,300 acres). In Figure 1, undeveloped parcels within Portland's UGB are shown in green.

A Regression Discontinuity Design Approach

The identification problem

To set the stage for the RDD, we examine a standard hedonic model in which the UGB is an exogenous determinant of land value. This is the model estimated by Knapp (1985) and is similar to many others in the literature. Formally, we write

(1) $$Y = \beta_1 X_1 + \alpha UGB + \varepsilon_1,$$

where *Y* is a vector of land values for the parcels in the sample, X_1 is a matrix of parcel characteristics, *UGB* is a vector of indicator variables equal to 1 if the parcel is located outside the UGB and 0 otherwise, β_1 and α are conformable parameter vectors, and ε_1 has the standard properties. Unbiased estimation of α requires, among other assumptions, that *UGB* is uncorrelated with ε_1.

As discussed, Metro designates the UGB and, thus, for the above sample of parcels determines the variable *UGB*. We assume that Metro applies the following rule:

(2) $$UGB_i = \begin{cases} 1 \text{ if } V_i \geq 0 \\ 0 \text{ if } V_i < 0 \end{cases},$$

where V_i is the score that Metro assigns to parcel *i* in determining whether to locate it inside or outside the UGB. Metro's score is presumably based on a parcel's characteristics, as in:

(3) $$V_i = \beta_{2i} X_{2i}$$

where β_2 and X_2 are defined in the same manner as above. Clearly, the assumptions needed for unbiased estimation of α in (1) are violated when X_2 is correlated with ε_1. This can occur if Metro considers land values directly in making the UGB assignment decision or if variables in X_2 are omitted from X_1. The latter case seems likely as it is difficult to know exactly which variables Metro considers. As well, some variables in X_2 may be observed only by Metro. In the latter case, we could express the score variable as:

(4) $$V_i = \beta_{2i} X_{2i} + \varepsilon_{2i}$$

where ε_2. With the appropriate distributional assumptions for ε_1 and ε_2, we obtain the reduced-form version of the Heckman (1978) dummy endogenous variable model. Instrumental variables is the standard approach used to identify the model parameters. In our application, we take advantage of the sharp discontinuity in treatment represented by the location of the UGB and use RDD to identify α.

Regression Discontinuity Design

RDDs involve a binary treatment on an outcome of interest where treatment is a deterministic function of a single continuous, observable variable. Under a relatively weak set of continuity assumptions, RDD is able to identify the local causal effect of treatment even when selection for treatment is non-random (Lee 2008). Adapting the notation introduced above, let Y_1 and Y_0 be outcomes of interest under treatment and non-treatment, respectively. Define *V* as a continuous observable variable, or score, that determines treatment. As in (2), individuals receive treatment whenever *V* exceeds some threshold *V*=0. The assumption needed to identify a causal average treatment effect is that $E[Y_1|V]$ and $E[Y_0|V]$ are continuous at *V*=0, which implies that the mean outcome of individuals marginally below the treatment threshold represents a valid counterfactual to the mean outcome of those individuals marginally above it. In an applied setting, this assumption cannot be tested directly because we observe neither Y_0 above the threshold (the treatment applied to the untreated individuals) nor Y_1 below the threshold (treated individuals without the treatment).

Lee (2008) links RDD to classical randomized experiments and establishes testable conditions under which a non-random treatment assignment mechanism shares the same properties (locally) as a classical randomized experiment. Let *V* and *W* be a pair of random variables where *V* is observable and determines treatment status as in (2) and where *W* is unobservable. The *W*s can be thought of as unobservable characteristics of individuals that determine the outcome of interest, $Y = y(W)$, and pre-treatment individual characteristics, $X = x(W)$. Assume $F(V|W)$, the cdf of *V* conditional on *W*, is continuously differentiable at *V*=0 and satisfies $0 < F(0|W) < 1$. The dependence of *F* on *W* allows individuals to influence their probability of receiving the treatment. However, the condition $0 < F(0|W) < 1$ implies that individuals cannot do so perfectly—there remains a random chance element to the treatment decision. Lee proves the following results: 1) the average treatment effect (ATE) is given by

$$ATE = E[Y_1 - Y_0 | V = 0] \tag{5}$$

and 2) the pre-treatment characteristics *X* should vary continuously at threshold *V*=0.

Lee's first result says that the discontinuity in the conditional expectation function at the threshold value of V identifies the average treatment effect. Lee cautions that (5) does not give the average treatment effect for the entire population, nor does it just measure the treatment effect for the subpopulation of individuals at V=0. Rather, (5) is a weighted average treatment effect for the entire population, where weights are higher for individuals closer to the threshold than those further away.[23] Lee's second result is important for empirical testing of the validity of the RDD. The continuity assumption on $F(V|W)$ requires that the individual characteristics W vary continuously across the treatment threshold, which implies that the pre-treatment variables X must do so as well. Thus, as a specification test, one can examine the Xs to ensure that they change smoothly at the threshold. If they do not, then these variables, rather than the treatment, may explain the discontinuity in outcome variable Y.

The RDD framework described above is well suited to measuring the effects of the Portland UGB. Let Y_1 and Y_0 represent the land value per acre inside and outside the UGB, respectively. Define W as a vector of unobservable parcel characteristics that determine the pre-treatment variables X. The variables in X could include soil quality, topography, and other physical characteristics of parcels. We do not directly observe the score variable V. In general, one needs to observe V in order to determine how close an individual is to the treatment threshold. For our application, we exploit the fact that the UGB delineates a contiguous area and use the distance of a parcel to the UGB to measure closeness to the threshold. To formalize the idea, note that by construction $V \geq 0$ for parcels within the UGB, $V < 0$ for parcels outside, and V=0 at the boundary. Our key assumption is that V is declining as one moves from inside to outside the UGB. This assumption allows us to use distance to the UGB in place of V itself. A primary function of the UGB is to promote compact development near existing urban centers and, thus, it

[23] In our application, the relevant population varies depending on the bandwidth selected. Bandwidth refers to the width of designated zones on each size of the UGB that determine which parcels are used to compute the average treatment effect.

is reasonable to suppose Metro's score decreases as one moves farther from the interior of the urban area.[24]

Data

Sample construction

Metro's Regional Land Information System (RLIS) is an extensive source of data for the study of land-use regulations in the Portland metropolitan region. RLIS was established in the late 1980's for general planning purposes and currently consists of detailed and high quality GIS data collected on 24 cities and three counties. The publicly available dataset includes information on infrastructure, political and regulatory boundaries, and physical land features such as rivers, floodplains, topology, and soil quality. This study uses Metro's November 2008 RLIS data set and relies primarily on its parcel-level taxlot layer and assessor data. Parcel attributes include estimates of real market land and building value, sales value and date, and current land-use and zoning categories.

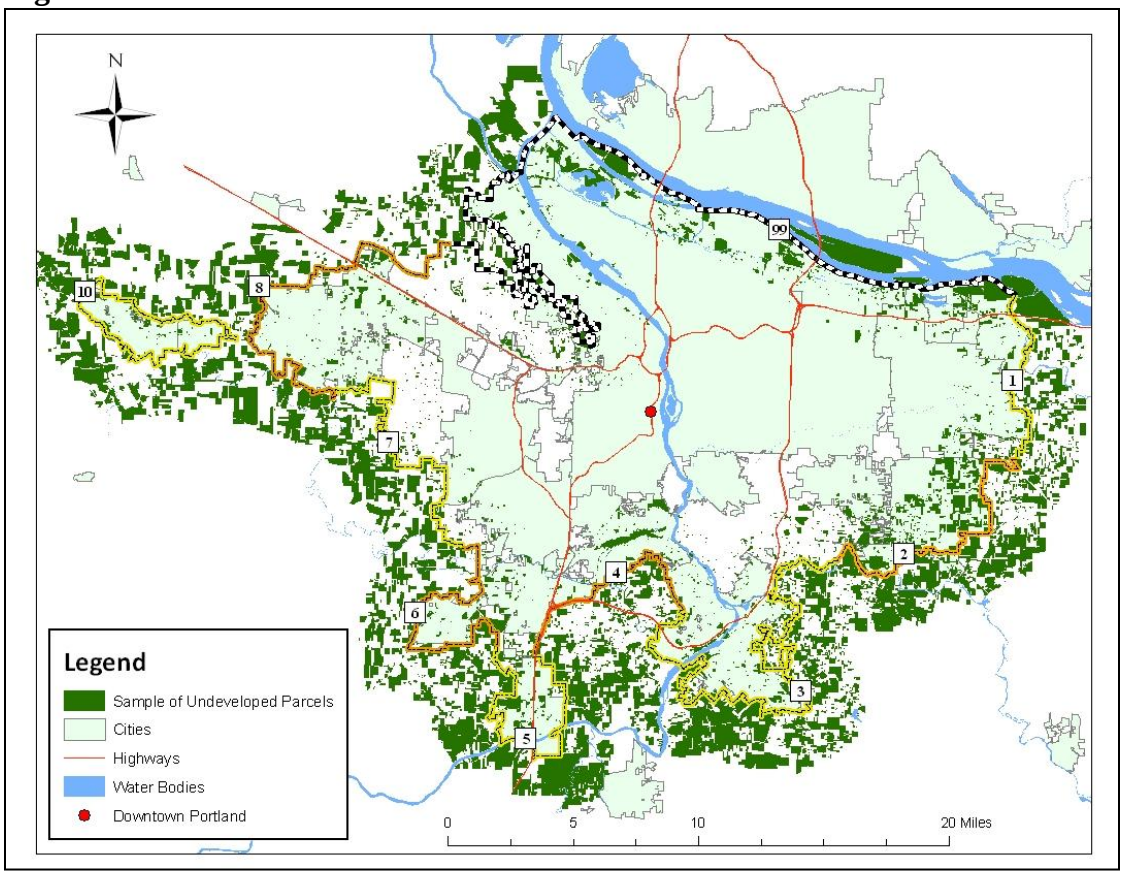
For our study of Portland's UGB, we use a subset of the taxlot data on undeveloped parcels. To produce a data set that can be managed efficiently, as a first cut we restrict the sample to parcels within 2 miles of the UGB on both sides. A parcel is included if it is possible to reach the UGB by moving 2 miles in any direction. The sample of parcels ultimately used to estimate the model depends on the selected bandwidth. As explained below, the results are relatively insensitive to the choice of bandwidth. We select only undeveloped parcels to avoid confounding influences of heterogeneous structures such as houses on property values. Inclusion of only undeveloped parcels raises the possibility of sample selection bias. Undeveloped parcels within the UGB may have particular features that explain why they have remained

[24] The UGB is delineated so that it contains multiple urban areas. This produces irregularities that make it possible to move in a straight line and cross the UGB more than once (e.g., moving directly south from the Portland downtown) (Figure 1). In this case, V would fall as one crosses the boundary the first time and then rise as the boundary is crossed a second time. We assume this switching point for V is at the mid-point between the boundaries. Because a given parcel is only used to measure the treatment effect for the closest UGB segment, this ensures that V is monotonically decline in the relevant neighborhood of the threshold.

undeveloped. In the results section, further testing is done to examine the possible influences of sample selection on our results.

Undeveloped parcels were included in our sample based on the following criteria: 1) current land use is not identified as commercial, industrial, public, nor multi-family residential, 2) building value or building value per acre is less than $15,000, 3) acreage is greater than 0.5 acres, and 4) the parcel is not owned by a public entity, utility, nor railroad. The second criterion is used to allow minor structures (e.g., utility sheds) on small parcels and larger structures (e.g., storage buildings) on large parcels, while excluding parcels with houses or other significant development. The dataset was cleaned to eliminate oddly shaped parcels. Parcels bordering the north and northwest portions of the UGB were dropped from the sample: the northern portion of the UGB borders the Columbia River, which is the state line between Oregon and Washington, and much of the northwestern portion of the UGB borders a steep ridgeline that is unsuitable for development. The black and white line in Figure 3.2 indicates the segment of the UGB that we omitted.

Figure 3.2 Portland Metropolitan Area: Sample of Undeveloped Parcels and UGB Segments



While two parcels on opposite sides of the UGB are likely to have similar characteristics, parcels on opposite sides of the metropolitan area could be very different. To accommodate this potential heterogeneity, we divide the UGB into nine segments and evaluate them independently. This also allows us to consider the possibility that the effects of the UGB are not uniform throughout the metropolitan area. Each UGB segment is aligned with existing city or county jurisdictional boundaries. For example, the transition from segment 1 and 2 coincides with the transition from Multnomah County to Clackamas County (Figure 2). With a 2-mile bandwidth, the total sample consists of 4,068 parcels outside and 2,839 parcels inside the UGB. The number of observations for each segment range between 189 and 1,214 outside the UGB, and between 121 and 676 inside the UGB.

Estimates of Real Market Value

Assessor estimates of real market value (RMV) are used to study the effect of Portland's UGB on property values. While the use of arms-length transaction price data is often regarded as preferable, their use is problematic in the current study. The available data on sales do not identify which sales are arms length transactions nor are sales prices decomposed into land and improvement values. Further, the sample on sales is small for an RDD analysis given that we need parcels within a short distance of the UGB. Finally, a sample of sold parcels is vulnerable to sample selection bias. Most land is sold infrequently, giving rise to the concern that during a given time period properties with certain unobservable characteristics are less likely to be offered for sale. The primary concern about using assessor RMV estimates is that they may not accurately reflect true sale prices. It is important to emphasize that Oregon is different from many states in that assessors are required to estimate RMV, defined as the amount a parcel would sell for in an arms-length market transaction. The RMV is separate from the assessed value, referred to in Oregon as the maximum assessed value, which is used as the basis for computing property taxes.

Because the RLIS provides some information on sales, we can examine the correspondence between RMV estimates and sales prices. For each segment, we compare RMV estimates to the prices of parcels that were sold in 2008 and test for differences between them. Overall, we find a close correspondence between average RMV estimates and average sales prices. Our focus on average values for each segment is appropriate given that our RDD produces an estimate of the average treatment effect by segment. In a few instances, we find a statistically significant difference between average sales prices and average RMVs. However, in these cases the sample of sold parcels is small and may include sales that cannot be considered arms-length transactions.

Assessors are not always able to update RMV estimates immediately as new information about market conditions becomes available. This suggests that RMV estimates may lag behind sales prices. Indeed, we find that in most cases average RMV is lower than the average sales price. To investigate further, we assemble data on parcels sold in 2005. We find a closer correspondence between average 2005 sales prices and

average 2008 RMVs, which is consistent with the aforementioned lag. Overall, our assessment of the data indicates that RMVs provide accurate estimates of sales prices.

Results and Robustness Tests

Basic results

We estimate the average treatment effect by fitting local linear regression functions to observations on either side of the UGB and then comparing the estimated intercept terms. As is discussed in the RDD literature, local linear regression is preferred to kernel density estimation for estimating boundary points (Hahn et al. 2001, Imbens and Lemieux 2008, McCrary 2008). Define D_i as the distance of parcel *i* to the UGB where $D_i < 0$ for parcels inside the boundary and $D_i > 0$ for parcels outside. Further, denote the bandwidth by *h* and define the sets of parcels within *h* miles of the UGB inside as $S_1 = \{i : -h \le D_i \le 0\}$ and outside as $S_0 = \{i : 0 \le D_i \le h\}$. Following McCrary (2008), the local linear regressions are estimated with the observations in S_1 and S_0:

$$\min_{\alpha_1,\beta_1} \sum_{i \in S_1} \left(Y_i - \alpha_1 + \beta_1 D_i\right)^2 K\left(\frac{D_i}{h}\right)$$
$$\min_{\alpha_0,\beta_0} \sum_{i \in S_0} \left(Y_i - \alpha_0 - \beta_0 D_i\right)^2 K\left(\frac{D_i}{h}\right) \quad (6)$$

where $K(t) = 1 - |t|$ is a triangular kernel density that gives greater weight to observations closer to the UGB. The average treatment effect is the difference between the estimated intercepts: $ATE = \hat{\alpha}_1 - \hat{\alpha}_0$. While more sophisticated kernels and techniques to select the optimal bandwidth are available, Imbens and Lemieux (2008) recommend using a simple kernel and verifying the robustness of the results to different choices of bandwidth. We produce a basic set of results with a bandwidth of 0.25 miles, and then test their sensitivity to bandwidth choices of 0.125 and 0.5 miles. Results are presented in Table 3.1 below.

Table 3.1 Average Treatment Effect (dollars) by Segment and Bandwidth

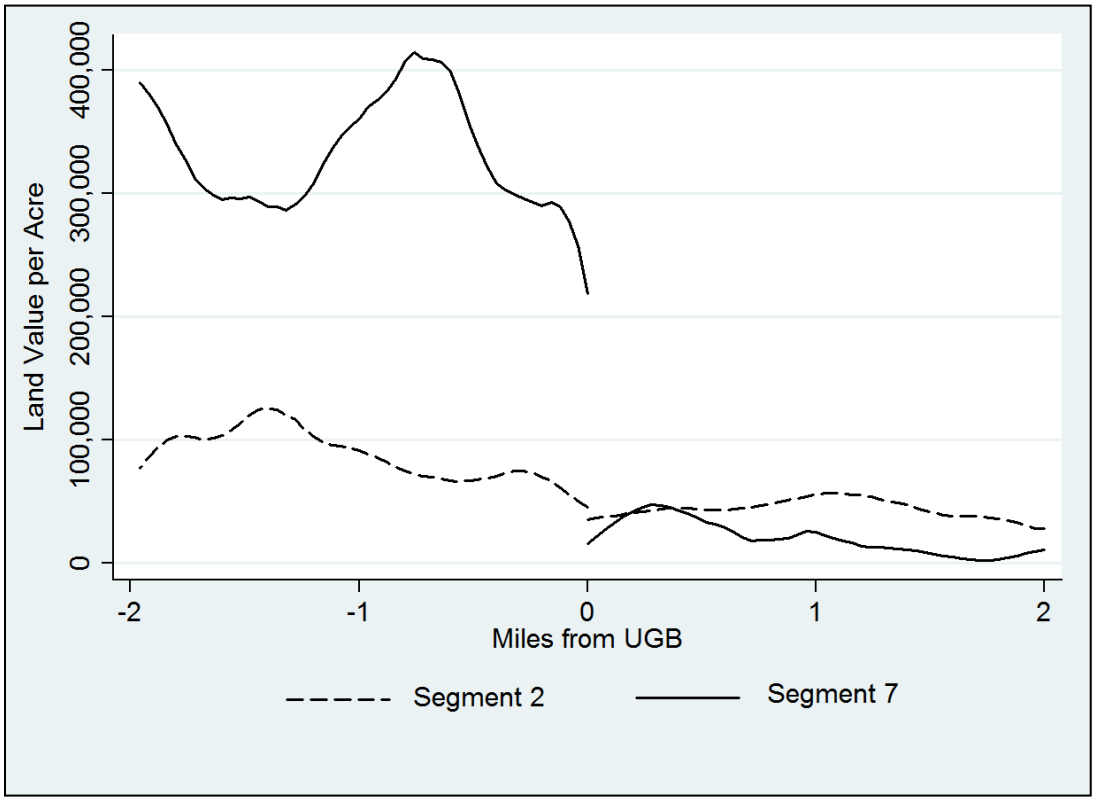
	Bandwidths (miles)		
Segment	**0.125**	**0.25**	**0.50**
1	-3,830	9,108	18,819
2	15,166	10,690	13,026
3	31,417 **	34,347 **	35,043 **
4	253,586 **	225,099 **	207,135 **
5	33,574	71,981 **	96,338 **
6	107,410 **	128,472 **	136,895 **
7	184,353 **	203,651 **	225,868 **
8	73,679 **	89,327 **	105,556 **
10	95,866 **	104,760 **	105,877 **

** indicates statistical significance at the 1% percent level.

For every segment there is a positive effect associated with being inside the UGB, but for segments 1 and 2 the effect is small and not statistically significant. Along the southwest portion of the UGB, particularly segments 4 and 7, the magnitude of the discontinuity is the greatest. As the bandwidth is increased, there is a modest increase in the size of the effect for almost all segments. Nevertheless, with the exception of segment 5, significance levels are robust to the choice of bandwidth. The change in the ATE with larger bandwidths suggests non-linearities in the urban rent gradient that are not captured by the linear regression models in (6). Such non-linearities are evident from smoothed plots of land values. Figure 3.3 presents land values functions for segments 2 and 7, which we estimated with the local linear regression smoothing procedure in McCrary (2008).[25] Non-linearities are apparent as is the large discontinuity in land values at the UGB for segment 7. For segment 7, the large dip in average land value at 1.5 miles within the UGB is due to a cluster of relatively low-valued parcels in unincorporated part of the metropolitan area. Because we estimate the ATE using bandwidths less than 0.5 miles, this has no consequences for our results.

[25] To produce these results, we used 50 bins on each side of the UGB and a bandwidth of 0.25 miles.

Figure 3.3 Local Linear Smoothing of Land Values for Segments 2 and 7



Continuity of pre-treatment covariates

As previously discussed, the identification strategy requires that the distribution of each pre-treatment variable is smooth in the neighborhood of the threshold. The pre-treatment covariates that we have data on are physical land features such as topography, soil quality, and the location of floodplains and wetlands. These variables are not affected by the treatment but plausibly influence the value of land for urban development and agricultural uses. Other observable variables include lot size and access to city sewer and water. While these factors clearly affect land value, they are determined by the treatment. For instance, once land is brought inside the UGB, it can be subdivided into much smaller lots.[26] Thus, the influence of these variables on land value is a component of the treatment effect we wish to measure.

A visual inspection of inspection of GIS map layers is used to evaluate the continuity of observable baseline covariates in the neighborhood of the UGB. Along

[26] Thorsnes and McMillen (1998) find a non-linear relationship between value per acre and parcel size for undeveloped parcels in the Portland metropolitan area.

segments 3, 6, 8, and 10 of the UGB, there are clear discontinuities in the distribution of some physical landscape features. For example, the southern portion of segment 3 corresponds with a transition from flat land inside the UGB to steeply sloped land outside the UGB (Figure 3.4). Along segments 6, 8 and 10, portions of the UGB abut floodplain boundaries (see, for example, Figure 3.5). We test the sensitivity of the model to these discontinuities by re-estimating the average treatment effect, omitting the observations along the problematic portions of the UGB.

Results using a bandwidth of 0.25 miles are presented in Table 3.2 for all of the observations and for the restricted sample of observations. With the exception of segment 3, the sign and magnitude of the effects are similar to our basic results. The largest change occurs for segment 5, where the average treatment effect drops by about forty-four thousand dollars. The treatment effect for segment 3, where a substantial portion of observations were dropped, is smaller and no longer statistically significant.

Table 3.2. Results of Robustness Test on Effects of Discontinuous Covariates

	Average Treament Effect (dollars)	
Segment	All Observations	Restricted Sample
1	9,108	32,899
2	10,690	12,527
3	34,347 **	9,753
4	225,099 **	254,328 **
5	71,981 **	115,567 **
6	128,472 **	90,315 **
7	203,651 **	168,199 **
8	89,327 **	120,994 **
10	104,760 **	114,156 **

** indicates statistical significance at the 1% percent level.
Note: A 0.25 mile bandwidth is used.

Figure 3.4 Topography in the Vicinity of UGB Segment 3

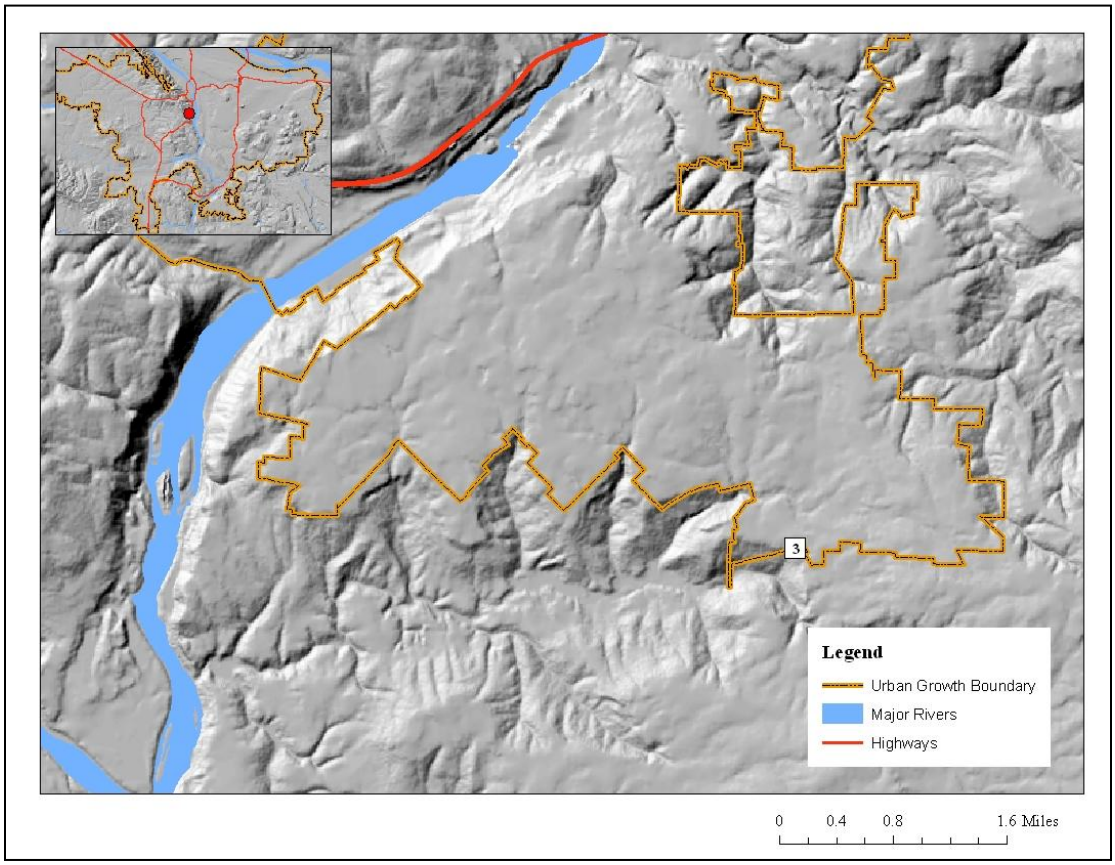
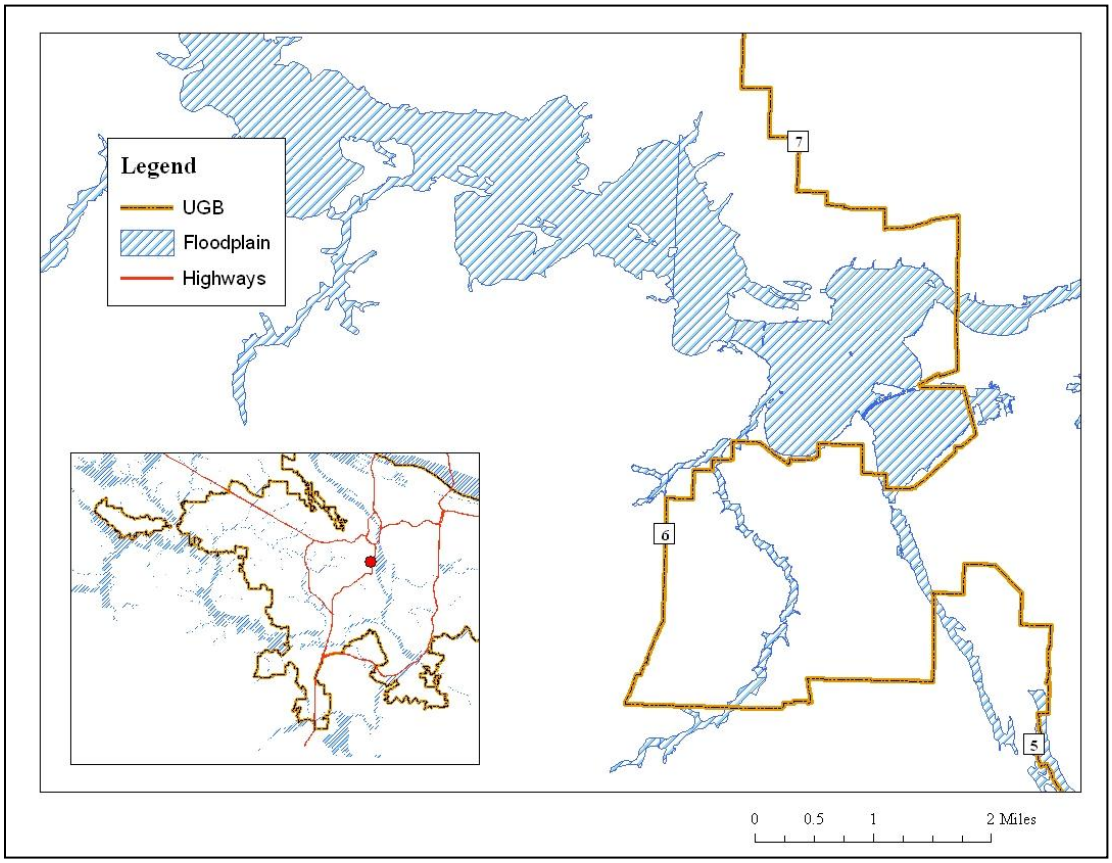


Figure 3.5 Floodplains and Wetlands in the Vicinity of UGB Segment 6



Test for Sample Selection

By focusing on parcels of land that are currently undeveloped, we introduce the possibility of sample selection. A particular concern is that undeveloped parcels inside the UGB are not representative of the population of parcels inside the UGB that includes parcels that have already been developed. For example, suppose that parcels with the highest development value are developed first. Then, those that remain undeveloped inside the UGB will have a lower average value compared to a representative sample. This will lead us to under-estimate the average treatment effect. Since limited development is also allowed outside the UGB, there is further potential for sample selection, though we would expect less of an effect in this case.

We investigate this issue using data on a sample of parcels at two points in time.[27] First, we selected a sample of undeveloped parcels from the 2000 taxlot data using the same criteria used to form the 2008 sample. Parcels that were in the 2000 sample but not in the 2008 sample were identified as having been developed. We denote as $Y_1(u,u)$ the value of a parcel inside the UGB that remained undeveloped in both periods. $Y_1(u,d)$ refers to a parcel inside the UGB that was undeveloped in 2000 but developed by 2008. $Y_0(u,u)$ and $Y_0(u,d)$ have corresponding definitions for parcels outside the UGB. Using the 2000 data, we compute the average of each variable for each segment. We find that the average of $Y_1(u,d)$ exceeds the average of $Y_1(u,u)$ for every segment. The same is true for $Y_0(u,d)$ and $Y_0(u,u)$, but the magnitude of the difference is considerably smaller. These findings are suggestive of the phenomenon discussed above. We now test whether it has implications for our results.

The average treatment effect is re-estimated using the full sample of parcels that were undeveloped in 2000. For parcels that remained undeveloped by 2008, we simply retain the 2008 values of $Y_1(u,u)$ and $Y_0(u,u)$. For parcels that were developed by 2008, we construct estimates of the 2008 values of $Y_1(u,d)$ and $Y_0(u,d)$ for the counterfactual case in which these parcels remained undeveloped. This is done by inflating the 2000 values of $Y_1(u,d)$ and $Y_0(u,d)$ using the average change in the per-acre values of $Y_1(u,u)$ and $Y_0(u,u)$ between 2000 and 2008.[28] These inflation factors are calculated separately for each segment as well as inside and outside the UGB. The results for the 2008 and 2000 samples of undeveloped parcels and a bandwidth of 0.25 miles are presented in Table 3.3. There are small differences between the results for segments 1, 2, and 3. Modest differences are found for segments 5, 8, and 10. In these cases, the

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[27] We thank Luc Behaghel from the Paris School of Economics for elucidating the potential sample selection problem and suggesting a solution.

[28] We noted above that the UGB was expanded twice after 2000, with the largest change occurring in 2002. If the effects of the UGB expansion were unanticipated in 2000, we may underestimate the 2008 counterfactual values of $Y_1(u,d)$ in the case of parcels that were outside the 2000 UGB but inside the 2008 UGB. The reason is that the 2000 values of these parcels would not reflect the influence of the subsequent UGB adjustment, leading us to underestimate the average treatment effect. Fortunately, this has little consequence for our results since most of these expansions took place in Section 2 where we estimate an insignificant effect of the UGB.

average treatment effect rises when we estimate it with the larger 2000 sample. This is what we would expect if sample selection tends to eliminate parcels with high development potential. For the remaining three segments, the estimate effect is smaller and, in the case of Segment 4, dramatically so. This indicates that a different type of selection process was operating in these cases. In any event, our basic result of significant treatment effects for all segments except 1 and 2 is produced with both samples.

Table 3.3 Results of Robustness Test on Sample Selection Effects

	Average Treament Effect (dollars)	
Segment	2008 Sample	2000 Sample
1	9,108	-480
2	10,690	6,169
3	34,347 **	29,933 **
4	225,099 **	52,431 *
5	71,981 **	124,352 **
6	128,472 **	67,646 **
7	203,651 **	140,766 **
8	89,327 **	104,591 **
10	104,760 **	129,905 **

** and * indicate statistical significance at the 1% and 5% percent levels, respectively.
Note: A 0.25 mile bandwidth is used.

Discussion

Most of the earlier analyses of land-use regulations have assumed that regulations are exogenous determinants of property values. However, it is likely that many factors affecting property values also influence government decisions about how to implement regulations. This is clearly true in the case of Portland's UGB. In this study, we employ RDD to measure the effects of the UGB on property values. RDD provides an unbiased estimate of the average treatment effect under relatively mild continuity assumptions, and is well-suited to this application because the UGB defines a sharp treatment threshold. We find that Portland's UGB has a significant effect on property values in the southern and western portions of the metropolitan area, but not in the eastern portion. This basic finding is robust to changes in the sample that address discontinuities in pre-treatment covariates and potential sample selection bias. While the changes in the sample affect the magnitudes of the measured effects in individual segments, we find that the UGB, where

it is binding, creates a discontinuity in property values ranging from about $30,000 per acre to at least $140,000 per acre.

Our results suggest that Portland's UGB is not a globally binding constraint on development. The discontinuities in land values in the western and southern portions of the metropolitan area indicate that it is binding locally, but the lack of a discontinuity to the east together with the existence of undeveloped parcels within the UGB indicate that the total developed area is unconstrained. Thus, from one perspective the Portland UGB is working as intended. It is directing where development occurs—away from the west and south and towards the east—but not constraining the total amount of development. Nevertheless, for discontinuities in land values and available land for development to coexist, undeveloped parcels within the UGB cannot be perfect substitutes for one another. If they were, arbitrage would eliminate any price differences. From a social welfare perspective, the justification for limiting a westward and southward expansion of the metropolitan area must be non-market factors that are not reflected in private valuations of land. As noted, Oregon's land-use planning system is designed to address a number of regional goals related to agriculture, transportation and the environment that would not be internalized in private market transactions.

As discussed in the Introduction, our RDD estimates measure the average price differential between parcels inside and outside the UGB. Our studies of Measure 37 in Oregon (Jaeger 2006, 2007; Jaeger and Plantinga 2007a, 2007b) reveal that support for the measure was fueled by price differences such as these among parcels subject to different regulations. However, the fact that a parcel with development restrictions is worth less than parcels without these restrictions does not mean that the regulations have reduced the property's value. First, there is the issue of comparability. Parcels located outside the UGB are usually farther from city centers than parcels within the boundary, and this may explain the difference in value. Figure 1 shows Measure 37 claims far outside the UGB, even though there was developable land within the boundary that was closer to Portland and other cities within the boundary.

Second, current price differentials are not, in general, equal to the difference between the current property value and its value under the counterfactual case in which the regulation was never adopted. Claimants under Measure 37 sought compensation

equal to the former, when, from an economic perspective, it could only make sense to base payments on the latter price difference. Consider the following example. If not for agricultural zoning restrictions, a landowner outside the western portion of Portland's UGB might be able to profitably develop her land for residential housing. But, it would be illogical to base compensation on this lost development value because the development opportunity may itself be due to land-use regulations that restrict the supply of developed properties or create attractive pastoral landscapes. The problem, as noted in the Introduction, is that the counterfactual scenario is difficult, if not impossible, to reconstruct in the case of land-use regulations that have been in place for many years.

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INCENTIVES FOR SPATIALLY COORDINATED LAND CONSERVATION: A CONDITIONAL AGGLOMERATION BONUS

Cyrus A. Grout

Western Economics Forum

Dept. of Agricultural and Applied Economics
University of Wyoming
Dept. 3354
1000 E. University Ave.
Laramie, Wyoming 82071

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Incentives for Spatially Coordinated Land Conservation: A Conditional Agglomeration Bonus

Introduction

Land conservation is a tool extensively used by governments and environmental organizations to obtain a multitude of environmental benefits. The largest land conservation program in the U.S. is the USDA's Conservation Reserve Program (CRP). It pays farmers to retire land in crop production in favor of conservation measures that will achieve environmental objectives such as reducing soil erosion, improving air and water quality, and providing wildlife habitat. Over 33 million acres were enrolled in CRP programs as of September of 2009. The efficient allocation of funds is a subject of interest to economists in that annual expenditures for land conservation range in the billions of dollars. An extensive economic literature has emerged analyzing the cost-effectiveness of conservation programs in achieving environmental objectives. See Claassen et al. (2008) for a review of U.S. conservation programs and previous research.

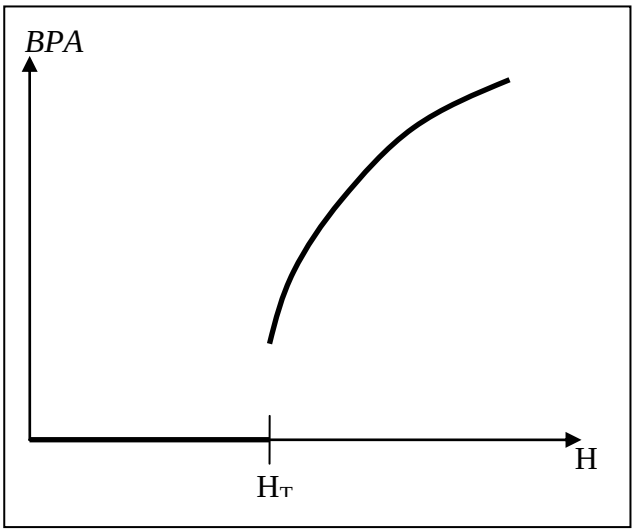
The marginal benefit of a conservation effort is often small until some threshold level of conservation has been reached. For example, the population of a species may not be viable when contiguous habitat is below some minimum acreage H_T. Conservation efforts resulting in the creation contiguous habitat of a size below H_T would provide no environmental benefits in terms of improving the viability of the species (see Figure 4.1).

Examples of such "threshold effects" considered in the economic literature include the effect of habitat fragmentation on bird and mammal species (Lewis and Plantinga, 2007; Parkhurst and Shogren, 2007; Parkhurst et al., 2002), and the effect of water quality on fish populations (Wu, et al., 2000). The marginal benefit of conserving a parcel of land may depend not only upon the parcel's characteristics, but on the spatial pattern of conservation among neighboring parcels given the presence of threshold effects. The concern is that ignoring threshold effects will result in an

allocation of conservation funding that is spatially overly dispersed, as demonstrated by Wu and Boggess (1999).

Wu et al. (2000) consider a conservation issue prominent in the western United States: habitat enhancement for steelhead trout, a salmonid fish species. The authors identify a threshold effect in water temperature's impact on the steelhead abundance in the John Day River fishery in eastern Oregon: stream temperatures should not exceed 18° C. Measures that lower stream temperature one or two degrees when stream temperature is above 20° C have little effect on steelhead abundance. The authors find that the equal allocation of funds across sub-basins to improve stream habitat would tend to be inefficient because marginal benefits vary significantly depending on the condition of surrounding habitat. In the extreme case, benefits might even be zero if the allocation to each sub-basin fails to reduce temperatures below the threshold level.

Figure 4.1 Benefit per Acre (BPA) of Contiguous Habitat Acreage (H)



An incentive mechanism proposed in the literature to encourage spatially coordinated conservation is the agglomeration bonus. It awards landowners bonus payments for the conservation of adjacent portions of land (Parkhurst and Shogren, 2008; Parkhurst and Shogren, 2007). In an experimental study, Parkhurst and Shogren (2007) found that groups of four players in a coordination game with an agglomeration bonus mechanism were able to achieve desired spatial configurations of land

conservation (e.g., a wildlife corridor or core habitat) with over 90% efficiency. While these experimental results are encouraging, they were limited to the context of conserving endangered species habitat that overlapped several parcels of land. Furthermore, each player had exact knowledge of the other players' opportunity costs, and the total incentives paid to conserved land were disproportionately large.[1]

Real-world applications of the agglomeration bonus are rare. One is Oregon's Conservation Reserve Enhancement Program (CREP), established in 1998 with the goal of assisting the recovery of salmon and trout species by creating riparian buffers along stream habitat. The program includes a provision that awards a one-time "Cumulative Impact Incentive Bonus" (CIIB) wherever at least 50 percent of any 5 mile section of streambed is enrolled in the CREP (USDA 1998). In a 1998 survey of potential CREP participants, approximately 76% indicated a willingness to work with neighbors toward enrolling contiguous stream miles (Kingsbury, 1999). One reason cited by landowners for not wishing to take advantage of the bonus program was the perception that it would require a large investment in time to coordinate with neighbors. During the past decade CIIB awards in Oregon have not been extensive. However, the incentive has proven successful in encouraging CREP participants who have enrolled without bonus compensation to promote the program to neighbors who can put them above the 50% threshold required for CIIB eligibility (Sundseth, 2009).

Incomplete information is a frequent impediment to the design of effective incentive mechanisms. Regarding the agglomeration bonus, its functionality is dependent on landowners' knowledge of their neighbors' willingness to participate in conservation. For example, consider a farmer for whom the bonus level of compensation (paid to contiguous conservation) exceeds rents from agriculture, and suppose his agricultural rents are higher than some base-level compensation (paid to non-contiguous conservation). His payoff from enrolling in the conservation program

---

[1] In the 2007 study, incentives totaling $1,168 were paid to four players who conserved the desired configuration of core habitat, while the forgone rent (i.e. opportunity cost) on that portion of land totaled only $192. From a cost-benefit perspective, it would be preferable to simply make a take-it-or-leave-it offer of less than $1,168 for the desired core habitat.

may be positive or negative depending on whether the pattern of his neighbors' enrollment is sufficient to warrant bonus compensation. Hence, the farmer's expected payoff is a function of each neighbor's probability of enrolling. The farmer takes on risk by enrolling because his payoff could be negative. If information about neighbors' willingness to participate is limited, he may forego participation even when he and his neighbors would mutually benefit from enrolling as a group.

The above example illustrates a significant limitation to the agglomeration bonus mechanism as it has been represented in the recent literature: the agreement to enroll is binding on both the landowner and regulator. The agglomeration bonus literature has not examined the potential for conditional agreements to overcome the informational requirements necessary to induce spatially coordinated land conservation. The real-world applicability of the agglomeration bonus has likely been constrained by its strong information requirements. The modification to the agglomeration bonus mechanism proposed in this paper improves its applicability by limiting landowners' information requirements to knowledge of their own opportunity costs and eliminating the need for landowners to coordinate their enrollment decisions.

Landowner Responses to Voluntary Incentives

Predicting a landowner's response to an incentive such as a subsidy from the USDA's Conservation Reserve Program can be complex. Underlying the landowner's decision to accept or reject such a subsidy is the quality (i.e. productivity) of his land, and by extension, the stream of rents he can earn from its highest and best use. Two factors that introduce complexity to predicting a landowner's response to an incentive are the long term commitment inherent to most conservation programs (the minimum CRP contract is 10 years) and the individual characteristics of the landowner.

A landowner's calculation of expected opportunity cost under a long-term commitment will incorporate his current rents as well as expectations of the levels and prices of future inputs and outputs. A group of landowners with similar parcels of land are likely to form variable expectations about the proceeding 10 to 15 years. A landowner's willingness to enroll in a conservation program is also likely to depend on

his personal characteristics. Conservation payments provide a relatively predictable stream of rents compared to crop production and a landowner's calculation of expected opportunity cost depends on his risk profile.[2] Due to such human heterogeneity, a fragmented response to an incentive is possible even where land rents and characteristics exhibit little heterogeneity.

The agglomeration bonus attempts to overcome fragmented responses by creating a positive network externality among neighboring landowners (Parkhurst and Shogren, 2007). It requires each landowner to perform what can be a complex task: to incorporate expectations of neighbors' responses into his own enrollment decision. Each landowner's expected payoff from enrolling in a conservation program is a function of his expected opportunity cost and expectations about his neighbors' enrollment decisions (which are equally complex). For reasons discussed in the above paragraph, predicting the response of any particular landowner to an incentive can be difficult even where land characteristics are observable.

Unless the agglomeration bonus is very large or small relative to opportunity costs, each landowner is likely to face some degree of uncertainty about his neighbors' willingness to enroll their lands. Where a large number of landowners are involved and/or communication among landowners is poor, the ability of an agglomeration bonus to induce coordinated land conservation is likely to be limited. The following section proposes a modification to the agglomeration bonus that eliminates the need for landowners to form expectations about others' willingness to enroll.

A Conditional Agglomeration Bonus

Asking landowners to predict neighbors' responses to an incentive is unnecessary when landowners' agreements to enroll are binding if and only if a desired pattern of enrollment is achieved (e.g., n contiguous acres). A conditional agglomeration bonus (CAB) program would pay compensation only where the desired pattern of enrollment occurs. As represented in Figure 2 below, a regulator would offer some level of

[2] For example, Parks and Kramer (1995) found that older landowners were more likely to enroll land in the Wetlands Reserve Program.

compensation (S^{CAB}) to landowners and observe the spatial pattern conditional enrollment. Where the desired pattern of enrollment does not occur, the landowner is released from his obligation to enroll land and the regulator is released from his obligation to compensate the landowner. Assuming zero transaction costs, landowner i will conditionally enroll in the program whenever his opportunity cost is less than the CAB incentive because in that case his expected payoff π_i is always greater than or equal to zero:

(1) $E(\pi_i) = p * (S^{CAB} - OC_i) + (1 - p) * 0.$

Where S^{CAB} denotes the CAB bonus payment, landowner i's opportunity cost of enrolling is OC_i, and p is the probability that his neighbors' enrollment will be sufficient to generate the regulator's desired pattern of conservation.

Under the CAB program a landowner's expected payoff remains a function of his neighbors' opportunity costs; they affect the probability that the agreement to enroll will become binding. However, information about neighbors' willingness to enroll (i.e. p) is no longer relevant to a landowner's enrollment decision. The probability p affects only the magnitude of the expected payoff. The sign of the expected payoff, which determines whether or not landowner i will conditionally enroll, is determined entirely by the landowner's opportunity cost and the size of S^{CAB}.[3]

Figure 4.2 below demonstrates the landowner's enrollment decision and payoff structure under a CAB program. Initially, the incentive S^{CAB} is offered. If S^{CAB} is less than landowner i's opportunity cost, then the offer is rejected and the payoff is zero. If landowner i's opportunity cost is less than S^{CAB}, then the offer is conditionally accepted. Finally, if an accepting landowner is part of the desired spatial pattern of conservation he is enrolled in the program obtaining a payoff of $S^{CAB} - OC_i > 0$.

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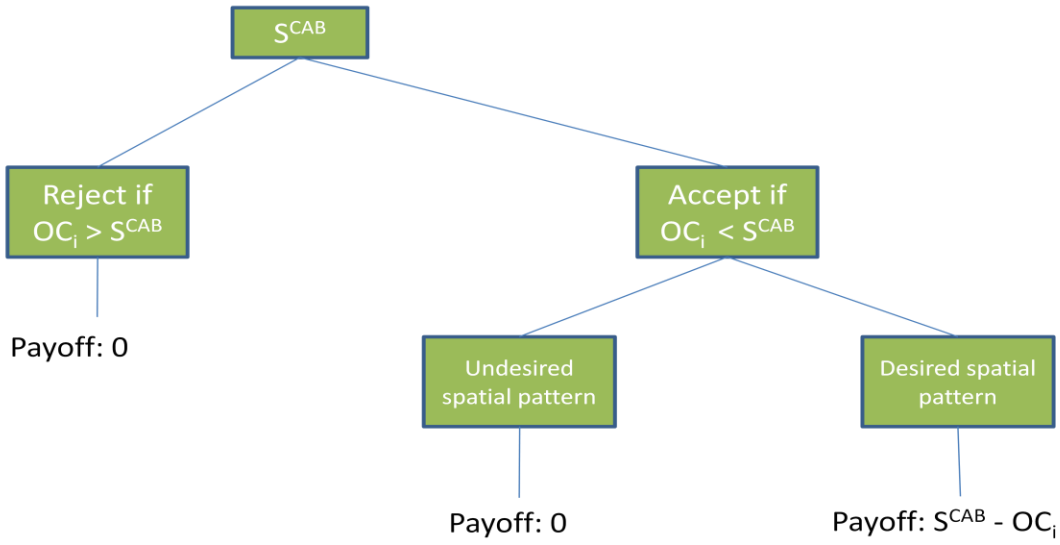
[3] For the purposes of this paper, I assume that the CAB program is offered once and only once. If the CAB were offered periodically, a landowner may find it optimal to delay his enrollment decision, even where $S^{CAB} > OC_i$, if his option value is positive.

Figure 4.2 Landowner's Enrollment Decision and Payoff Structure



Figures 4.3 and 4.4 represent the operation of a CAB program on a hypothetical landscape. Figure 3a shows parcels of land conditionally accepting the CAB offer. That is, all parcels for which $S^{CAB} > OC_i$. Figure 3b shows the parcels of land ultimately enrolled in the CAB program when the desired pattern of conservation is three or more contiguous units of land. Any landowner not contiguous to at least two other parcels of land is released from his conditional enrollment.

What should be clear is that the CAB program functions *without* the coordination of landowners. Each landowner's optimal strategy (accept if $S^{CAB} > OC_i$ and reject otherwise) is informed only by his own costs and S^{CAB}. Information about neighbors' willingness to enroll, represented by p, is irrelevant.[4] Hence, the CAB can achieve desired patterns of spatially coordinated conservation *without* making any assumptions about the level of information available to landowners and their ability to cooperate.

[4] Under a standard agglomeration bonus the size of p is relevant to the enrollment decision, and the functionality of the agglomeration bonus will depend on each landowner accurately determining p. The information contained in p is complex: it is the joint probability of each landowner enrolling and it is endogenous.

Figure 4.3 Parcels Conditionally Accepting S^{CAB}

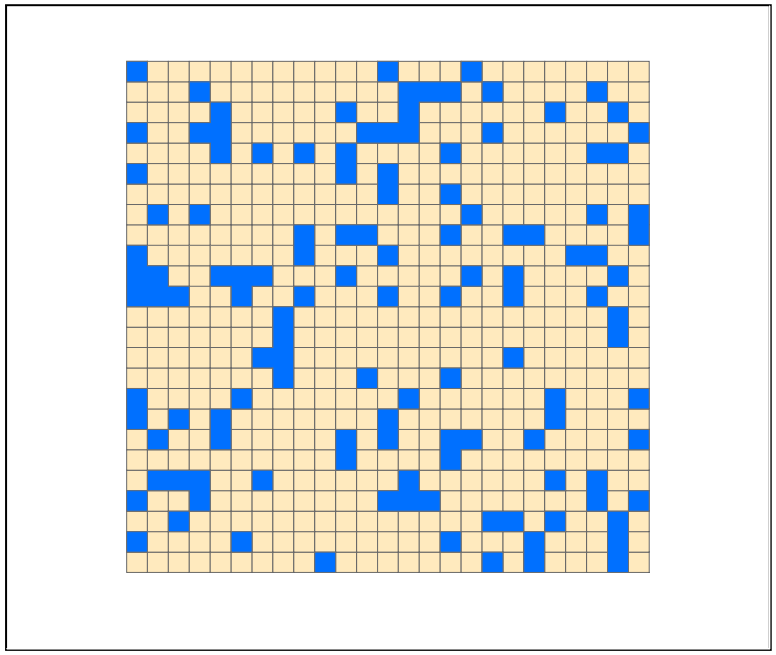
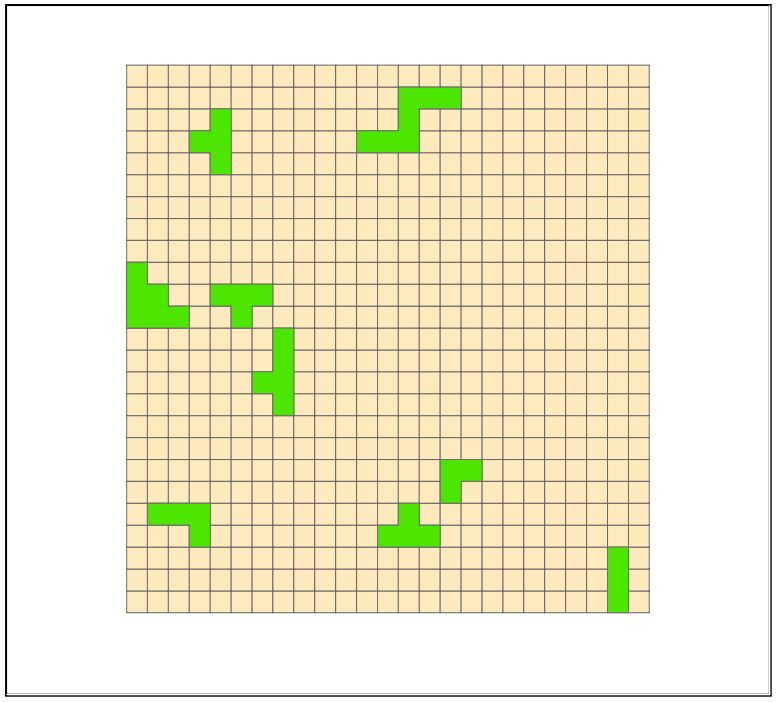


Figure 4.4 Parcels Enrolled (criterion of at least three contiguous parcels)



From the landowner's standpoint, the conditional agglomeration bonus improves upon the agglomeration bonus as it has been represented in the literature in two important ways. First, the CAB simplifies the landowner's decision process by eliminating the need to coordinate one's decision with others. Second, the possibility of coordination failure caused by uncertainty of neighbors' willingness to enroll is eliminated. Wherever a group of landowners is each better off enrolling, that group is ultimately enrolled (see Figures 4.3 and 4.4).[5]

Applications to Conservation

The ability of an incentive mechanism such as the agglomeration bonus to induce spatially coordinated land conservation does not alone recommend its application to conservation in the presence of threshold effects. The appeal of an agglomeration bonus incentive to a budget-constrained regulator will depend on how effectively it can be implemented. Factors affecting the efficiency of conservation incentive mechanisms that have been discussed in the literature include offsite environmental benefits, relationships between alternative environmental benefits, the correlation between land value and environmental benefits, threshold effects, and slippage caused by output price effects (Babcock, et al., 1997; Wu, 2000; Wu, et al., 2000).

Here the focus is on threshold effects and I assume that a single environmental benefit (e.g., habitat for a particular species) is being targeted. Suppose that the marginal benefit of conservation exhibits threshold effects such that the benefit per acre of conservation (BPA) is small until some threshold of contiguous acreage H_T has been conserved (see Figure 1). A cost effective allocation of conservation funds will target low opportunity cost parcels of land that form contiguous areas $H_j > H_T$.

In the context of the previous section, the CAB successfully targets high-benefit/low-cost parcels by identifying all parcels for which $OC_i < S^{CAB}$ (see Figure 3a), and enrolling only those parcels that contribute to the formation of contiguous

[5] It is possible for some landowners to be thwarted by an irrational neighbor who does not enroll, but they will be no worse off than the status quo.

areas for which $H_j > H_T$ (see Figure 3b). From the standpoint of a regulator, the CAB improves upon a standard agglomeration bonus by eliminating the possibility of coordination failure, which could result in the enrollment of fragmented parcels of land with small benefits. Allowing the final enrollment decision to be made after the spatial distribution of lower opportunity cost parcels is revealed enables the regulator to allocate funds exclusively to high-benefit contiguous parcels.

A difficulty faced by the regulator is how to choose the size of the incentive S^{CAB}. If the regulator knows the distribution of opportunity costs he may predict how many landowners will conditionally accept his offer of S^{CAB}. However, the number of parcels that satisfy the desired pattern of enrollment, and are ultimately enrolled and compensated, is unknown without knowledge of the spatial distribution of low opportunity cost parcels. For a given S^{CAB}, a landscape with spatially correlated opportunity costs will tend to enroll a large number of parcels compared to a landscape with spatially fragmented opportunity costs. Such uncertainty is likely to be problematic for a regulator facing a budget constraint.

The use of auctions in conservation contracting has been proposed in the literature as a way to overcome information asymmetry between landowners and regulators (Latacz and Hamsvoort, 1997; Romstad and Polasky, 2008). An *n*-price auction could solve the regulator's information problem by inducing landowners to reveal information about their true opportunity costs prior to choosing S^{CAB}. In an *n*-price auction, the level of compensation is set equal to the highest accepted bid. Each bidder has an incentive to bid his true reservation price because the level of compensation is independent of the size of the bid, except for the highest accepted bidder (Romstad and Polasky, 2008).

An *n*-price auction applied to this hypothetical conservation problem would produce the same outcome as a CAB program whenever the highest accepted bid is equal to S^{CAB}. The advantage of the auction is that it allows the regulator to set the level of compensation in accordance with his budget constraint. With information about the level and location of landowner opportunity costs revealed by the bidding

process, the regulator would be able determine the levels of enrollment and total compensation resulting from accepting progressively higher bids. A level of compensation could then be selected that would satisfy the budget constraint.

Concluding Remarks

The importance of considering threshold effects in the geographic allocation of funds to land conservation has been well demonstrated in the literature. The agglomeration bonus is a targeting mechanism that attempts to spatially coordinate the allocation of conservation funds using a voluntary incentive mechanism. The primary weakness of the agglomeration bonus as it has been represented in the literature is that it requires landowners to do the coordinating amongst each other. Landowners may be able to coordinate enrollment decisions well, or poorly, depending on any number of conditions (e.g., the number of landowners involved). However, the possibility of coordination failure is always present and limits the mechanism's applicability to policy problems.

The primary contribution of this paper is to demonstrate that spatially coordinated land conservation can be achieved *without* landowners coordinating their enrollment decisions. Because a landowner's enrollment decision under a CAB program is determined entirely by his private costs and benefits, the possibility of coordination failure caused by uncertainty about others' willingness to enroll is eliminated. The elimination of coordination failure is attractive to both landowners and regulators. A group of landowners will want to participate in conservation whenever doing so results in each being better off. A regulator wants to enroll contiguous parcels of land while avoiding the enrollment of fragmented parcels.

In the limited context of targeting an environmental benefit exhibiting threshold effects, the cost-effectiveness of the CAB mechanism is attractive. A CAB identifies the spatial distribution of the parcels of land with lower opportunity cost and only enrolls those that satisfy the desired spatial pattern of conservation. That said, a host of other factors typically affect the cost-effectiveness of conservation strategies and a regulator must take those into account when considering a CAB. In some cases,

it may be possible to incorporate a CAB into other incentive mechanisms such as competitive-bid auctions.

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