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Effects of local land-use planning on development and disturbance in riparian areas

Judith A. Dempsey[a], Andrew J. Plantinga[b,*], Jeffrey D. Kline[c], Joshua J. Lawler[d], Sebastian Martinuzzi[e], Volker C. Radeloff[e], Daniel P. Bigelow[f]

[a] Federal Communications Commission, United States
[b] Bren School of Environmental Science and Management, University of California, Santa Barbara, United States
[c] U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, United States
[d] School of Forest Resources, University of Washington, United States
[e] Department of Forest and Wildlife Ecology, University of Wisconsin, United States
[f] U.S. Department of Agriculture, Economic Research Service, United States

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ABSTRACT

Land-use change can significantly affect the provision of ecosystem services. On a local scale, zoning laws and other land-use regulations are commonly used to influence land-use change, but their effectiveness is often unclear. We evaluate the effectiveness of local land-use planning in concentrating development and minimizing impacts in riparian areas. We use spatially-explicit land cover data from the USGS Land Cover Trends project to measure development and disturbance rates before and after implementation of Oregon's land-use planning system. We apply a difference-in-difference estimator to address the problem of non-random assignment of regulations on the landscape. We find that land-use laws in Oregon have concentrated development inside of UGBs and lowered development rates in riparian areas. However, disturbance in riparian areas has increased inside of UGBs. Overall, our findings suggest that local land-use planning can be an effective tool for promoting the provision of non-market ecosystem services.

1. Introduction

Land-use change has large effects on the provision of ecosystem services and biodiversity (Lawler et al., 2014; Millennium Ecosystem Assessment, 2005). The conversion of land from less to more intensive uses, such as the transformation of native grasslands into cropland or of forests into development, has greatly increased the production of market goods, including food, fiber, and housing. However, these changes often come at the expense of other ecosystem services, such as air and water quality and open space, and ecosystem functions, such as habitat for wildlife. There are a number of ways that land-use policy can be used to achieve more balance between market and non-market ecosystem services, including implementing market-based incentives to deter harmful private land-use decisions, establishing conservation areas, and using zoning and other land-use regulations to prevent deleterious land-use changes. Of these approaches, zoning and regulatory approaches have the potential to most effectively control land-use decisions, because of the greater control they afford land managers in targeting protection measures to specific locations and for their ability to overcome market forces driving land-use change (Lawler et al., 2014). The provision of important ecosystem services such as carbon sequestration, pollination, pest control, and water purification often depends on how land uses are arranged on a landscape.

At local scales, land-use planning is the primary approach used to influence the spatial pattern of land use. Zoning has been used in the U.S. since the early 20th century to specify permitted uses of land (Mills, 1979). In recent decades, urban containment policies, such as urban growth boundaries (UGBs), have become a common tool used to promote compact development (Wassmer, 2006). There are many earlier analyses of the effects of land-use regulations on housing and land prices (McMillen and McDonald, 2002; Quigley and Rosenthal, 2005; Ihlanfeldt, 2007; Lynch, et al., 2007; Grout et al., 2011), and a smaller number of studies that examine their effects on the rate of land development (recent examples include Cunningham, 2007; Boarnet et al., 2011; Dempsey and Plantinga, 2013). Several of the studies consider land-use regulations in Oregon, which is our focus as well. Knapp (1985) finds that land values are higher within the Portland Metropolitan Area UGB in two of three counties. Grout et al. (2011) find land price differ-

* Corresponding author.
E-mail address: plantinga@bren.ucsb.edu (A.J. Plantinga).

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entials of between $30,000 and $140,000 per acre at the Portland UGB, but also identify sections of the UGB where there is no price change. Dempsey and Plantinga (2013) find higher development rates inside of many of the UGBs in Oregon's Willamette Valley compared to outside, but in some cases find no difference.

The previous literature consider effects of land-use regulations on property values and development rates, but does not analyze the effectiveness of land-use regulations at preventing development of particular types of land, such as forests or riparian areas. Forests sequester carbon and play a major role in climate change mitigation and biodiversity conservation (Dixon et al., 1994), while riparian vegetation protects streams from nonpoint source pollutants and provides habitat for wildlife (Dosskey et al., 2010). Understanding how regulations affect different types of land is important for assessing effects on ecosystem services because of the variation among land uses in the kind and amount of services provided.

Our analysis evaluates zoning and urban growth policies in the U.S. State of Oregon, which is distinctive for its comprehensive and coordinated statewide program. Although Oregon's planning system includes strict land-use controls, such as urban growth boundaries, it is not designed to prevent all development. In this study, we consider the effectiveness of local land-use planning at containing development and limiting development and disturbance in riparian areas. We also present some suggestive evidence on how agricultural and forest lands have been affected under planning rules. Any effort to measure the effects of land-use planning must confront challenges arising from the non-random assignment of zoning and urban growth restrictions to land parcels. In the recent literature, this problem has been addressed with instrumental variables, matching methods, and regression discontinuity design (e.g., Lynch et al., 2007; Grout et al., 2011). In this study, we employ a technique from the program evaluation literature (Imbens and Wooldridge, 2009) called difference-in-difference (DID) estimation. Dempsey and Plantinga (2013) also use a difference-in-difference estimator to study the effects of UGBs on development rates in Oregon. Our study differs from Dempsey and Plantinga (2013) in that we distinguish effects on riparian and non-riparian lands, consider disturbance in addition to development, and evaluate a broader set of land-use regulations.

2. Background on Oregon's land-use planning program

The current land-use planning system in Oregon was created by Senate Bill 100, approved in May 1973, with the goals of protecting farm and forest lands, conserving natural resources, ensuring orderly and efficient land development, facilitating coordination among local governments, and providing for citizen involvement. It directed the Land Conservation and Development Commission (LCDC) to develop planning goals that must be addressed in all local comprehensive land-use plans. The original set of 14 goals was adopted in December 1974. We focused our study on how well cities and counties have addressed Planning Goals 3, 4, 5, and 14. Goal 14 seeks "to provide for an orderly and efficient transition from rural to urban land use" (DLCD 2010). Cities and counties are required to designate UGBs and consider a variety of factors when doing so, such as the need to accommodate projected population increases and satisfy demands for housing and employment. Goal 3 requires that agricultural lands be inventoried and then preserved through the designation of exclusive farm use (EFU) zones. All agricultural lands that are not contained within a UGB, and not specifically designated for nonfarm use, are zoned EFU. Minimum lot sizes are 32 ha for agricultural land, unless it can be demonstrated that commercial agricultural enterprises can be maintained on smaller parcels. Construction within EFU zones is limited to dwellings and buildings that support agricultural activities. Goal 4 is similar to Goal 3 except that it applies to forests and requires the designation of "forest zones" that are typically 80 acres or greater in size.

Goal 5 requires local governments to "adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations" (DLCD 2010). Particular emphasis is given to riparian corridors. The Administrative Rule for Goal 5 instructs governments to limit permanent alterations to riparian areas, such as the placement of structures or impervious surfaces, and removal of native vegetation. For the most part, locally-adopted Goal 5 ordinances are applied to lands inside of UGBs, one important exception being land zoned for rural residential uses. Riparian management on commercial forest lands outside of UGBs is regulated by the Oregon Forest Practices Act. The Forest Practices Act was passed in 1971, but the rules for riparian management were not developed until the early 1990s, with the final rule adopted in 1994. The rules give landowners flexibility in managing lands in riparian areas, as long as progress is made toward the overarching objective of establishing mature forests. Agricultural lands outside of UGBs are subject to Oregon's Agricultural Water Quality Management Act, which was passed in 1993. This policy requires the development of regional water quality management plans, but does not contain specific rules for riparian management.

Despite the requirements of the land-use planning system, there are a number of ways that development can occur on agricultural and forest lands and in riparian areas. Under Goal 5 rules, local governments can decide not to protect certain natural resources depending on the results of an economic, social, environmental, and energy analysis. Even if forest and riparian areas are protected, exceptions can be granted for roadways and paths, water conveyance, and water-dependent and water-related uses. In these cases, local governments may either grant variances to zoning rules or modify zoning designations in their comprehensive plans. Because land-use planning ultimately is carried out by a large number of local governments, the degree of State oversight is necessarily limited. For all of these reasons, the effectiveness of Oregon's land-use planning system in promoting land conservation has remained an open question (Pease, 1994).

3. Data

We use USGS Land Cover Trends (LCT) data (Loveland et al., 2002) to estimate land-use changes in areas with and without land-use restrictions. The LCT is a publicly-available, national dataset derived from satellite images, aerial photography, and topographic maps via manual digitizing. The data represent a stratified (by ecoregion) random sample of 100-km^2 blocks for the years 1973, 1980, 1986, 1992, and 2000. Within each block, land cover is mapped at 60-m resolution using the Anderson Level I classification system. More recent LCT observations are also available at 30-m resolution. However, because our analysis included the earliest (1973) observations, we use 60-m data throughout our study period.

We focus our analysis on the Willamette Valley (approximately 30,000 km^2), which contains Oregon's major cities (Bend and Medford being notable exceptions) and over 70 percent of the State's population. There are thirty-two LCT blocks in the Willamette Valley ecoregion (Fig. 1); twenty-nine of these blocks are completely within the Willamette Valley and 3 are partially within the Valley. We use data for 1973 to measure conditions before land-use planning was implemented (i.e., the "before" observations). The enabling legislation for Oregon's land-use planning system was passed in 1973, but actual implementation took place in the years that followed. We use data for 2000 for the "after" observations,