Does land conservation raise property taxes? Evidence from New England cities and towns

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Abstract

Protected lands provide high ecological and social value, yet a perception that conservation erodes local property tax bases and shifts tax burdens to other owners creates barriers for new protection. We investigate the impacts of changes in land protection on local property tax rates using panel data from more than 1400 towns and cities in New England between 1990 and 2015, including both ownership and easement-based protection. We find that on average, new protection results in small property tax rate increases, with an estimated average elasticity of 0.024-0.026. This corresponds to an increase in a homeowner's annual tax bill of $0.72-$0.92 per $100,000 of property value for the average annual new area protected (84.9 acres). We do not find evidence that impacts last over time or affect municipal expenditures. However, for towns that are growing slowly, have lower household incomes, or adopt municipal land protection, we estimate greater impacts, ranging from a $5 to $30 tax bill increase for each $100,000 of value. These results provide evidence that land protection does not have a substantial impact on property taxes, but also highlight the importance of maintaining and expanding public compensation mechanisms such as payments in lieu of taxes where expected burdens from new protection may be greater.

Keywords: land conservation, property taxes, local economies, New England, protected areas, public finance. JEL: (Q24, Q28, R51)

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1. Introduction

Protected land provides multiple ecological and social benefits including carbon sequestration, habitat for a diverse set of plant and animal species, watershed functioning, preservation of prime agricultural soils, and space for recreation and cultural preservation (Dinerstein et al. 2019; Watson et al. 2014; Brauman et al. 2007). In the U.S., the rate of land protection has expanded rapidly in recent decades, motivated by the continued loss of open space to development (Nelson, Uwasu and Polasky 2007; Kotchen and Powers 2006). This increase has been facilitated by state and federal funding (The Trust for Public Lands 2021; Stubbs 2020), shifts in land ownership (Meyer et al. 2014), tax incentives (Parker and Thurman 2018), and funding for open space protection through local referenda (Lang 2018). High levels of federal funding are currently available for new land protection through the reauthorized Land and Water Conservation Fund (National Park Service 2020) and the Farm Bill (Stubbs 2020), motivating the need for an understanding of the expected impacts of land conservation.

The fiscal implications of protecting natural land from development are of great interest to local taxpayers, government officials and other stakeholders. Proponents of land protection have argued that open space pays for itself, requiring less in municipal expenditures than it contributes to revenues, while protecting crucial ecosystem services, increasing amenity values and creating natural resource-based economic opportunities (e.g. Trust for Public Land 2007). Yet landowners and government officials worry that land protection may erode the local property tax base due to reduced valuation of protected land or ownership by tax-exempt entities (Brandon 2021; Ricketts 2021; Rule 2019; Neuman 2018; LePage 2018). These concerns have fueled opposition to both local land protection efforts (LePage 2018) and national conservation initiatives like President Biden’s 30-by-30 conservation target (Brandon 2021). Despite the crucial role that local taxes play in funding public goods, few studies have quantified the possible causal impacts of land protection on property taxes to inform this debate (Vandegrift and Lahr 2011; King and Anderson 2004).

Economic theory suggests that the impacts of land protection on local property tax rates could be either positive or negative (King and Anderson 2004; Geoghegan, Lynch and Bucholtz 2003). Land that is protected through conservation restrictions or ownership by public and non-profit organizations is frequently tax-exempt or taxed at lower rates than developed or unprotected land. New land protection may therefore reduce revenues collected and lead to a need to raise tax rates. On the other hand, land protection can create amenity value which may boost surrounding property values (Lang 2018; Vandegrift and Lahr 2011; Anderson and West 2006; Irwin 2002) and increase collected revenue as assessments are adjusted. Prior studies have shown that land protection can also have positive impacts on local employment outcomes and economic growth, potentially increasing other revenue sources (Walls, Lee and Ashenfarb 2020; Sims et al. 2019; Chen, Lewis and Weber 2016; Rasker, Gude and Delorey 2013). In addition, the cost of services is often higher for new development than for undeveloped land, so new development may increase expenditures even though it also increases revenue, actually leading to higher tax rates (Murray and Catanzaro 2019; Kotchen and Schulte 2009).

While there is a clear need for empirical research to understand the impacts of land protection on property tax rates, estimating these relationships is difficult due to the potentially endogenous nature of land protection. Communities that engage in more land protection may be those with greater wealth, past history of conservation, or that stand to gain from recreation-based economies. Our research provides a novel analysis of fiscal impacts, using plausibly exogenous changes in land protection over time within municipalities to overcome these potential concerns. Specifically, we estimate the effects of new land protection on local property tax rates using municipal-level panel data from 1990 to 2015 across five New England states. We combine data on tax rates, tax levies, and taxable property value for more than 1400 municipalities in the region (also referred to as New England's "towns and cities"). We match these with detailed spatial data on new land protection over time assembled by the Harvard Forest and the Highstead Foundation.

Our identification strategy relies on variation in the timing of new protection within each municipality. Specifically, we employ a first differences approach, estimating changes in tax rates as a function of lagged changes in land protection, with controls for state-year fixed effects, core-based statistical area trends, and lagged changes in the labor force, unemployment, and tax base growth. This approach differences out unobserved time-invariant characteristics of municipalities and reduces serial correlation. Our key identifying assumption is that the timing of new protection within municipalities, conditional on these controls, is exogenous to potential outcomes. This is plausible because this protection is the result of decentralized and uncoordinated actions by more than 350 separate land trusts, hundreds of local governments, and multiple state and federal agencies. Land trusts overlap in their spatial jurisdictions and missions (Wildlands and Woodlands 2021; Foster et al. 2017; Labich 2015), and many local protection successes have been driven by the efforts of just a few committed individuals. In addition, opportunities for protection often occur when there is a generational shift within families due to health shocks or deaths (Markowski-Lindsay et al. 2017; Bigelow, Borchers and Hubbs 2016). The nature of these protection processes within New England creates considerable randomness in the extent and timing of new land protection, which we exploit to estimate the impacts of protection on tax rates and other fiscal outcomes.

We estimate average effects as well as test for differential impacts across land protection types and by key characteristics of the communities where land protection is occurring, including the rate of growth of the town's tax base, median household income, and extent of land enrolled in current use programs, which reduce taxes for undeveloped land uses. We also examine fiscal outcomes (municipal revenues, expenditures) for the states with available data in order to study the possible fiscal response to land protection, as localities may respond to revenue shortfalls by reducing outlays for public goods.

We find that on average, new land protection has had small impacts on property tax rates that do not last over time. We find an estimated annual elasticity of 0.024-0.026, indicating the expected percentage increase in taxes attributable to a one percent increase in the share of land protected. For the average annual increase in new land protection of 84.9 acres among towns that engaged in land protection, this translates to an annual property tax bill increase of just \$0.72-\$0.92 per \$100,000 of property value, or \$1.92-\$2.46 for an owner of a typical New England home (\$266,497 in value; \$3475 estimated annual tax bill). We do not find evidence that municipalities collect fewer revenues or reduce expenditures on public goods as a result of land protection. We also do not find evidence that tax rate increases last over time or that they are generally larger for towns that already have a high share of land protected or smaller tax bases.

However, although average impacts are small, we observe substantial heterogeneity in impacts by land protection type and local characteristics, with magnitudes ranging from \$5 to \$30 per \$100,000 of value. The types of towns that are associated with greater estimated impacts are those that are growing slowly, have lower median incomes, little land taxed under current use, or fewer second homes. We also find suggestive evidence for larger tax increases associated with municipal land protection, particularly in towns with smaller tax bases or slow growth. Taxes may also increase as a result of federal and state protection for towns with a very high existing share of land protected.

Overall, our findings indicate that the tax rate changes due to land protection are generally not substantial, particularly in comparison to the magnitude of changes that residents experience for capital projects such as new buildings or increases in municipal staff. Yet the heterogeneity in impacts highlights the importance of understanding where expected tax rate increases are likely to be greater. They also emphasize the importance of public compensation mechanisms, such as state and federal payments in lieu of taxes, that can assist communities engaging in land protection, and a rationale for targeting these programs to the types of communities that may be most impacted by new land protection.

2. Contributions to the Literature and Theoretical Framework

2.1 Prior Literature

Prior research on the fiscal impacts of land protection indicates that it may have both positive and negative impacts on local tax rates and expenditures. The main concern is that protected lands will contribute less revenue to local coffers, particularly when they are owned by NGOs or other tax-exempt institutions (Neuman 2018; LePage 2018; Davis et al. 2018). Facing budgetary pressures and growing amounts of protected land, municipalities have resisted granting land trusts tax exemptions on land owned in fee, including through high-profile court cases in the New England region (Cameron McWhirter 2014). Anecdotally, concerns about tax revenue loss from protected land have been greatest for towns with large amounts of conserved land, and small, not very diverse tax bases, where the cumulative impact of tax exemptions for land assessed at its current use value, state ownership and conservation easements can add up to a major reduction in tax revenues and higher tax rates for local landowners (Neuman 2018; LePage 2018; Davis et al. 2018).

At the same time, these concerns are countered by prior research on amenity values and cost of community services. Prior research on how the value of open space is capitalized into property values includes studies at the parcel (Chamblee et al. 2011; Anderson and West 2006; Geoghegan et al. 2003; Irwin 2002; Thorsnes 2002) and zip code (Lang 2018) levels. Hedonic studies of open space impacts on property values consistently find positive, although localized impacts of protected land on property values (Chamblee et al. 2011; Anderson and West 2006; Geoghegan et al. 2003; Irwin 2002; Thorsnes 2002). At the zip code level, Lang (2018) observes positive impacts of open space expenditures on median home values, an impact that remains positive and significant ten years after funding is approved through referenda authorizing open space expenditures. These findings suggest that land protection can contribute to growth in the municipal tax base by protecting natural amenities that are then capitalized into the values of nearby properties.

Cost of community services studies have also been used to compare the fiscal costs and benefits of different land uses (Clapp et al. 2018; Kotchen and Schulte 2009). These studies separate land use into residential, commercial/industrial and open space/agricultural classes. Researchers then work with local officials to interpret and apportion municipal revenues and expenditures to land classes with the goal of comparing the ratio of expenditures to revenues for different land uses (Kotchen and Schulte 2009). The findings from this literature consistently show that open space/farmland and commercial/industrial land uses have expenditures to revenues ratios of less than one, meaning they “pay for themselves.” Since the results are based in accounting methods, the conclusions drawn can be strongly related to case-by-case decisions about how to allocate expenses such as emergency services or water treatment services across each land use in a particular community.

The potential for fiscal impacts of land protection has also been addressed within the literature on preferential taxation of working lands. All states provide some form of tax relief to land used for forestry and agriculture, usually with the goals of promoting rural livelihoods and providing incentives to reduce the conversion of working lands to developed uses (Anderson 2012). The most common mechanism for tax relief is through current use provisions (also referred to as use value assessment). Under current use, eligible property is assessed for its income-producing capacity in agriculture and forestry, instead of its potential market value, which results in substantial reductions in tax obligations (Anderson and England 2015). County-level studies document reductions in tax revenue from land under current use on the order of 46-70% (Coogan, Bell and Brunori 2014; Chicoine et al. 1985; Dunford et al. 1981) and an overall decline in per capita property tax revenue of 15% (Bigelow and Kuethe 2020). The decrease in tax revenue from land value assessment under current use has been found to be associated with tax increases on other property classes (Chicoine et al. 1985; Dunford et al. 1981).

Our work is most closely related to the small number of empirical studies that examine the impact of permanent land protection on property tax rates or tax base. We are aware of only two such studies: King and Anderson (2004) investigated the effect of new land protection with conservation easements in 29 Vermont towns, during a 10-year time period. They found that tax rates can increase for up to four years after land is protected. After four years, the impact on the tax rate goes to zero and in some model specifications even becomes negative, which is consistent with tax base growth due to increased amenity value. Vandergrift and Lahr (2011) examined the impact of open space acquisition on tax base growth in 566 New Jersey municipalities between 1995 and 2000. The authors measured open space in terms of contemporaneous aggregate expenditures on land protection from 1995-2000 as well as historic expenditures from 1961-1995, at the municipal level. This study found that contemporaneous expenditures on open space were associated with reductions in tax base growth, while historical expenditures did not have a significant impact on the tax base, suggesting that the effect of land protection on the tax base was small and might not persist in the long run.

Our paper substantially advances this literature by studying the effects of land protection on tax rates using plausibly exogenous changes in both public and private conservation and across a wide set of municipality types. By using panel data on more than 1400 towns and cities over a 20-plus year time span, we are able to isolate impacts by using variation within municipalities over time, and by controlling for potentially confounding trends at the regional level or within time periods. In addition, we are able to assess impacts of both public and private protection and in communities that span the rural-urban gradient. Private land protection through legal easements plays an increasingly important role in conservation (Cortés Capano et al. 2019; Parker and Thurman 2019; Land Trust Alliance 2015). In New England, private landowners own more than 75% of the region's forests, including thousands of family forest owners with small to mid-sized parcels (Butler et al. 2016). New England therefore provides a setting in which it is possible to study the full mosaic of fee and easement protection by multiple actors, a pattern that is likely to be more characteristic of the future of land protection across the country as a whole. We also examine heterogeneity in impacts across multiple local economic characteristics. An understanding of this heterogeneity is particularly crucial given growing concerns about equity in the benefits and costs of environmental policies, including land conservation (Currie, Voorheis and Walker 2021; Shapiro and Walker 2021; Sims et al. 2021; Carley and Konisky 2020; Colmer et al. 2020; Banzhaf, Ma and Timmins 2019). Sims et al. (2021) finds significant disparities in access to protected land in the region by income, educational attainment and race, including from new land protected between 1990 and 2015. Greater equity in access may be achieved partly through additional protection in disadvantaged communities, further motivating an understanding of potential heterogeneity in impacts.

2.2 Theoretical Framework: Impact of Land Protection on the Property Tax Rate

Land protection can potentially impact property tax rates through the municipal tax base and expenditures. A simple form of the relationship that determines the tax rate, which assumes a balanced budget and a single tax rate, can be expressed as:

$$Tax\ Rate = \frac{Total\ Expenditures - Other\ Revenue}{Tax\ Base} = \frac{Property\ Tax\ Levy}{Tax\ Base} \quad \text{(Eq 1)}$$

where the property tax levy is the amount needed to cover the total budget expenditures less other available sources of revenue.

This relationship highlights the typical concerns about land protection raising tax rates. Protected status typically causes a reduction in the taxable value of the protected parcel or removes it from the tax rolls altogether if the owner is tax exempt. This reduces the value of the tax base, and if other revenues are constant, requires an increase in the property tax rate to maintain the existing level of municipal expenditures. However, in reality, the direction and magnitude of changes in tax rates may actually vary considerably depending on the specific type of land protection, how property is taxed before it is protected, the expenditure behavior of the town, and whether the value of surrounding property increases through amenity effects. As a result, land protection can either increase or decrease local property values and municipal revenues, depending on local conditions (Wu, Xu and Alig 2016; Wu 2014).

Different types of land protection are expected to have different immediate impacts on tax revenue. We distinguish between four types of land protection, grouped by expected impacts. Figure 1 shows the distribution of land protected in total and under each of these four categories at the town or city level across the region and Table 1 provides a summary. The first type is fee simple acquisition of land by non-governmental, not-for-profit organizations. Typically, the full taxable value of land conserved in this way would be removed from the tax base, since non-profit organizations are generally tax exempt. Some NGOs do make voluntary payments to the towns, or provide infrastructure and services that might otherwise be paid for by municipalities. The second is fee simple acquisition of land by municipalities. All property value is removed from taxation following a municipal purchase, since municipalities do not receive taxes for land that they themselves own. Additionally, in some cases, municipalities must raise the funds to purchase the land in the first place, which may require a tax increase or additional local fees. (The land may also be donated to the municipality or a third-party may help to raise funds; or the funding may come out of existing planned expenditures.) The third type that we consider is easement protections on private land. Conservation easements are voluntary, legal agreements between a landowner and a qualified NGO or public agency that extinguishes the right to develop the land. An easement generally lowers the taxable value of property by restricting future development unless such development was already restricted due to the presence of wetlands or zoning requirements. While an easement can be placed on NGO, municipal, state or federally owned land, the majority are on private land. We restrict this category to easements on private land in order to create mutually exclusive categories for analysis. In cases where there is an easement on land already in municipal, state/federal or NGO ownership, we characterize protection according to the ownership type. Our fourth category includes land acquired in fee simple by state and federal agencies. These lands also cannot be taxed by municipalities. The federal government and all states in our sample except for Maine do make payments in lieu of taxes (PILOTs) to municipalities as compensation for the lost property tax revenue. However, while these PILOTs are intended to offset the loss of tax revenue, in practice they are often small or underfunded, and there is considerable variation in how actual compensation relates to lost tax revenue (Bump 2020; Pinho and Dilworth 2020; DeNucci 2001; DeNucci 1994). Finally, we note that for each of these protection types, the expected change in the tax base due to permanent land protection may also be related to current use value assessment programs. If land is already given tax breaks under current use provisions at the time of conservation, we expect the additional impact of land protection on taxes to be smaller (Table 1).

In addition to type of protection, the relationship in equation 1 also indicates that the size and growth of the local tax base may play an important role in how tax rates respond to new protection. All else equal, a town with a smaller tax base should experience a proportionally greater loss of taxable property value for the same type and acreage of land conserved compared to a town with a larger tax base. The size of the tax base may be correlated with whether the town is primarily rural, exurban, or urban. At the same time, parcels of the same size may have lower valuation in rural towns with less development pressure, potentially mitigating impacts in towns with small tax bases. Finally, the tax rate impacts of land protection may appear small if towns cut expenditures in response to tax revenue loss, changing the numerator in equation 1, or if there are increases in the values of other properties due to amenity effects.

Tax impacts may also depend on community incomes. Prior studies have demonstrated a positive relationship between willingness to pay for open space and income (Earnhart 2006; Breffle, Morey and Lodder 1998), and have found increasing demand for open space with income in the context of open space referenda (Nelson et al. 2007; Kline 2006; Kotchen and Powers 2006), environmental ballot measures (Kahn and Matsusaka 1997), and municipal open space acquisitions (Bates and Santerre 2001). There is also evidence that the amenity value of nearby open space increases with neighborhood income (Anderson and West 2006). Accordingly, land protection may disproportionally boost property values in high income municipalities. Additionally, higher income municipalities may have more resources to obtain grants and leverage existing experience with land protection in ways that can mitigate the loss of taxable property value. Consistent with this, prior research indicates large disparities in access to nearby protected land within the New England region by income (Sims et al. 2021). Given the potential role of municipal level wealth in the expected impacts of new protection, we will examine potential heterogeneity in impacts according to measures of the tax base (level and growth) and town-level income, both separately and in combination.

In addition, we will examine impacts according to the share of land already protected and the share of second homes, as well as the longer-term impacts of new land protection. On one hand, land protection may constrain future development, meaning forgone revenue from new houses. At the same time, land protection may also create new recreation opportunities or scenic value for a town, which can be capitalized into the value of other property or can attract and drive re-development of existing land or new amenity-based development if other land is available (Lang 2018; King and Anderson 2004). Many areas that were once primarily forestry or agriculture-based economies have shifted toward value based on natural amenities and leisure activities by “lifestyle landowners”, who place greater emphasis on environmental amenities than the productive value of the land (Polyakov et al. 2013; Irwin et al. 2010). Capitalization of amenity value into other properties may take would ultimately increase the tax base, potentially offsetting a need for a tax rate increase or even lowering the tax rate, although resulting in higher tax bills for those whose property value increased. Land protection may boost local property values to a greater extent in amenity rich locations with a lot of lifestyle landowners or over a longer time horizon. New development attracted by higher amenity values may also offset the loss of tax revenue from protected land, although this again depends on whether new revenue from development actually outweighs the cost of new services needed (Murray and Catanzaro 2019; Kotchen and Schulte 2009).

Our study seeks to understand empirically the net effect of land protection on taxes, keeping in mind this overall framework and the multiple possible channels through which protection may change tax rates.

3. Study Area and Data

To examine the impact of land protection on property tax rates, we assemble an annual panel at the municipal level. We combine data on municipal fiscal outcomes, land protection, land with current use tax breaks, and socio-economic characteristics from 1990-2015 for 1436 municipalities (also “towns and cities”) in the New England region.

3.1 Regional Overview

We examine data from the five states of Massachusetts, Connecticut, New Hampshire, Vermont, and Maine (which comprise 5/6 of the New England states and the large majority of land area).[1] Towns and cities in our study area are charged with providing local services such as schools and fire-departments, collecting taxes to pay for them, and allowing building permits for new development. We refer to both types of these jurisdictions as municipalities since all have the crucial authority and responsibility to provide local public goods and levy taxes to pay for them. Municipalities can vary extensively in their provision of public goods, based on local preferences as well as historical constraints and relative wealth. New England has weak county government structures and except in Maine and limited areas of New Hampshire and Vermont, all land is incorporated into municipalities. We exclude these unincorporated areas since they do not control their tax rates, as well as excluding towns with population of less than 100 in 1990. The excluded population is a very small share of the total state population in our region, representing 0.11% of the 2015 population. Our area of interest includes 97 cities and 1339 towns (see Figure 1).

The population included in our study region was 13.6 million in 2015, and includes a continuum of urban areas like Boston, Hartford, and Worcester, dense and sparse suburban areas, and rural areas (U.S. Census Bureau 2016). Approximately 77.5% of the land area in our study region has forest cover and 7.1% is in agriculture, as shown in Figure 1 (panel F). Despite the extensive forest cover, however, forestry and related sectors make only a modest contribution to

[1] Our study excludes Rhode Island due to limited availability of fiscal data.

the regional economy[2] due to the development of other industries, the decline in employment and output within the forest products sector in recent decades (Woodall 2011), and the large share of forestland under smallholder land ownership, particularly in southern New England.[3] Much of this forest is also overlapping with residential development and is highly fragmented. After more than 150 years of reforestation that accompanied a shift away from agriculture, forest land cover in the region has declined since 1970 as a result of conversion to developed uses. Olofsson et al., (2016) report a rate of forest loss of approximately 24,000 acres/year for New England from 1985-2011, which amounts to a loss of 5% of regional forest cover since 1985. At the same time, the region has seen extensive land protection activity. A fifth of our study area is under some form of land protection, with considerable variation in protection type (Figure 1), creating a complex mosaic across space. As of 2015, 20.2% of our study area was protected, up from 12.8% in 1990.

Municipalities throughout New England have a similar process for setting municipal budgets. Most towns have a budget or finance committee that works in collaboration with municipal departments to prepare a budget for the upcoming fiscal year, which runs from July 1 through June 30th (Byrnes 2017; Massachusetts Municipal Association 2014; Neal 2012; Vermont League of Cities and Towns 2002; Hill 1992). The budget balances proposed expenditures against expected revenues and is adopted or rejected by the municipality's residents

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[2] From 1997-2015, forestry and related wood products manufacturing share of state GDP was 0.48% in Connecticut, 0.82% in New Hampshire, 4.43% in Maine, 0.59% in Massachusetts and 1.63% in Vermont (Bureau of Economic Analysis 2020).

[3] About 42% of the forestland acreage is under family ownership (>13 million acres), with 40% of this land owned in small to mid-size holdings (<100 acres), which can be more challenging to profitably manage for timber harvest. Smallholder forestland owners tend to prioritize landscape amenity value over timber harvest in management (Butler et al. 2016). Commercial timberland accounts for 39% of forest area (>12.4 million acres), with most of this acreage (82%) located in Maine (Butler et al. 2016). In practice, relatively small forest area is harvested annually in New England, <1% of forest area in southern New England and about 5% in Maine (Thompson et al. 2017).

via a vote at a town meeting for smaller municipalities or by the city councilmen in larger cities (Byrnes 2017; Massachusetts Municipal Association 2014; Neal 2012; Vermont League of Cities and Towns 2002; Hill 1992). Once a budget is approved, a property tax rate is set to raise the revenue required to cover the approved municipal appropriations in excess of local revenues and transfers from the state (Reid 2012). The tax rate is set based on the value of taxable property in the municipality, according to the most recent valuation from the municipal assessor.[4] To set a tax rate, the levy is divided by the total taxable property value in the municipality, which is the sum of all assessed property value, excluding tax-exempt property.

New England towns and municipalities are quite dependent on property tax revenue, making it a good region of study to potentially detect impacts of land protection on property tax rates. The share of local government revenue from property taxes in 2015 was 55% in Connecticut, 54% in Maine, and 60% in New Hampshire, which is twice the national average of 27% (Urban Institute 2020). In Massachusetts, the property tax revenue share was 43.7%, also considerably above average (Urban Institute 2020). Vermont has a local property tax revenue share of just 19%, but higher state-wide property taxes.[5] At the same time, New England towns rely less on other revenue sources like fees and non-property taxes.[6] Facing potential loss of tax revenue, municipalities in New England can increase tax rates and fees, reduce expenditures,

[4] The date of property value assessment varies across the states, from October 1st in Connecticut to January 1st in Massachusetts, and April 1st in New Hampshire, Maine, and Vermont. Assessed values approximate market values, although the ratio of assessed to market value can differ across municipalities and by state according to state rules.

[5] Vermont's low property tax revenue share reflects a system of state-wide property taxes that are returned through state aid to local governments, and an increased role of the state in education funding following education funding reforms in 1990's and 2000's. Vermont state aid accounts for 58% of local government revenues, which is twice the amount received by towns in other New England states where state transfers account for 24-28% of local government revenues.

[6] In 2015, these revenues sources accounted for 14-17% of local revenues in Maine, New Hampshire and Connecticut and 21-27% in Vermont and Massachusetts, relative to an average of 40.1% for local governments in the rest of the U.S. (Urban Institute, 2020).

take on debt, or try to secure additional funding from the state or external grant programs. However, given the large role that property taxes play, the primary response to a revenue shortfall is likely to involve either an increase in the property tax rate or a decrease in expenditures.

While land ownership in our study area is predominantly private, some towns have considerable land shares under state or federal ownership (>40% town area). New England states and the federal government vary in their approaches to compensating municipalities for tax revenue loss from land acquired by public agencies (i.e., PILOTs). Usually, compensation is based on average tax rates in the state (DeNucci 2001), a fixed proportion of lost tax revenue (Office of Policy and Management n.d.), value of land under current use (Knapp et al. 2014) or a combination of factors like population and revenues received from public lands as in the case of the federal government (Hoover 2017). Additionally, in Massachusetts and Connecticut, state-level PILOT programs have been habitually underfunded (Bump 2020; Pinho and Dilworth 2020; DeNucci 2001; DeNucci 1994). Compensation that may not be tailored to town-level values and the inconsistent funding of PILOT programs is a reported source of fiscal stress for rural towns with a lot of public land (e.g. Davis, 2017; Schoenberg, 2019).

3.2 Municipal Fiscal Data and Tax Rate Measures

Municipal fiscal data were obtained from each state's department of revenue. Our main outcome of interest is the property tax rate, which is the rate of taxation levied by municipalities on property under their jurisdiction. We refer to this as the nominal tax rate, following conventions in the literature (Song and Zenou 2006; Dye, McGuire and Merriman 2001; Mikesell 1980).

The advantage of this measure is that it is intuitive and familiar to landowners and policy makers. It is the rate set by a municipality and paid by local property owners on their tax bill. This measure also has two disadvantages. One is that assessed values can include local differences in assessment practices, which can make nominal tax rates difficult to compare across towns and states. The second is that assessed values can experience large changes every 5-10 years due to municipal tax base revaluation, resulting in large tax rate changes as well (>80%). While these revaluation events are not caused by the timing of land protection (and thus are likely to be uncorrelated with changes in land protection), they also do not necessarily reflect real changes in property values. We therefore also compute an equalized tax rate (also known as the effective tax rate) that relies on equalized values of the tax base, which seek to measure the full, fair market value of properties. States in our study area compute equalized values for each municipality annually or bi-annually, by comparing sale and assessed values for all properties sold in the prior one or two years and adjusting assessed values by that municipality-specific ratio. Equalized value is also used for distributing the allocation of state aid between municipalities. The advantage of the equalized tax rate is that it allows a more equitable comparison of effective tax burdens across jurisdictions that is not affected by reappraisal cycles or town-level idiosyncrasies in assessment practices (Lincoln Institute of Land Policy and Minnesota Center for Fiscal Excellence 2015; Bell and Kirschner 2009; Clapp, Nanda and Ross 2008).

Differences in property tax systems across states create some challenges for our empirical strategy. While municipalities in Maine and Connecticut set a single property tax rate, municipalities in Massachusetts set separate tax rates for commercial, industrial, open space and residential uses. Towns in Vermont and New Hampshire have multiple subsets of tax due on each parcel, with separate tax rates for education, municipal, and county needs. Additionally, education reforms have led to some changes over time to how tax rates are set.[7] Finally, assessment practices themselves changed in Vermont in 1996. To account for these challenges and create the most comparable measures of impact on homeowners across time, we take three steps. First, we use only the municipal portion of the property tax rate for Vermont and New Hampshire, which has been consistently defined across time. Second, we do not use Vermont data prior to 1996, in order to use a consistently defined tax base from 1996 forward. Third, we use the residential property tax rate for Massachusetts.[8] We map the average equalized tax rate in Figure 3A. For the purposes of illustration, we show within-state percentile rankings to illustrate the spatial differences in this measure (our analysis uses changes in the tax rates themselves but includes state by year fixed effects).

Finally, we also assemble data on the municipal tax levy as well as budget revenues and expenditures. Revenue and expenditure data are only available for Connecticut and Massachusetts. Fiscal variable definitions are summarized in Table 2 and summary statistics are presented in Table 3.

[7] Education reforms in the 1990's and 2000's changed education funding formulas in New Hampshire in Vermont, increasing state support for local education spending and lowering local property tax burdens, while shifting control over property tax rates that fund education from municipalities to the states. Specifically, Vermont passed education reform bills in 1997 and 2003, Act 60 and Act 68, to mitigate the education funding inequality between towns that resulted from unequal local property wealth (Stadler et al. 2017). A new statewide property tax was created to fund local expenditures on education, leading to decreases in local property tax levies. The new funding approach aimed to equalize local property tax burdens for funding education based on per pupil expenditures, such that education tax rates would be the same in towns with equal per pupil spending, regardless of local property wealth (Stadler et al. 2017). As a result, changes in the tax base no longer affect the education tax rate. The way municipalities fund services through the municipal tax rate was not affected by these education reforms (Stadler et al., 2017).

[8] Equalized value is computed biannually in Massachusetts and annually elsewhere. To construct an annual equalized tax rate series for Massachusetts, we compute the ratio of assessed to equalized values when both outcomes are available in every other year. We hold this ratio constant over the subsequent year to back out the equalized values using the assessed values which are available annually.

3.3 Land Protection Data

Data on land protection come from the protected open space (POS) database (Harvard Forest 2020), which includes parcel-level spatial data including land ownership type, method of land protection (fee/easement), and the timing of the protection events. The novel aspect of these data is that they aggregate multiple data sources to provide a comprehensive layer of spatial land protection data with a consistent schema of attributes, crucially including year of protection. The POS data draw from multiple local and regional sources, including state GIS layers, the National Conservation Easement Database (NCED), Protected Areas Database of the US (PADUS), The Nature Conservancy, and data from individual land trusts in the region that do not necessarily contribute to these other information systems. We use version 1.0 of the POS data.[9] We measure land protection as a percentage of town land area protected to account for differences in town size (again see Figure 1 for shares of land protected by 2015). We also map the overall changes in land protection by type for the time-period between 1990 and 2015 in Appendix Figure A1 (but note that our empirical analysis uses annual changes averaged over three-year time periods).

Figure 2 summarizes the share of state area protected over time in total and for each type. In 1990, most protected land was publicly owned, with 62.2% of protected land area within our sample under state/federal ownership, 17.2% owned by municipalities, 9% owned by NGOs and 9.9% in private ownership with easement protection. Since 1990, there has been continued protection by all types, but the largest increases have come from land protection through easements on private land (Meyer et al. 2014). Among land protected between 1990 and 2015, 52.3% of the acreage was under private ownership with easement protection, 22.9% was under

[9] We drop from the sample lands owned by private landowners in fee simple, without easements (fee simple landowner type = PFP, PLO in the POS data) since landowners still pay full property taxes on such lands.

state/federal ownership, 14.8% was acquired in fee by NGOs, and 8.9% was protected through municipal acquisition.[10]

3.4 Current Use Value Assessments

We use two different types of data characterizing land enrolled in current use assessment programs. For Connecticut, Maine, Vermont, and New Hampshire, we know the acres of land enrolled in current use, by town for a limited set of years. In Massachusetts, we have the taxable property value of the parcels enrolled, as well as the total taxable property value by town, but not acreage. Using these variables, we compute the municipal land share under current use assessment or the municipal tax base share represented by parcels in current use. We convert these variables into a continuous, state-specific percentile ranking for towns. This allows us to create a single measure of land in current use assessment for all states (see map in Appendix Figure A2, panel A).[11]

[10] A very small share of protected land is owned by entities with incomplete or missing data (fee simple landowner type: Other, Missing or PXX) which makes it difficult to classify them into one of our protection categories, but also to exclude them entirely. Protected land in this category accounts for approximately 1% of the change in protected land in our study area between 1990 and 2015. These lands are included in the totals and aggregate changes but not one of the four categories. Results are robust to excluding these lands from the analysis.

Additionally, we note that the municipal protection category includes lands acquired by local school, water, fire and other types of special districts. Between 1990 and 2015, such districts accounted for 11% of the acreage protected in the municipal category, while land owned explicitly by municipalities accounted for the remaining 89% of the acreage protected.

[11] Unfortunately, data on land enrollment in current use assessment is not available annually for all states in our study area, so we assemble current use data at the town level for one year, 2010, when it is available in all states and towns. When current use data are included in the estimation, we limit the analysis time-period to 2004-2015 to match reasonably closest time-periods from which the current use data are drawn.

Substantial amounts of land are taxed under current use value within our New England study area.[12] State land shares in current use as of 2010 are: 30% in CT[13], 35% in ME (Maine Revenue Services, 2010), 38% in VT (Division of Property Valuation and Review 2011) and 52% in NH (Department of Revenue Administration, 2010). In Massachusetts, at least 9% of land in the state is under a form of current use assessment that requires a forestry management plan.[14]

3.5 Additional Municipal Characteristics

Figure 3B maps the tax base size variable included in our analysis of heterogeneous impacts. We specify the tax base size as a time invariant and state specific percentile rank variable. Municipalities within each state are ranked based on the size of their tax base, relative to other municipalities in the same state, in terms of equalized value per acre in the first analysis time-period. We use this relative percentile ranking to avoid the influence of extreme values and regional clustering of high and low tax base towns and because of the slow rate of change for this variable over time.

We represent tax base growth as a percentage change in equalized value relative to the previous year. We use the change in equalized value because it represents fair market value of

[12] The incidence of costs related to lost tax revenue from current use value assessment varies across our study area. In Massachusetts, Connecticut and New Hampshire, municipalities carry the cost of lost tax revenue and compensate by raising property tax rates or through other means. Vermont fully compensates municipalities for lost tax revenue from current use assessment. Maine compensates municipalities 90% of lost tax revenue, but only for losses related to the forestry focused Tree Growth program, which accounts for about 90% land assessed under current use in Maine.

[13] Connecticut data were obtained with help from staff at the Connecticut Department of Energy and Environmental Protection.

[14] Current use acreage for Massachusetts was obtained via communication with staff, Massachusetts Department of Conservation and Recreation

land and as a result should more accurately capture growth in the tax base resulting from demand side changes than assessed property value. We map average annual growth rates in Appendix Figure A2, panel B.

Data on housing density in 1990 comes from the U.S. Census. We use housing density thresholds to classify municipalities into rural, exurban, and urban categories, following (Radeloff et al. 2005). Municipalities with housing density < 16 homes/km^2 are considered rural. Exurban towns have housing density between 16 and 128 homes/km^2 and urban towns have a housing density >128 homes/km^2.

We use Census data on the share of municipal housing units consisting of vacation homes in 1990 as one potential measure of high amenity value. We map the percentage of municipal housing stock comprised by vacation homes in Appendix Figure A2C. We use census data on median household income in 1990 to examine variation in tax impacts of land protection with income. We construct our income measure as a time invariant and state specific percentile rank variable, like the tax base (Appendix Figure A2D). Our measure of income is time invariant because it is not available for municipalities at an annual time step and is a slow-moving variable.

4. **Empirical Strategy**

4.1 First Differences Model

We estimate the effect of land protection on property tax rates and other fiscal outcomes using a first differences model. We average annual differences over three-year time periods and use lagged changes in land protection to minimize concerns about possible reverse causation.

Using lagged changes also allows time for municipalities to adjust their tax base and tax rate following a change in taxable property value from land protection. Our main regression model is:

$$Ihs\Delta Y_{ic,t} = \beta_1 Ihs\Delta ProtectedLand_{ic,t-1} + Ihs\Delta X_{i,t-1} + \gamma_{st} + \Omega'(t \times \lambda_c) + \epsilon_{ic,t} \quad \text{(Eq 2)}$$

Where *i* denotes each municipality, c is the metro-region of that municipality[15], and *t* indexes the time period. We have eight three-year time periods: 1992-1994, 1995-1997, 1998-2000, 2001-2003, 2004-2006, 2007-2009, 2010-2012, 2013-2015.

The variable $Ihs(\Delta Y_{ic,t})$ is the inverse hyperbolic sine (Ihs) of the three-year average difference for each outcome of interest. Our outcomes include changes in the municipal property tax rate, tax levy, tax base, and municipal revenues and expenditures. Our key explanatory variable is the Ihs of the change in the percentage of town area protected in the previous time period, $Ihs(\Delta ProtectedLand_{ic,t-1})$. The remaining terms in Equation 2 describe control variables: $Ihs\Delta X_{i,t-1}$ is a vector of controls for local economic conditions that includes lagged changes in the labor force, unemployment rate and tax base growth[16], γ_{st} is a state by time-period fixed effect, and $(t \times \lambda_c)$ indicates linear time trends for each metro-region that account for possible differential trends in growth within sub-regions of New England. Our identifying assumption is that conditional on these controls, the remaining variation in new land protection is plausibly exogenous because it is driven by the uncoordinated activities of hundreds of land

[15] These are core-based statistical areas (CBSAs) for metro regions and similar groupings for areas outside of CBSAs. County based areas defined by the U.S. Census that include an urban area with population of at least 10,000 and adjacent counties integrated with the urban area through commuting ties (U.S. Census Bureau 2021). We use 2015 CBSAs.

[16] Growth is specified as a percent change and is not Ihs transformed.

trusts, local governments, state, and federal agencies, as well as randomness in the timing of property transitions.

To mitigate the influence of outlying observations, we winsorize non-percentile variables used in the estimation and use the Ihs transformation.[17] The advantage of the Ihs transformation is that it is defined for zero and negative values (Burbidge, Magee and Robb 1988), as compared to a logarithmic transformation. Additionally, our coefficient of interest β_1 is an elasticity, as with a log-log model (Bellemare and Wichman 2020). Bellemare & Wichman note that elasticities from Ihs transformed variables can be subject to approximation errors for small values of x and y (<10). As a robustness check, we compare our main estimates to elasticities derived from alternative model specifications without the Ihs transformation.

4.2 Heterogeneity in Impacts, Impacts Across Time

To examine heterogeneity in the impacts of new land protection, we interact the lagged total change in land protection with variables that characterize local economic conditions. These variables include municipal-level measures of land in current use assessment, tax base size and growth, municipality type based on housing density (rural, exurban, urban), percent of land protected in a municipality at the beginning of a time period, share of vacation homes in municipal housing stock and household income.

[17] We winsorize the top and bottom 1 % of the distribution for all non-percentile variables used in estimation except for the change in land protection variables, for which we winsorize only the top 1%. Variables are winsorized after averaging to three-year time periods. We check robustness of our results to using non-winsorized data (Table A1).

We first estimate a single interaction model with each characteristic separately. The single interaction model is specified as:

$$IhsΔY_{ic,t} = \beta_1 IhsΔProtectedLand_{ic,t-1} + \beta_2 IhsΔProtectedLand_{ic,t-1} \times LocalEconomicCondition_{ic,(t-1)} + IhsΔX_{i,t-1} + \gamma_{st} + \Omega'(t \times \lambda_c) + \epsilon_{ic,t} \quad \text{(Eq 3)}$$

Tax base growth and percent of land area protected are time varying and come from the prior time-period. Other interaction variables are generally slow-moving and are measured at baseline as discussed above. We also estimate versions of equations two and three where we separately estimate the impact of land protection by type (fee/easement/public), which requires separate interaction terms for each land protection type.

In addition, we estimate a fully interacted version of equation 3 with multiple interaction variables simultaneously, in order to account for the fact that there can be important co-variation in land protection types and municipal characteristics. Specifically, we include interactions between land protection type, tax base size, tax base growth, percent of municipality protected, share of vacation homes in housing stock and household income. Our variable selection is based on seeking to capture covariation between characteristics while minimizing potential collinearity.[18]

[18] On the basis of a review of correlations between variables (shown in Appendix Table A4), we exclude housing density from the fully interacted model due to the high degree of correlation between it and municipal tax base size (>0.7). Town percentile rank by land enrollment in current use assessment is excluded due to the relatively high correlation with tax base percentile (>0.6) and because data for this variable is available for only one year (2010). We include an additional interaction with the prior period level tax rate to control for differential effects that may be misattributed to the existing level of taxes.

Finally, to assess the potential impacts of land protection on taxes over the longer term, we modify Equation 2 by introducing up to three time-period lags for the change in total land protection:

$$Ihs\Delta Y_{ic,t} = \sum_{j=0}^{T} (\beta_j \, Ihs\Delta ProtectedLand_{ic,t-j}) + Ihs\Delta X_{i,t-1} + \gamma_{st} + \Omega'(t \times \lambda_c) + \epsilon_{ic,t} \quad \text{(Eq 4)}$$

where the subscript *j* represents the temporal lag. Each lag represents a three-year time period.

5. Results

5.1 Average Impacts of Land Protection

Table 4 presents our estimates for the average effect of new land protection on property tax rates in New England overall and by each state. We find that the average impact of new land protection across the region as a whole is positive but small in magnitude. The estimated tax rate elasticity with respect to new land protection is 0.024 for the equalized tax rate ($p < 0.05$) and 0.026 for the nominal tax rate ($p < 0.10$). This means that for a one percent increase in annual land protection in the prior three-year time- period, equalized and nominal property tax rates increase by 0.024% and 0.026% respectively.

To put the magnitude of this tax increase in perspective, we compute the change in the property tax bill associated with the average annual non-zero increase in land protection, which is equal to 84.9 acres. This represents a 2.72% increase in protected area relative to the average land area protected.[19] Using the average equalized and nominal tax rates of $11.17 and $13.04

[19] The average municipal area in our sample is 19,927.72 acres and the average share of area protected in a municipality is 15.68%, or 3124.67 acres protected. The average annual non-zero increase in land protection of 84.88 acres is 2.72% of the average area protected (100*84.88/3124.67=2.716)

per 1000 of property value respectively, we estimate that this change in land protection results in an annual tax bill increase of $0.72 and $0.92 per 100,000 property value.[20] For an owner of a typical single-family home in New England, valued at $266,497,[21] these changes translate to a tax bill increase of $1.92 and $2.46, which is a small change compared to the nominal tax bill of $3475 one would expect on that same home (Table 4).

We also estimate the annual tax bill changes associated with the 75th and 90th percentile annual increases in land protection of 102.8 and 217.1 acres. Using equalized tax rates, we estimate tax bill increases of $0.87 and $1.84 per 100,000 property value. With nominal tax rates, the tax bill increases are $1.12 and $2.36 per 100,000 property value.

Our estimates for the average impact of land protection are robust to alternative model specifications and choices of dependent variable transformation. Appendix Table A1 compares average effect estimates with and without winsorization, showing that winsorizing does not substantially alter the elasticity estimates for equalized and nominal tax rates. Tables A2 and A3 present estimates for equalized and nominal tax rates using level-level and percent change-percent change specifications. These estimates show similar estimates of tax bill change to our preferred Ihs-Ihs specification.

[20] The equalized tax rate elasticity is 0.0237 (Table 4), so for a 1% increase in land protection, we expect a 0.0237% increase in the tax rate. Converting this to a tax bill for $100,000 of value and an 84.88 acre increase in protection, we calculate: 0.000237*2.716%*$11.17*100k = $0.719. We repeat this calculation for the nominal tax rate outcome using the average nominal tax rate value ($13.04) and elasticity (0.0261).

[21] $266,497 (2015 dollars) represents the typical home value in our study area according to the Zillow Home Value Index (ZHVI) for 1996-2015. ZHVI is representative of home values in the 35-65th percentiles of home values.

5.2 Variation in the Average Impact Across States

Considering states individually, we find statistically significant tax rate elasticities of land protection for some states, but all estimates are small (Table 4). We find statistically significant increases in New Hampshire (elasticity of 0.058, equalized tax rate) and Massachusetts (0.040, nominal tax rate), and a marginally significant increase in Vermont (0.031, equalized tax rate). We do not find statistically significant impacts in Connecticut or Maine. Table 4 shows the estimated tax bill increases for each state, assuming state specific average non-zero annual increase in land protection and typical home values in each state.

For both regional and state estimates, models with equalized tax rates generally have higher adjusted R^2 values and lower standard errors. As discussed above, this may be due to the large changes that nominal tax rates can experience during periods of property revaluation. For this reason, we focus on changes in equalized tax rates in the rest of our analysis.

5.3 Impact Heterogeneity: Land Protection Types

While the average effect of new land protection on property tax rates is small, this may mask important impact heterogeneity, as discussed above. We examine how the impact of land protection varies by type of protection and across local economic conditions using individual interactions and then a fully interacted model (Tables 5 and A5, Figures 4 and 5).

Table 5 presents the coefficients for the single interaction model and Figure 4 plots the estimates and standard errors at different values of the interacted variables. Considering the different types of land protection, we find statistically significant impacts only for private easements, but positive estimated coefficients for municipal and state and federal protection. The estimated magnitude for NGO protection is negative (Column 1, Table 5, elasticity of -0.052;

Figure 4A), suggesting that it is associated with a decrease in the tax rate, but this estimate is not statistically different from zero. Municipal protection is associated with the highest estimated magnitude of tax rate increase, with an elasticity of 0.072 (Figure 4A) but marginal statistical significance (p=0.083). Conservation easements have a positive and statistically significant impact on taxes, with an elasticity of 0.036 (p=0.039), which is slightly larger than the average elasticity found in Table 4. The tax rate elasticity associated with state and federal protection is 0.031, which is also larger than the average for all land protection (Table 4), but not statistically significantly different from zero.

While there is considerable randomness in the overall process and timing of protection, average differences across types may still reflect some differential selection (Figure A1). From our visualization of the changes, we note that municipal protection is more common in the faster growing and more populous southern New England, while easements and state/federal land protection are more prevalent in more rural areas in western and northern New England. Some NGO protection in turn is occurring in amenity rich areas with more vacation homes (Figure A1). A more accurate comparison of the potential causal impacts of each protection type therefore is made by controlling for the other town characteristics in estimations of each type. For this reason, we estimate a fully interacted version of Equation 3 (coefficients in Tables A5 and A6). We plot the estimated marginal effect of each land protection type with respect to the 10^{th}-90^{th} percentile values of each variable included as an interaction term, while holding other variables at their means (Figure 5).

Generally, our results from this multiple interaction model are similar to the single interaction model. The ranking of impacts of the four protection types with respect to the tax rate elasticity remains the same, with slightly larger elasticities. The largest tax rate increases are associated with municipal protection (elasticity = 0.10, p=0.045, other variables held at their means), followed by conservation easements (elasticity = 0.048, p=0.042), state/federal protection (elasticity=0.032, p=0.26), and NGO protection (elasticity= -0.032, p=0.41). In dollar terms, assuming the average annual increase in protection of 84.9 acres and a typical home value, these results translate to annual tax bill increases of $14.95, $8.18, and $2.00 per $100,000 of property value, while NGO protection is associated with a tax bill decrease of -$8.37 per $100,000 of property value. These larger tax bill change magnitudes result from using protection type specific area shares in computing the changes, as well as from the higher elasticity estimates for individual land protection types.[22] Our conservation easement results are of a similar magnitude to those found in the most relevant previous study. King and Anderson (2004) estimated that a 100-acre easement resulted in a short run tax rate increase of $0.14 per $1000 of property value, which amounts to a $14 annual tax bill increase for a $100,000 property.

These findings may be partly explained by expected differences across protection types as discussed in Section 2. In particular, municipal land acquisition may require raising funds to purchase land, so the expected impact could be greater than for other types. Easement protection is likely to result in smaller changes in tax rates, compared to municipal land acquisition, because only a portion of taxable property value is lost when an easement is established and many lands were in current use assessment prior to being protected. The fiscal impacts of state

[22] While the average town area share protected across all protection types is 15.68%, individual protection shares are 1.80% for NGO protection, 3.27% for municipal, 2.80% for easements and 7.55% for state/federal protection (Table 3). To take municipal protection as an example, 84.88 acres represents a 13.02% increase in municipal protection: 84.88 / 19927.72 (avg town area) * 0.0327 (avg municipal protection share) = 13.018. The calculation for the tax bill change resulting from 84.88 acres of additional municipal protection is: 0.1028 (elasticity)*13.018 (% increase from 84.88 acres) * $11.17 (equalized tax rate) = $14.95. For an owner of a typical single-family home in New England ($266,497), these protection type specific changes translate to an annual tax bill increase of $39.85, $21.80, and $5.33 for municipal, easement and state/federal protection respectively, while NGO protection is associated with a tax bill decrease of $22.30.

and federal protection may be partially offset by PILOT payments, which may explain why they do not have a large average impact on tax rates. However, potentially negative impacts for NGO protection are more surprising, as NGOs are not required to pay taxes or make PILOT payments. Anecdotally, NGOs in the region do often invest in infrastructure for recreation or historical visitation and work in partnership with towns; this may result in amenity effects that outweigh the loss of tax revenue. In addition, lands acquired by NGOs may also already have been taxed less because of current use value provisions.

Indeed, a possible reason for overall small impacts of land protection on taxes overall is that many lands were already paying relatively low taxes due to current use value assessment programs prior to acquisition or easements. We find that the tax rate impacts do decline with increasing amount of land in current use (Column 2 in Table 5 and Figure 4B) and may even be negative for towns with large amounts of enrolled land.

5.4 Impact Heterogeneity: Local characteristics

To further understand how town-level characteristics may matter, we consider additional interaction terms in the single and multiple interaction models: tax base size, tax base growth, housing density, share of land area already protected, vacation-home share, and median household income.

In the single interaction model, we find that on average, the tax impacts of new land protection do not vary substantially by property tax base size (Column 3, Table 5, Figure 4C). These results may seem surprising, as we might expect towns with large tax bases to be better positioned to absorb a loss of revenue when land is protected. Instead, we find that it appears to be the rate of growth that generally matters more than the level of the tax base (Column 4 of

Table 5, Figure 4D). The coefficient on the interaction term between new land protection and tax base growth is negative and statistically significant. This indicates (as also shown in Figure 4D) that new land protection does result in significant tax increases when it coincides with low rates of tax base growth. At high rates of tax base growth, new land protection may even reduce tax rates. This indicates that the towns that may need to worry most about seeing larger tax increases from land protection are those that are experiencing slow growth in their tax base over time. However, as Column 5 in Table 5 indicates, this cannot be easily predicted simply on the basis of whether areas are more urban vs. more rural. We find that the magnitude of the property tax increase is significantly different from zero only for exurban towns (coefficient of 0.032). Although this is imprecisely estimated, town and cities classified as urban had the largest estimated increase in tax rates (Figure 4E). Rural areas, which often draw the most attention in debates about land conservation and might be expected to be growing more slowly, did not see large or statistically significant impacts on taxes on average as a result of land protection.

Interestingly, our results also indicate that while tax base growth may reduce the tax impacts of land protection, tax base growth by itself is consistently associated with an increase in the property tax rate (as shown across all columns in Table 5, last row of the table). This is consistent with the findings from the costs of community services literature suggesting that growth actually raises taxes because the increasing costs of municipal services associated with new development outweighs the additional revenue that this development brings in (Murray and Catanzaro 2019; Clapp et al. 2018; Kotchen and Schulte 2009).

Considering the impacts from the fully interacted model by tax base size (Figure 5B) allows us to further consider potential impacts of new land protection by protection type. We find suggestive evidence of higher tax impacts for smaller tax base towns that engage in municipal protection. The estimated tax rate elasticity for municipal protection for towns at the 10th percentile of tax base size is about 8 times larger than the overall average (elasticity = 0.19, p=0.056). For 84.9 acres of new protection, this translates to an annual tax bill increase of $27.63 per $100,000 of property value.[23] However, we do not find evidence for differential impacts by tax base size for easements on private land or state and federal land, nor positive results for NGO protection.

Again, tax base growth appears to be a more consistent predictor of the impacts of land protection on tax rates (Figure 5C). We find that the tax rate increase associated with new land protection decreases with the rate of tax base growth across all land protection types. This highlights the potential role of growth as an important factor for mitigating tax rate increases that can result from land protection, even though growth by itself does not necessarily reduce tax rates. We observe some of the highest tax rate elasticities in our analysis for the slowest growing towns (See 10th percentile results in Table A6), with elasticities of 0.15 for municipal protection (p=0.034), and 0.095 for easements (p<0.01). For the average annual increase in protected land, these elasticities represent annual tax bill increases of $21.46 and $16.23 per $100,000 of property value for municipal and easement protection respectively, assuming the average annual non-zero change in protection and holding all other variables at their means.

In addition to growth rates, debates about land conservation and tax rates often focus on possible constraints to development (or at least development of single-family homes with large lot sizes) that are posed when a high share of town land is set aside as protected. For this reason, we test whether the impact of additional protection is different for municipalities with a high cumulative share of area already protected. Column 6 of Table 5 shows that on average, there is

[23] Again based on a 13.02% increase in municipal protection as in the prior note.

no significant variation in impact of land protection by land share protected at the start of the prior period. In fact, on average, there are smaller expected increases in taxes in the towns with a high share of land already protected (Figure 4F). These results may indicate either that most towns in the region had not yet hit “build-out” constraints, or that such concerns can be overcome by re-development and increased density of housing. Alternately, a high share of land protection may substantially raise the value of the existing housing stock. Regardless, this result is important to note as it runs against the conventional wisdom that taxes will generally increase the most where there is already a lot of protected land.

Using the multiple interaction model, we corroborate the finding that the share of land already protected in the town is not a consistent predictor of where tax impacts may be higher (Figure 5D). For NGO, municipal and private easement protection, our results actually indicate a pattern of lower expected impacts for towns that already have a high share protected. For these protection types, the towns and cities most affected by tax increases appear to be those with little existing land protection. In particular, among municipalities in the 10th percentile of already protected land, we find elasticities of 0.21 for municipal protection (p=0.031) and 0.079 for easement protection (p=0.013). These elasticities are associated with tax bill changes of $29.97 and $13.36 for municipal and easement protection, assuming the average annual change in protection. However, for state and federal protection, we estimate higher tax rate increases with more land protected. The tax rate elasticity is 0.090 (p=0.025) for towns in the 90th percentile of pre-existing land protection (>34% land area protected). Among the towns in the 90th percentile of pre-existing land protection, state and federally owned land on average accounts for 73% of total protected land. The larger tax rate elasticity associated with new state and federal protection in these towns may reflect the cumulative impact of state and federal land ownership and the associated PILOT payments that don't fully offset the lost tax revenue (Bump 2020; Pinho and Dilworth 2020; DeNucci 2001; DeNucci 1994). This suggests that special attention is warranted to tax impacts in towns where new state and federal protection is proposed and large amounts of land are already in reserves.

As we noted in the theoretical framework section, communities may also be better positioned to benefit from land protection if they have a larger number of second homes or greater average incomes. Second homes tend to use fewer local services and may also proxy for areas particularly rich in natural amenities, such as near coastlines or lakes (Irwin et al., 2010; Polyakov et al., 2013). The benefits of land protection may capitalize into local property values faster and to a greater extent in scenic, high amenity areas as well as in higher income towns with greater ability to pay for amenities. Indeed, where there is a larger share of vacation homes in the municipal housing stock, we find smaller impacts on tax rates (Column 7, Table 5, Figure 4G). These results also hold for all protection types in the multiple interaction model (Figure 5E).

In addition, we find that the impact of land protection on tax rates increases as municipal-level median household income decreases (Column 8, Table 5 and Figure 4F). We estimate a tax rate elasticity of 0.037 (p=0.049) for low-income towns (10^{th} percentile rank). In the fully interacted model (Figure 5F), we also find that income is a consistent predictor of tax rate change across all types of protection, with largest tax rate increases resulting from land protection in low-income municipalities. For towns at the 10^{th} percentile of median household income, we find tax rate elasticities of 0.15 for municipal protection (p= 0.068), 0.080 for easements (p=0.021) and 0.085 for state/federal protection (p=0.080) (Appendix Table A6). For the average non-zero change in land protection, these elasticities represent annual tax bill increases of $22.13, $13.58

and \$5.38 per \$100,000 of property value for municipal, easement and state/federal protection. These results indicate that greater attention to the potential tax impacts of land protection is warranted for lower-income municipalities.

5.5 Impact of Land Protection on Levies and Expenditures and Over Time

A fundamental concern about land protection is that it could affect spending on other public goods that towns provide. If land protection results in a loss of revenue that is not made up for by increases in taxes, towns may be forced to reduce expenditures. Using the data from Massachusetts and Connecticut where expenditure data is available, we do not find evidence that new land protection leads to decreased spending. In fact, we find positive but not statistically significant impacts of new land protection on expenditures and revenues (Table 6).

In addition, using data from all five states, we test for impacts on the property tax levy and total property values. We find a small, estimated increase in the property tax levy (for both MA and CT and for all states), indicating that the amount of tax revenue collected from property did not decrease following new land protection (Table 6, column 3, $p<0.003$ for all states). This is potentially consistent with the small increase in tax rates we found earlier. Finally, we find small and not statistically significant decreases in total assessed and equalized property values in towns and cities as a whole following new land protection (Table 6, columns 4 and 5). Here we would expect to see decreases as land protection takes land off the tax rolls, but potential increases if those losses are more than compensated for by amenity values. Our results indicate that neither effect clearly dominates on average.

Overall, these results are consistent with a scenario where towns generally slightly overshoot in adjusting tax rates. They may set tax rates based on expectations of lost revenue from land protection without counting on potential gains from amenity effects. If protection does then raise the value of surrounding properties, it will result in slightly higher levies than expected and additional funds available for expenditure. Most crucially, these results suggest that municipalities were not fiscally constrained by land protection.

Finally, to understand the possible persistence of tax impacts from land protection, we use lags of the change in land protection, as described in Equation 4. We find that on average, the tax rate increase associated with land protection is short-lived (Table 7). New land protection in the last three years has a positive and significant impact on tax rates, but land protection from six to three years prior or nine to six years prior are estimated to result in either small decreases or near zero change in tax rates.[24] These results are not statistically significant, so the conclusions we are able to draw are limited. Nonetheless, this finding is potentially consistent with amenity effects boosting local property values over the longer term, as previously found by (Chamblee et al. 2011; Anderson and West 2006; Geoghegan et al. 2003; Irwin 2002; Thorsnes 2002).

6. Conclusion

Public demand for new land protection and also for low property taxes is a perennial source of tension and debate. The aim of this study was to estimate the impacts of new land protection on property tax rates, and to test for heterogeneity in impacts across protection types, municipal characteristics and conditions that may amplify or moderate these effects. Using data

[24] Robustness checks using annual data and successive annual lags confirmed these general patterns.

from more than 1400 towns and cities in New England, we analyzed plausibly exogenous changes in the extent and timing of new land protection, using a first differences panel approach.

Our results indicate that on average, the tax impacts of new public and private land protection are small, adding just a few dollars to the annual tax bill for most homeowners in the short run. These results suggest that for the majority of towns and cities, new land protection can be achieved without substantial impacts for other taxpayers or the provision of public goods. The local benefits of this protection, including recreational opportunities, preservation of cultural heritage, wildlife habitat, and ecosystem services such as improved water quality, decreased flood risk and increased climate resilience may be considerably larger in value to residents than the modest increase in taxes.

While the impacts are typically small, they are heterogeneous, with some types of towns and cities likely to experience relatively larger tax rate increases than others. This includes municipalities with slowly growing tax bases, fewer vacation homes, or lower average household incomes. Slower wage growth for lower-income workers across recent decades has led to slower overall growth in home prices and tax bases for some towns in the region. Lower abilities to pay for housing may limit the potential for protected amenities to be capitalized into nearby property values and for these towns to absorb changes in tax revenue. We also found greater tax impacts for towns that engaged in substantial municipal protection when they had low growth rates or small tax bases, and for towns that received state and federal protection when they already had a very high share of land protected.

These results highlight disparities in impacts and suggest that the towns least able to afford tax increases may often be those that see greater expected impacts. At the same time, while these potential tax impacts are borne by the municipalities where the protection occurs, the benefits of land conservation extend to communities throughout the region. In recognition of these broader public benefits, state and federal agencies can support local fiscal health by ensuring that payments in lieu of taxes programs are fully funded and are large enough to provide real compensation for the value that these protected lands provide, particularly in the communities with fewer fiscal resources. Public and private organizations can also play a role in ensuring access to additional funds for land protection. Current requirements for municipalities to provide matching funds or prepare open space plans in order to receive state or federal grants for municipal conservation may create barriers to accessing outside funds; these requirements could be reconsidered or reduced. Finally, conservation NGOs can be aware of where they are supporting new protection and what the likely fiscal impacts may be, as well as how they can share strategies or resources that support healthy municipal budgets while also supporting land protection and empowering local communities to make decisions about new land protection.

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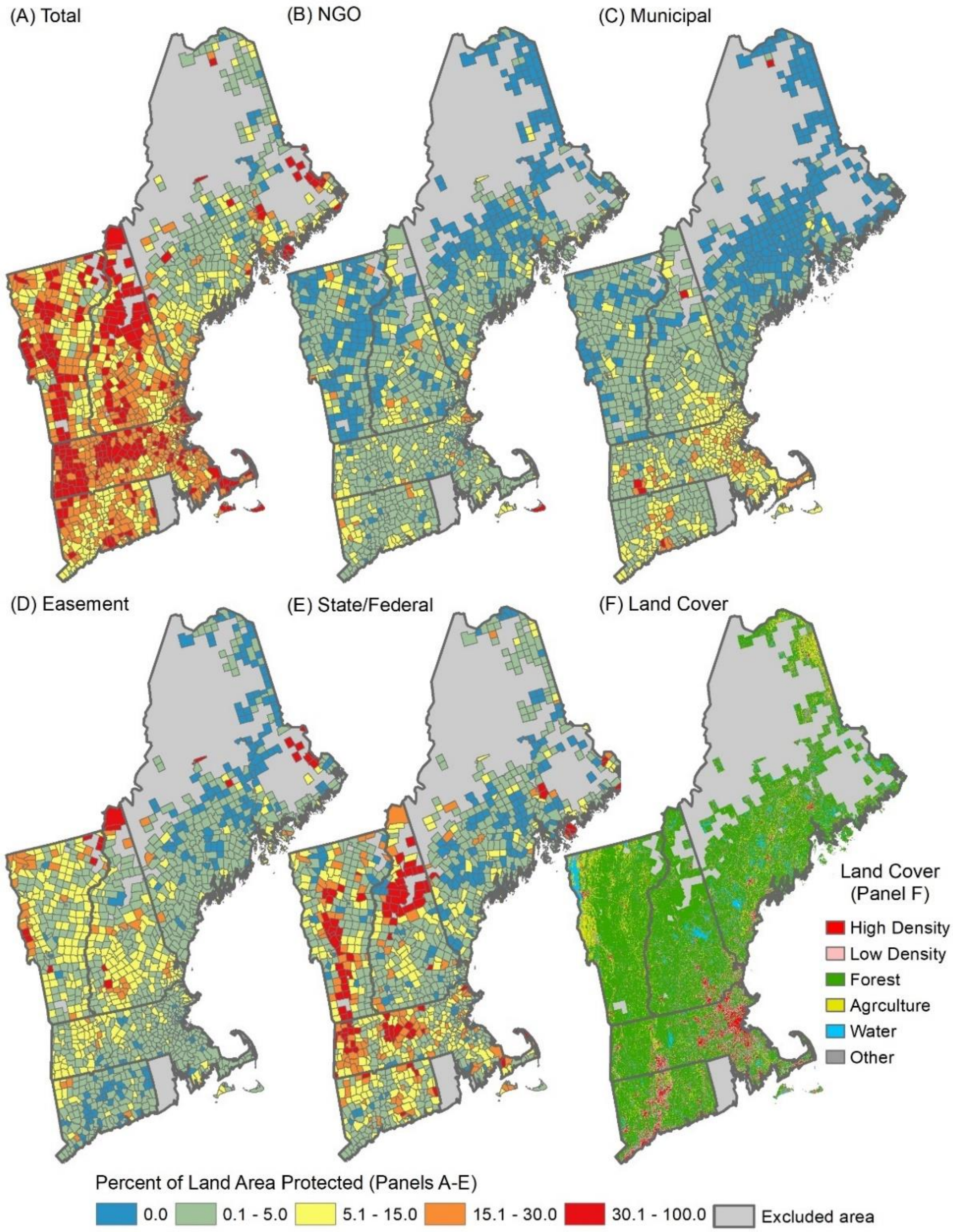
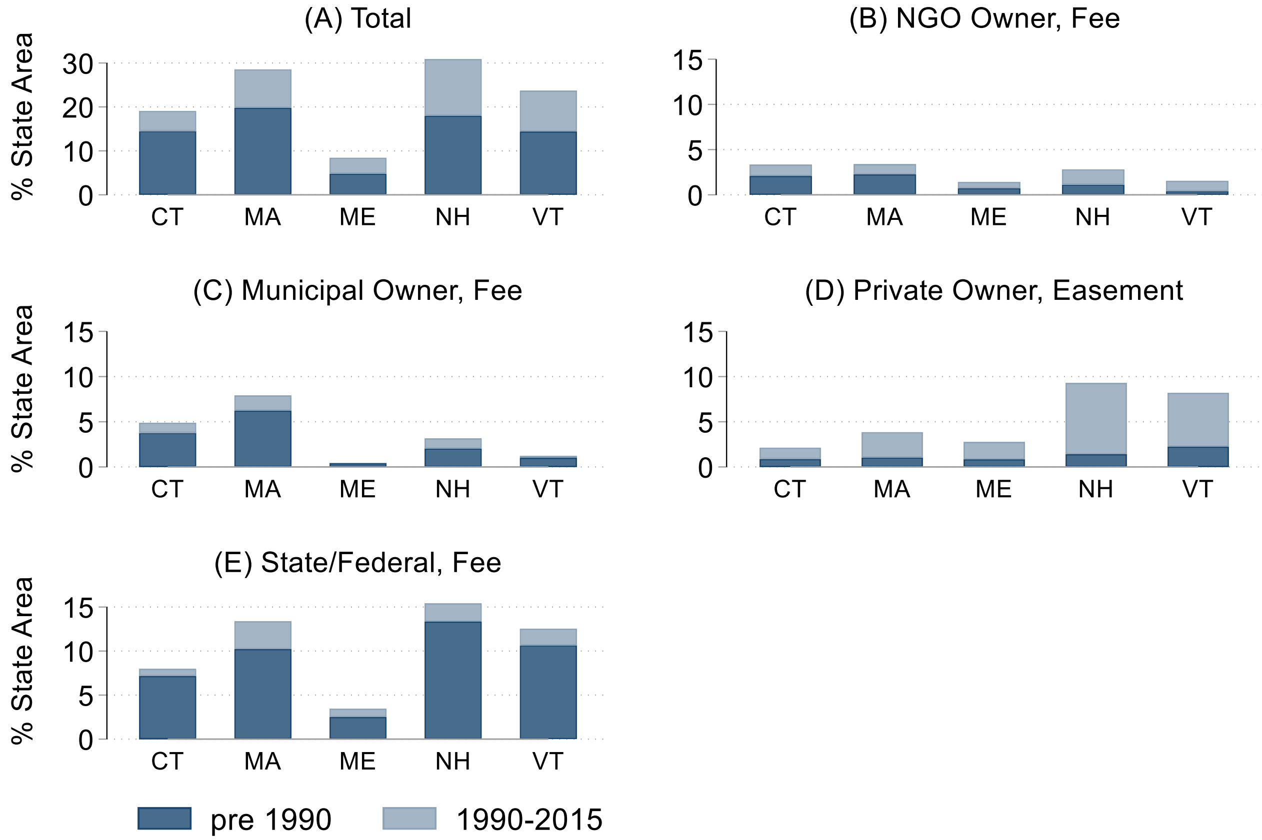
Figure 1: Study Area and Land Protection in New England by 2015



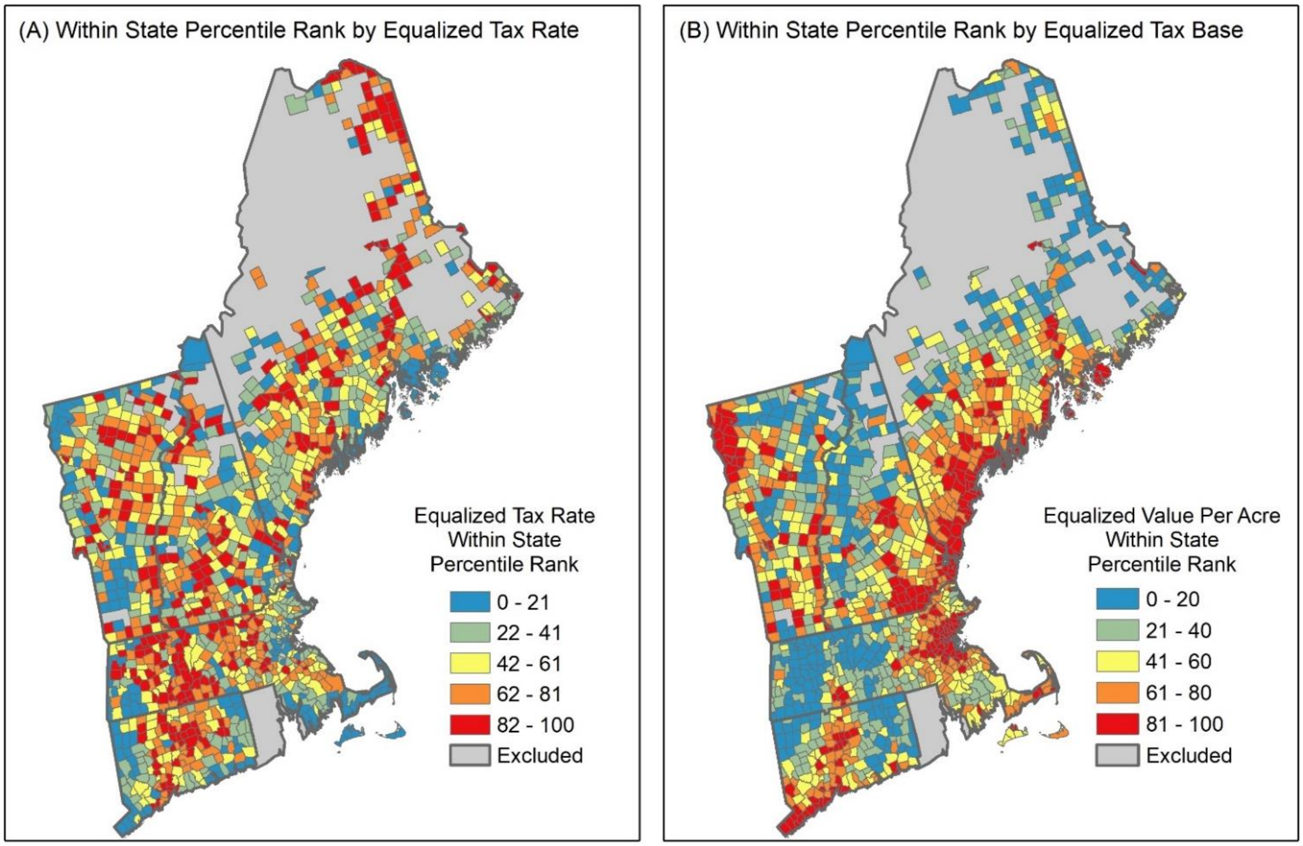
Notes: Protected land is shown as percentage of area within a municipality (towns and cities) in 2015, disaggregated by type. Subfigure (A) shows total land protected, while Subfigures B-D map protection for mutually exclusive categories: (B) land owned in fee by NGOs (C) land owned in fee by municipalities (D) easements on private land (E) land owned in fee by state/federal govt and (F) 2016 land cover from the National Land Cover Database (Dewitz 2019). High and low density refer to developed land cover. High density combines high and medium intensity development classes from 2016 NLCD. We exclude unincorporated areas and towns with population less than 100 in 1990, and the state of Rhode Island.

Figure 2: State Area Protected Over Time, Disaggregated by Land Protection Type.



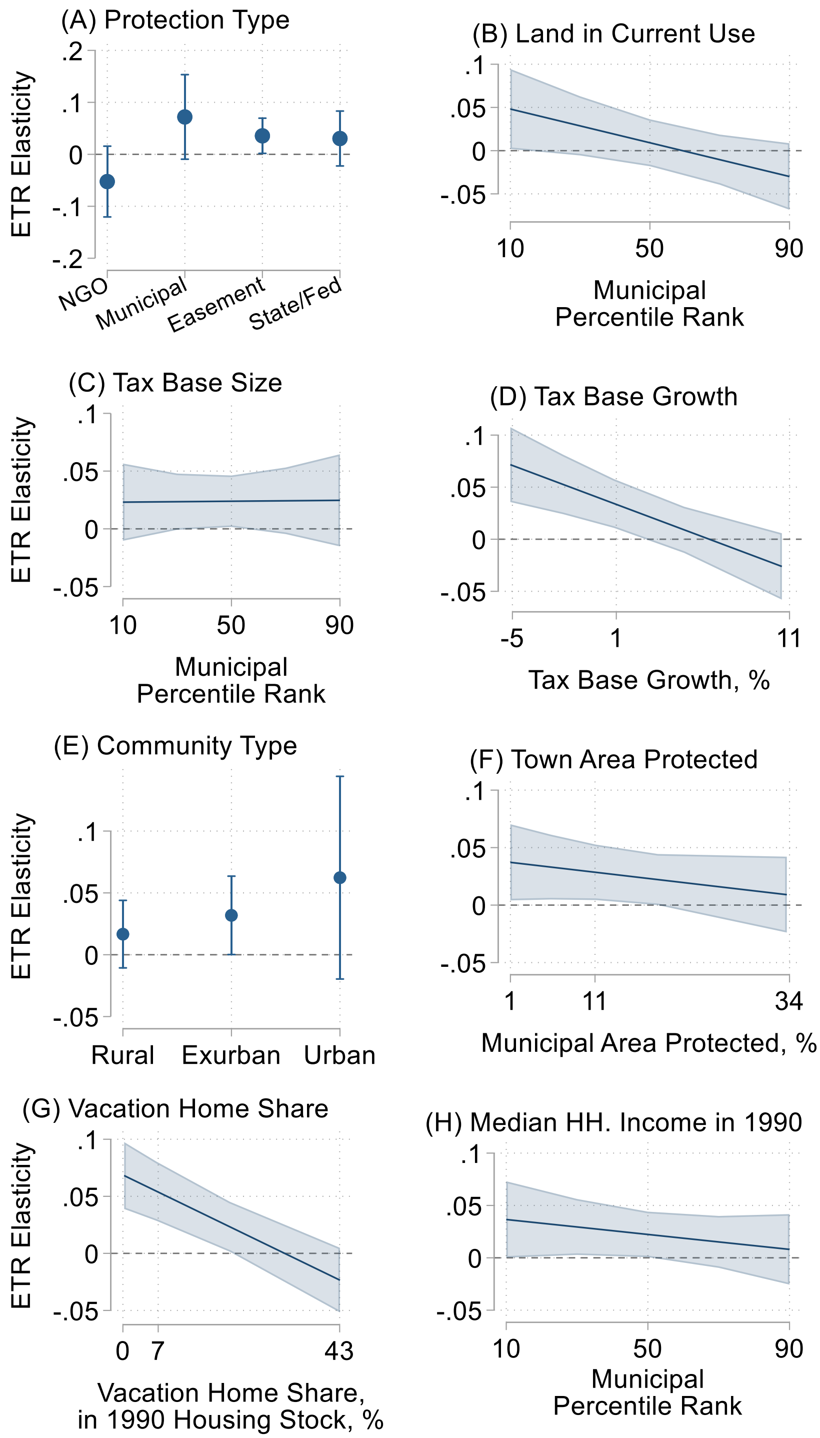
Notes: We show the percent of state area protected in 1990 and the change in percent of state area protected between 1990 and 2015, by land protection type. As in Figure 1, these statistics exclude unincorporated areas and towns with population less than 100 in 1990.

Figure 3: Municipal Tax Rate and Tax Base



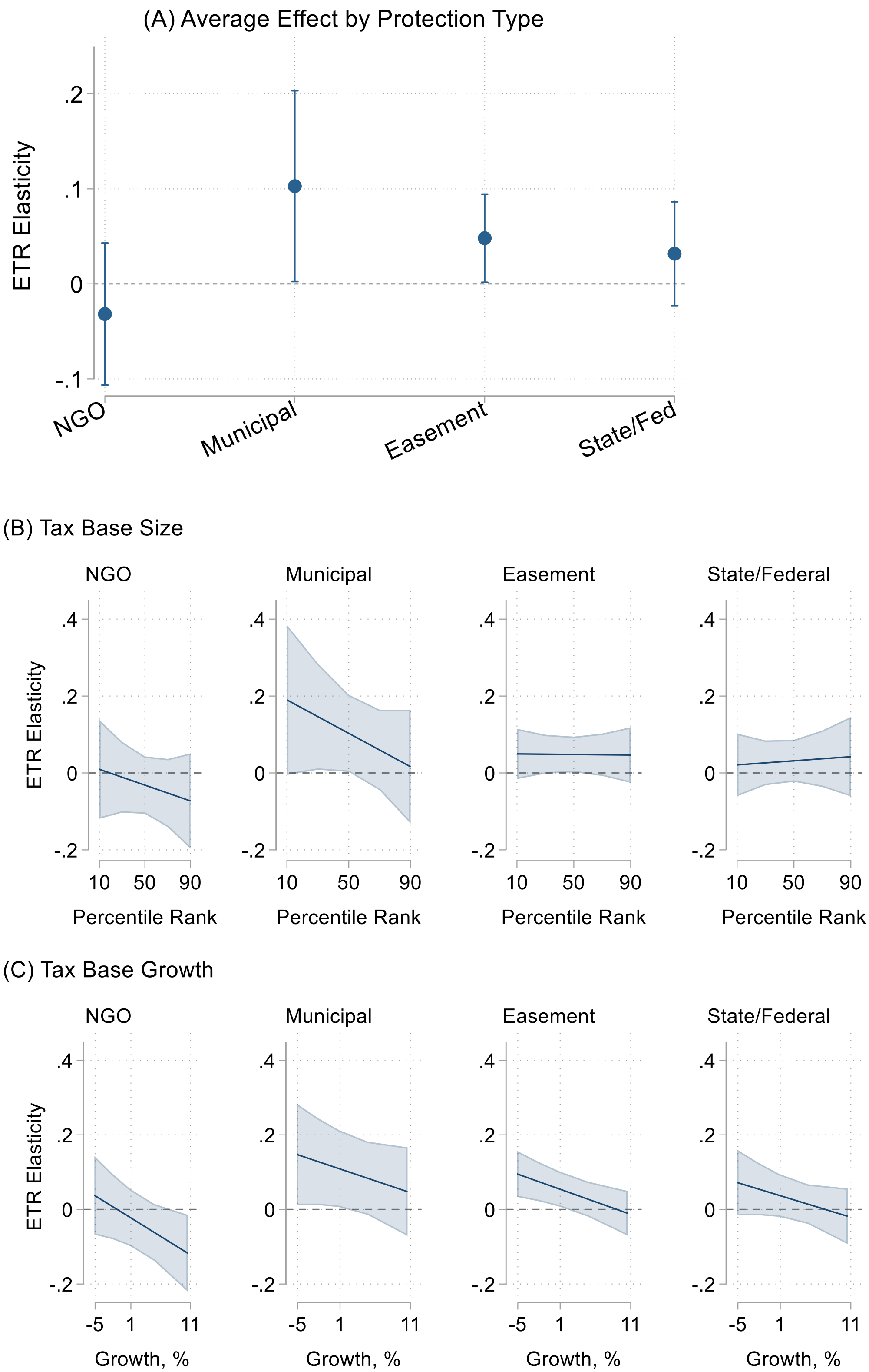
Notes: Subfigure (A) shows within state municipal percentile rank based on average equalized property tax rate over study period. Higher rank municipalities have higher property tax rates on average relative to other municipalities in the same state. Subfigure (B) shows within state municipal percentile rank based on equalized value per acre in the first time-period. Municipalities with higher rank have larger tax bases relative to other towns in the state.

Figure 4: Heterogeneity in Marginal Effects of New Land Protection, Single Interaction Model

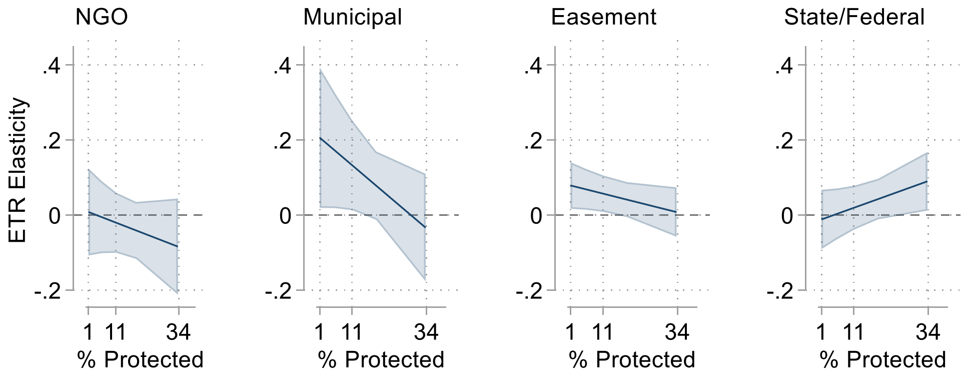


Notes: Heterogeneity in the marginal impacts of new land protection on equalized property tax rates, plotting equalized tax rate (ETR) elasticity estimates from the interaction model in Equation 3 and Table 5. Elasticities are shown at 10th-90th values of the variables used in the interaction in the case of continuous variables. The 10th, 50th and 90th percentile values are labeled on the x axes.

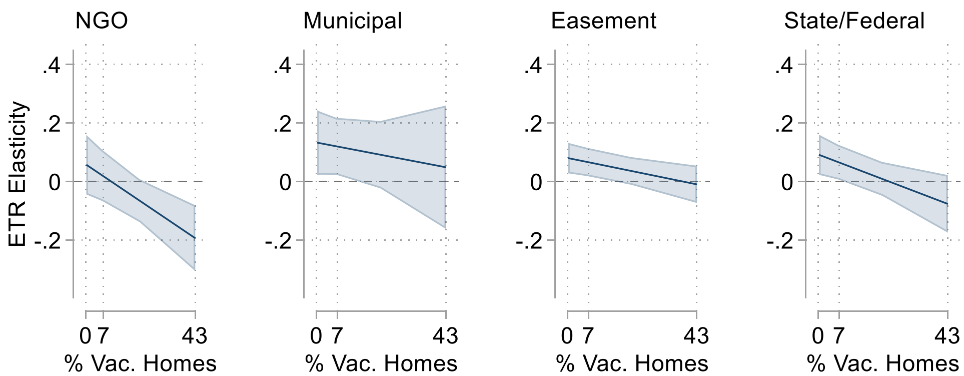
Figure 5: Heterogeneity in Marginal Effects of New Land Protection, Multiple Interaction Model



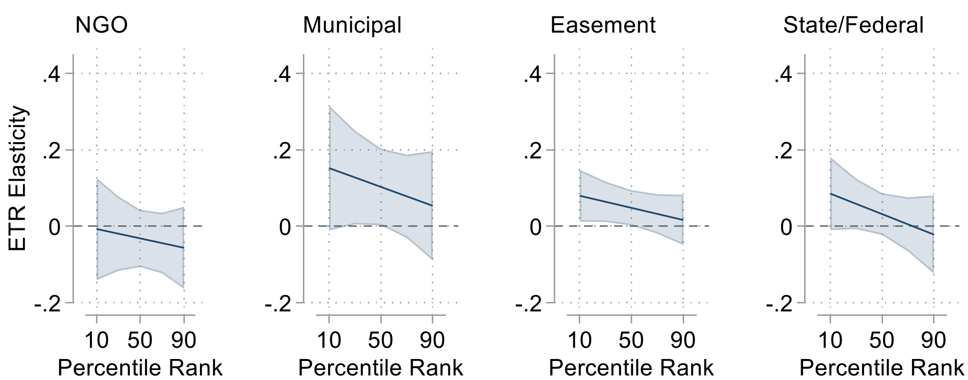
(D) Municipal Area Protected, %



(E) Vacation Home Share in 1990



(F) Median Household Income in 1990



Notes: We show how equalized tax rate (ETR) elasticity with respect to new land protection varies with terms included in the multiple term interaction model described in Section 4.3 while holding other variables at their means. Subfigures show variation in the elasticity by (A) land protection type (B) municipal percentile rank by tax base size (C) municipal tax base growth rate (D) percent municipal area already protected (E) percent vacation homes in 1990 municipal housing stock (F) municipal percentile rank by median household income. Subfigures B-F label the 10th, 50th and 90th percentile values of the variables interacted with land protection. Multiple interaction model estimation results are presented in Appendix Table A5 while the coefficients plotted here are presented in Appendix Table A6.

Table 1: Expected changes in Tax Obligations by Protection Type

Protection Type	Pre-Protection Taxation Regime	Property Value Removed from Tax Base	Payments that Offset Lost Tax Revenues
1) Municipal Fee Acquisition	Full Market Value	Total Taxable Value	No
2) NGO Fee Acquisition	Full Market Value	Total Taxable Value	Sometimes[1]
3) Easement on Private Land	Full Market Value	Partial Taxable Value	No
4) State/Federal Fee Acquisition	Full Market Value	Total Taxable Value	Yes[2]
1) Municipal Fee Acquisition	Current Use Assessment	Current Use Value	No
2) NGO Fee Acquisition	Current Use Assessment	Current Use Value	Sometimes[1]
3) Easement on Private Land	Current Use Assessment	Little to No Additional Impact	No
4) State/Federal Fee Acquisition	Current Use Assessment	Current Use Value	Yes[2]

Notes: This table describes the expected first order fiscal impacts associated with each land protection type and pre-protection taxation regime of the land. [1]Sometimes land trusts choose to make voluntary payments in lieu of taxes to municipalities to offset the tax revenue loss resulting from their land acquisition. They are not required to do so however and there is not a systematic way of knowing who is making such contributions. [2]The federal government and all states except for Maine make compensating payments in lieu of taxes to municipalities for state/federal owned land.

Table 2: Fiscal Variable Definitions

State	Definition
Nominal Property Tax Rate	***Rate of taxation levied on property ($/1000 of value)***
CT, ME	Uniform state property tax rate
MA	Residential property class tax rate
NH, VT	Municipal portion of the property tax rate
Property Tax Levy	***Property taxes collected by a municipality***
ME, CT, MA	Total property tax levy collected. For Maine, the tax levy is constructed by multiplying the assessed property value by the nominal property tax rate.
VT, NH	Tax levy collected for municipal purposes only (excludes school funding). For NH, the levy is constructed by multiplying the nominal municipal tax rate by assessed property value.
Assessed Values	***Value of all taxable municipal property in a municipality, as valued by town assessor***
ME, NH, VT, MA	Sum of all taxable property value
CT	Sum of all taxable property value assessed at 70% of market value
Equalized Value	***Fair market value (FMV) of all taxable property in a municipality.***
ME, NH, CT, VT, MA	FMV of all taxable property
Equalized Property Tax Rate	***Tax levy divided by the fair market value of taxable property in a municipality***
CT, ME	Total property tax levy as share of FMV
MA	Residential property class tax levy as share of FMV
NH,VT	Municipal levy as share of FMV. Equalized municipal tax rate in NH is constructed by multiplying the nominal municipal tax rate by assessed property value to obtain the municipal levy share, and then dividing that by the equalized value.
Municipal Revenues & Expenditures	***Municipal budget revenues and expenditures***
CT, MA	Municipal annual revenues & expenditures

Table 3: Summary Statistics for Differenced and Level Variables

			Level Variables		*Differenced Variables*		
	Count	Units	Mean	SD	Units	Mean	SD
Fiscal Variables							
Tax rate, equalized	9581	$/1000 FMV	11.17	5.61	$/1000 FMV	0.07	0.63
Tax rate, nominal	9581	$/1000 AV	13.04	7.55	$/1000 AV	0.07	0.82
Assessed value per acre	9581	USD, thousands	100.64	300.15	% change	2.75	7.93
Equalized value per acre	9581	USD, thousands	113.57	327.43	% change	2.27	5.80
Municipal revenues (CT,MA)	3457	USD, million	66.91	139.91	% change	2.22	2.50
Municipal expenditures (CT,MA)	3457	USD, million	59.71	129.45	% change	2.22	2.91
Property tax levy	9581	USD, million	16.41	51.29	% change	3.09	5.22
Land Protection							
Total land protected as of prior time period	9581	% town area	15.68	15.12	% town area	0.23	0.50
Ngo protection as of prior time period	9581	% town area	1.80	3.48	% town area	0.03	0.12
Municipal protection as of prior time period	9581	% town area	3.27	5.09	% town area	0.02	0.09
Easement protection as of prior time period	9581	% town area	2.80	5.35	% town area	0.10	0.28
State/federal protection as of prior time period	9581	% town area	7.55	13.17	% town area	0.04	0.18
Current Use Value							
Land share in current use in 2010 (No MA)	7140	% town area	35.90	22.15	–	–	–
Value share of land in current use in 2010 (MA)	2447	% taxable value	0.17	0.24	–	–	–
Socioeconomic Variables							
Unemployment rate, prior time period	9581	percent	5.34	2.94	percent	-0.02	0.81
Labor force, prior time period	9581	labor force/acre	0.43	1.15	labor force/acre	0.00	0.01
Median household income in 1990	9581	USD, thousands	62.50	21.20	–	–	–
Municipal Characteristics							
Municipal area	9581	acres	19927.72	10647.26	–	–	–
Vacation home share 1990	9581	percent	15.42	18.37	–	–	–
Urban municipality	9581	0/1	0.13	0.34	–	–	–
Exurban municipality	9581	0/1	0.35	0.48	–	–	–
Rural municipality	9581	0/1	0.52	0.50	–	–	–

Notes: Summary statistics showing average values and standard deviation for level and differenced variables at the three-year analysis time period. Level variables represent average values within three-year time periods used in the analysis, while differenced variables represent first differences averaged over three years. For some fiscal variables, differences are specified in terms of percent change.

Table 4: Average Impacts of Land Protection on Tax Rates in New England and by State

Table 4.1 Avg Impact Estimates	New England (1)	CT (2)	MA (3)	NH (4)	VT (5)	ME (6)
Equalized Tax Rate						
Ihs Δ Protected	0.0237**	0.0293	0.0278	0.0581***	0.0311*	-0.0515
	(0.0113)	(0.0656)	(0.0209)	(0.0209)	(0.0169)	(0.0318)
R^2_{adj}	0.4453	0.5223	0.5919	0.2837	0.2118	0.3831
Nominal Tax Rate						
Ihs Δ Protected	0.0261*	-0.0151	0.0396**	0.0492**	0.0231	-0.0108
	(0.0150)	(0.1218)	(0.0201)	(0.0234)	(0.0218)	(0.0516)
R^2_{adj}	0.2936	0.3454	0.6151	0.1573	0.0845	0.1493
Observations	9581	1010	2447	1577	1425	3122
LaborMarketControls	Yes	Yes	Yes	Yes	Yes	Yes
StateByYearFE	Yes	No	No	No	No	No
YearFE	No	Yes	Yes	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes	Yes	Yes	Yes
Tax Base Growth	Yes	Yes	Yes	Yes	Yes	Yes
Table 4.2 Change in Land Protection & Tax Bill						
Annual Change in Acres Protected	84.88	44.51	54.15	118.48	175.63	76.53
Typical Home Value	$266,497	$297,465	$361,662	$249,847	$226,221	$197,290
Δ *Tax Bill, per $100,000 of value*						
Tax-bill change, Equalized.Tax Rate	$0.72	$0.77	$0.58	$0.84	$0.61	$-3.64
Tax-bill change, Nominal Tax Rate	$0.92	$-0.59	$0.88	$0.74	$0.49	$-0.88
Tax Rate & Tax Bill						
Avg Nominal Tax Rate	$13.04	$26.23	$13.35	$5.44	$5.47	$15.82
Avg Equalized Tax Rate	$11.17	$17.74	$12.59	$5.17	$5.03	$13.76
Typical Nominal Tax Bill	$3475.12	$5461.75	$4828.19	$1359.17	$1237.43	$3121.13

Notes: Table 4.1 presents the average impact of land protection on equalized and nominal property tax rates. Dependent variables are Ihs transformations of the average changes in the equalized and nominal property tax rates. The explanatory variable is the Ihs transformation of the average prior period change in percent area protected within a municipality. Control variables include the Ihs transformations of the prior period average change in labor force per acre and unemployment rate, average prior period tax base growth, year and state by year fixed effects depending on the column, and linear CBSA specific time trends.

Table 4.2 presents the average annual non-zero change in land protection, typical home values based on Zillow ZHVI index (35^{th}-65^{th} percentile home values), tax bill change associated with the average non-zero change in protection, average nominal and equalized tax rates and tax bills for a typical home value, by state. We note that the average sample tax rate is the mean of aggregate (for MA, CT and ME) and municipal tax rates (in VT and NH). We show calculations for the nominal tax bill change and level below, based on nominal tax rate results in column 1.

The tax bill change is calculated from the elasticity coefficients. An 84.88 acre increase in protection is a 2.716% increase in protection (see footnote 19), so it is associated with a 0.0261 (elasticity) * 2.716 (% change in protection) = 0.0709% increase in tax rate. Average nominal tax rate is 13.04, so the tax bill increase is 13.04*0.000709 *100=$0.92 (multiplying the tax rate increase by 100 to get change per $100K). The tax bill is computed by multiplying the average nominal tax rate by the typical home value in thousands. For col. 1, that yields $13.04 * 266.497 = $3475.12. Tax bill change calculations for equalized tax rates use average equalized tax rates and elasticities. Standard errors in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01

Table 5: Analysis of Impact Heterogeneity for Total Land Protected.

	Prot. Type (1)	Current Use (2)	Tax Base (3)	Tax Base Growth (4)	Comm. Type (5)	Share Protected (6)	% Vac. Homes (7)	Median Income (8)
Ihs Δ NGO Protected	-0.0524 (0.0347)							
Ihs Δ Muni Protected	0.0720* (0.0415)							
Ihs Δ Easement Prot.	0.0357** (0.0173)							
Ihs Δ State/Fed Prot.	0.0305 (0.0269)							
Ihs Δ Protected		0.0580** (0.0271)	0.0229 (0.0200)	0.0397*** (0.0126)		0.0381** (0.0175)	0.0687*** (0.0150)	0.0402* (0.0215)
Ihs Δ Prot # Current Use		-0.0010** (0.0004)						
Ihs Δ Prot # Tax Base			0.0000 (0.0004)					
Ihs Δ Prot # Tax Base Growth				-0.0062*** (0.0017)				
Ihs Δ Prot # Rural					0.0166 (0.0139)			
Ihs Δ Prot # Exurban					0.0319** (0.0162)			
Ihs Δ Prot # Urban					0.0623 (0.0418)			
Ihs Δ Prot # % Area Protected						-0.0009 (0.0008)		
Ihs Δ Prot # % Vacat. Home Share							-0.0021*** (0.0004)	
Ihs Δ Prot # Income								-0.0004 (0.0004)
Tax Base Growth	0.0126*** (0.0013)	0.0133*** (0.0018)	0.0125*** (0.0013)	0.0138*** (0.0014)	0.0125*** (0.0013)	0.0125*** (0.0013)	0.0127*** (0.0013)	0.0126*** (0.0013)
Observations	9581	5545	9581	9581	9581	9581	9581	9581
R^2_{adj}	0.4454	0.5147	0.4453	0.4459	0.4453	0.4453	0.4461	0.4453
LaborMarketControls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
StateYearFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The outcome variable in all models is the Ihs transformed average change in the equalized tax rate. The key explanatory variables are Ihs transformations of the average prior period change in percent area protected within a municipality (total and by type) and the interaction of these variables with measures of local economic conditions. These results characterize the heterogeneity of the marginal tax impact of land protection through interaction of the change in land protection with individual measures of local conditions. The "#" indicates an interaction term. These estimates are variations of Equation 3. Standard errors in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01.

Table 6: Impact of Land Protection on Levy, Taxable Property Value, and Municipal Revenue and Expenditure.

	(1) PrctChng Expenditure	(2) PrctChng Revenues	(3) PrctChng Levy	(4) PrctChng AssdVal	(5) PrctChng EqlVal
MA & CT Only					
% Change Protected	0.0192	0.0164	0.0219*	-0.0145	-0.0232
	(0.0148)	(0.0136)	(0.0117)	(0.0222)	(0.0196)
Change for 84.9 acre annual increase in protection	\$30210.61	\$28902.67	\$22557.19	-\$897,086.86	-\$1,690,477.57
Observations	3457	3457	3457	3457	3457
R^2_{adj}	0.2317	0.2647	0.2656	0.6471	0.7066
All States					
% Change Protected	–	–	0.0166**	-0.0093	-0.0040
			(0.0080)	(0.0081)	(0.0047)
Change for 84.9 acre annual increase in protection	–	–	\$7,415.40	-\$275,456.04	-\$136,557.98
Observations	–	–	9317	9317	9317
R^2_{adj}			0.1410	0.3896	0.6800
LaborMarketControls	Yes	Yes	Yes	Yes	Yes
StateYearFE	Yes	Yes	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes	Yes	Yes
Tax Base Growth	Yes	Yes	Yes	Yes	Yes

Note: All outcome variables represent average annual percent change for each time period. The explanatory variable is the average annual percent change in percent area protected within a municipality, in the prior time period. The coefficients are interpreted as elasticities. The same control variables are used in all Table 6 regressions: Ihs transformations of the prior period average change in labor force per acre and unemployment rate, average prior period tax base growth, state by year fixed effects, and linear CBSA specific time trends. Change in revenues and expenditures are outcomes from municipal budgets and are available only for MA & CT, while changes in the municipal levy, assessed values and equalized values are available for all states. There are fewer observations in the full sample estimates compared to Tables 4 and 5 because we specify the land protection variable as a percent change to maintain coefficients as elasticities. Towns with zero land protection in a given time period drop out.

We use the sample wide average annual change in land protection of 84.9 acres to compute the change in the fiscal variables for both the full sample & the MA/CT sub sample, for consistency, but note that annual average change in protection is smaller in MA (54 ac) and CT (45 ac). Standard errors in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01

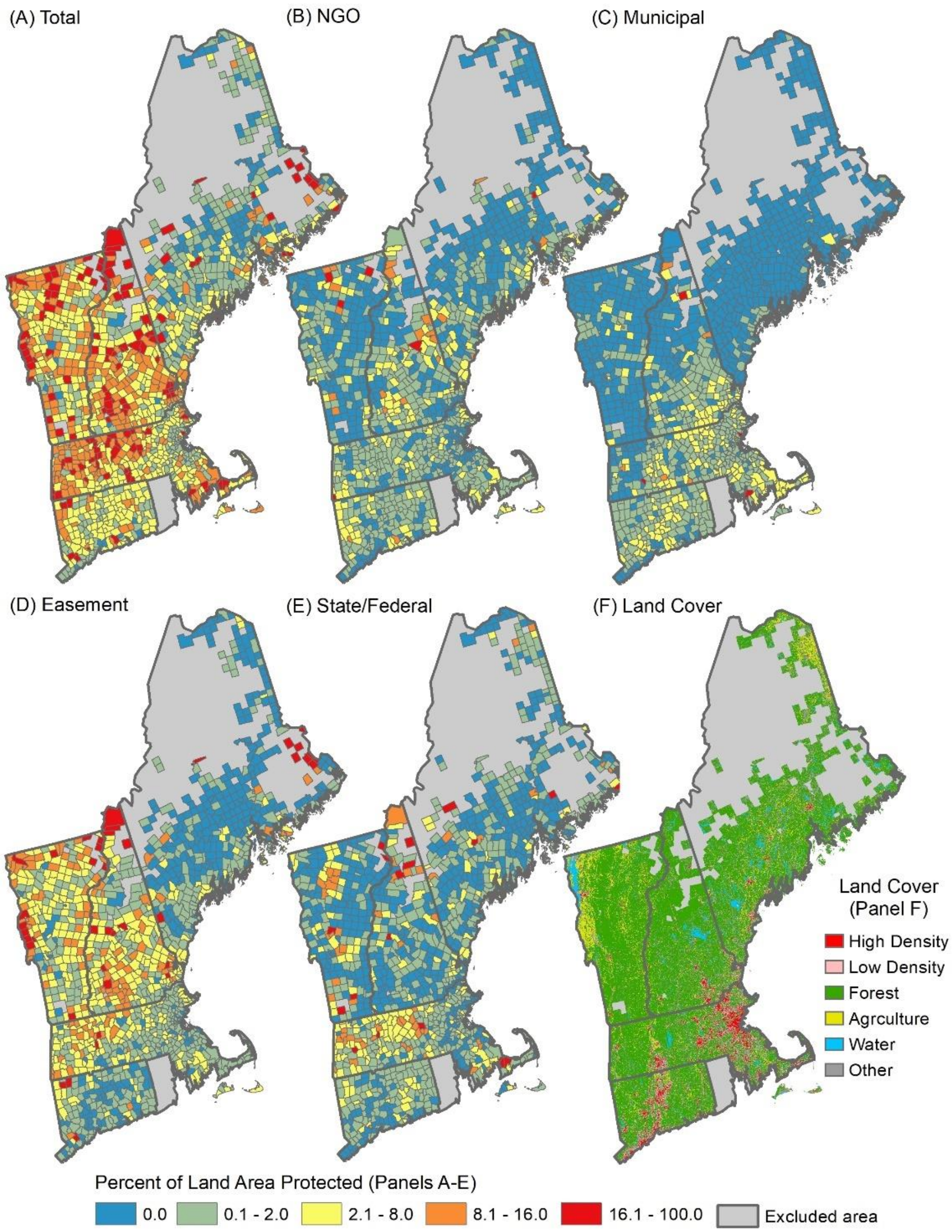
Table 7: Impact of Land Protection Over Time.

	3 year lag (1)	6 year lag (2)	9 year lag (3)
3 year lag Ihs Δ Protected	0.0237**	0.0149	0.0155
	(0.0113)	(0.0128)	(0.0141)
6 year lag Ihs Δ Protected		-0.0132	-0.0091
		(0.0122)	(0.0142)
9 year lag Ihs Δ Protected			0.0006
			(0.0127)
Observations	9581	7989	6398
R^2_{adj}	0.4453	0.4645	0.4911
LaborMarketControls	Yes	Yes	Yes
StateByYearFE	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes
Tax Base Growth	Yes	Yes	Yes

Note: The outcome variable is the Ihs transformation of the average change in the equalized property tax rate. The explanatory variables include multiple lags of the Ihs transformation of the average prior period change in total percent area protected within a municipality. Control variables include the Ihs transformations of the prior period average change in labor force per acre and unemployment rate, average prior period tax base growth, state by year fixed effects and linear CBSA specific time trends. Standard errors in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01

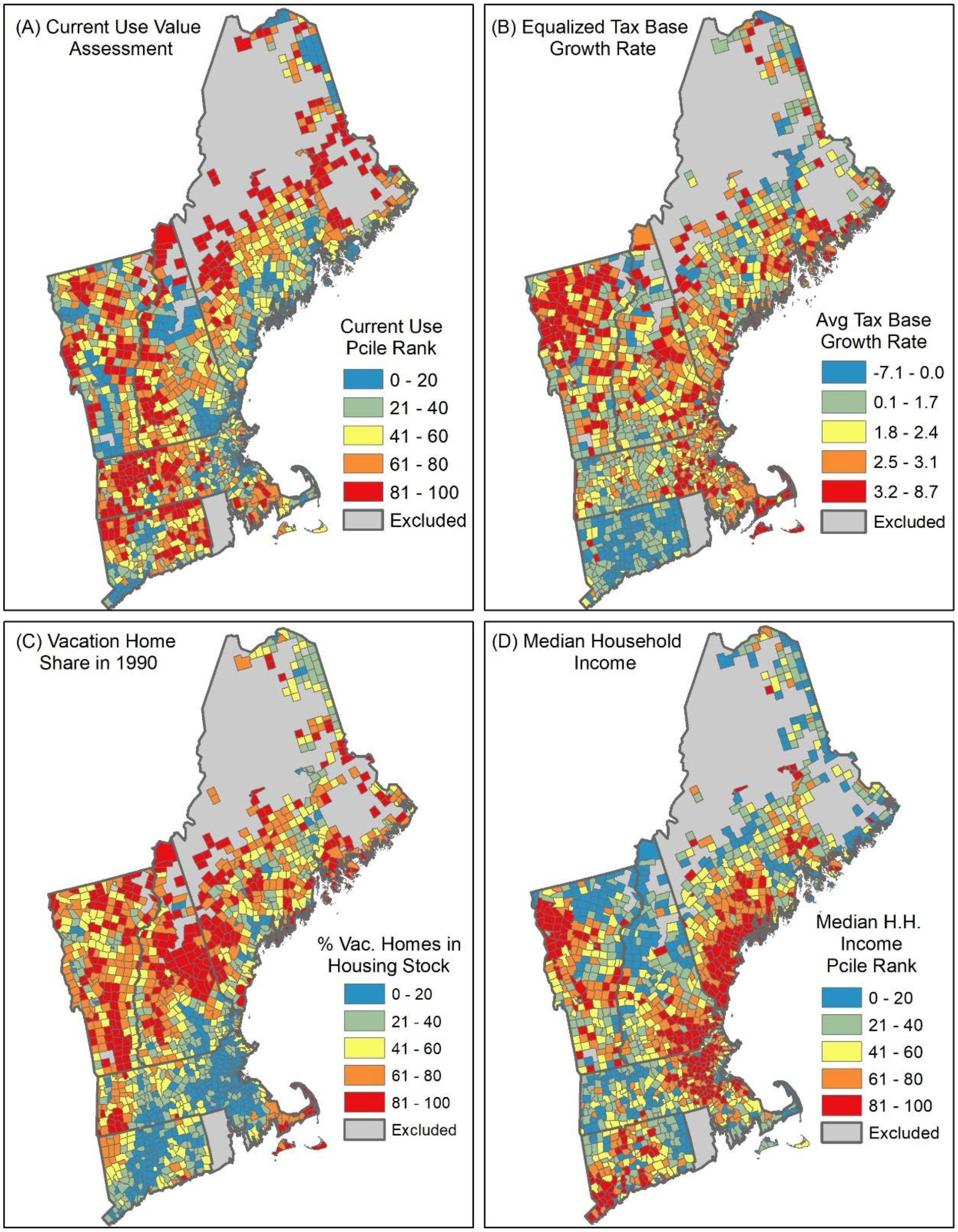
Appendix

Figure A1: Change in Land Protection by Type, 1990-2015



Notes: Change in protected land between 1990 and 2015 is shown as percentage of area in a municipality, disaggregated by type. Subfigure (A) shows total change in protected land, while Subfigures B-D show changes for mutually exclusive categories of protection: (B) land owned in fee by NGOs (C) land owned in fee by municipalities (D) easements on private land (E) land owned in fee by state/federal govt (F) 2016 land cover from the National Land Cover Database (Dewitz 2019).

Figure A2: Municipal Characteristics



Notes: Municipal characteristic include (A) within state percentile rank for municipalities based on amount of land under current use assessment (B) average annual tax base growth rate over our study period, with tax base defined as equalized value per acre (C) percent of housing stock made up by vacation homes in 1990 and (D) within state percentile rank for municipalities based on median household income in 1990.

Table A1: Main Avg Effects Specification – Robustness checks with Winsorizing Variables

	Non Winsorized (1) Ihs Δ Equalized Tax Rate	Winsorized (2) Ihs Δ Equalized Tax Rate	Non Winsorized (3) Ihs Δ Nominal Tax Rate	Winsorized (4) Ihs Δ Nominal Tax Rate
Ihs Δ Protected	0.0247**	0.0237**	0.0240*	0.0261*
	(0.0105)	(0.0113)	(0.0138)	(0.0150)
Observations	9581	9581	9581	9581
R^2_{adj}	0.4325	0.4453	0.2878	0.2936
LaborMarketControls	Yes	Yes	Yes	Yes
StateByYearFE	Yes	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes	Yes
TaxBaseGrowth	Yes	Yes	Yes	Yes

Note: The outcomes are the Ihs transformations of the average change in equalized (cols 1 & 2) and nominal tax rates (cols 3 & 4). The explanatory variable is the Ihs transformation of the prior period average change in town area protected. The variables used in the estimation are winsorized in columns 2 and 4. Standard errors in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01

Table A2: Alternative Specifications for the Average Effect of Land Protection on the Equalized Tax Rate.

	level-level (1) Δ Equalized Tax Rate	% chng - %chng (2) % Δ Equalized Tax Rate	ihs-ihs (3) Ihs Δ Equalized Tax Rate
Δ Protected	0.0179*		
	(0.0093)		
% Δ Protected		0.0246***	
		(0.0084)	
Ihs Δ Protected			0.0237**
			(0.0113)
Tax bill change per 100,000 of value for an 84.9 acre increase in area protected annually	$0.76	$0.75	$0.72
Observations	9581	9311	9581
R^2_{adj}	0.4301	0.3408	0.4453
LaborMarketControls	Yes	Yes	Yes
StateYearFE	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes
Tax Base Growth	Yes	Yes	Yes

Note: The outcome variable is the equalized tax rate. The explanatory variable is prior period change in percent land area protected. The specific form/transformation of these variables varies according to column headings. There are fewer observations for column 2 because the town with zero land protection in a given time period drop out, since one cannot divide by zero to compute % change. Standard errors in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01

Table A3: Alternative Specifications for the Average Effect of Land Protection on the Nominal Tax Rate.

	level-level (1) Δ Nominal Tax Rate	% chng - %chng (2) % Δ Nominal Tax Rate	ihs-ihs (3) Ihs Δ Nominal Tax Rate
Δ Protected	0.0216 (0.0137)		
% Change Protected		0.0214** (0.0088)	
Ihs Δ Protected			0.0261* (0.0150)
Tax bill change per 100,000 of value for an 84.9 acre increase in area protected annually	\$0.92	\$0.76	\$0.92
Observations	9587	9317	9587
R^2_{adj}	0.2725	0.2187	0.2931
LaborMarketControls	Yes	Yes	Yes
StateYearFE	Yes	Yes	Yes
CBSATrends	Yes	Yes	Yes
Tax Base Growth Control	Yes	Yes	Yes

Note: The outcome variable is the nominal tax rate. The explanatory variable is prior period change in percent land area protected. The specific form/transformation of these variables varies according to column headings. There are fewer observations for column 2 because the town with zero land protection in a given time period drop out, since one cannot divide by zero to compute % change. Standard errors in parentheses, clustered by township *p<0.1; **p<0.05; ***p<0.01

Table A4: Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Ln Housing Density	1.000												
(2) Curr Use Pcile	-0.507	1.000											
(3) Tax Base Pcile	0.731	-0.629	1.000										
(4) % Area Protected	0.013	-0.090	-0.160	1.000									
(5) Tax Base Growth	-0.036	-0.010	0.001	0.008	1.000								
(6) Household Income Pcile, 1990	0.135	-0.165	0.338	-0.024	0.042	1.000							
(7) % Vacation Homes, 1990	-0.439	0.124	-0.197	0.145	0.075	-0.197	1.000						
(8) Lagged Ihs Eq. Tax Rate	0.264	0.026	-0.004	-0.205	-0.156	-0.070	-0.394	1.000					
(9) Ihs Δ Protected	-0.045	0.123	-0.099	0.110	0.049	-0.007	0.043	-0.160	1.000				
(10) Ihs Δ NGO Protected	-0.004	0.044	-0.009	0.054	0.050	0.017	0.058	-0.043	0.427	1.000			
(11) Ihs Δ Municipal Protected	0.185	-0.038	0.063	0.057	0.074	0.084	-0.111	0.023	0.300	0.045	1.000		
(12) Ihs Δ Easement Protected	-0.106	0.141	-0.079	0.067	0.016	-0.003	0.059	-0.234	0.696	0.067	0.005	1.000	
(13) Ihs Δ State/Fed Protected	-0.022	0.059	-0.118	0.087	0.011	-0.051	0.002	0.030	0.531	0.037	0.013	0.067	1.000

Notes: Appendix Table A4 shows correlations between variables used to estimate individual interaction models in Table 4. These correlations are used as a guide for selecting variables for a multiple interaction model described in Sections 5.3 and 5.4.

Table A5: Multiple Interaction Model

	Ihs Δ Equalized Tax Rate
Tax Base Growth	0.0247***
	(0.0059)
Tax Base Growth # % Area Prot	0.0000
	(0.0001)
Tax Base Growth # Tax Base	0.0001***
	(0.0000)
Tax Base Growth # % Vac. Homes	0.0000
	(0.0000)
Tax Base Growth # Income Pcile	0.0001***
	(0.0000)
Tax Base Growth # Lagged Ihs Eq. Tax Rate	-0.0068***
	(0.0017)
Ihs Δ NGO Prot	0.9802***
	(0.2275)
Ihs Δ NGO Prot # Tax Base	-0.0011
	(0.0013)
Ihs Δ NGO Prot # Tax Base Growth	-0.0128**
	(0.0056)
Ihs Δ NGO Prot # % Vac. Homes	-0.0062***
	(0.0019)
Ihs Δ NGO Prot # % Area Prot	-0.0032
	(0.0030)
Ihs Δ NGO Prot # Income Pcile	-0.0007
	(0.0012)
Ihs Δ NGO Prot # Lagged Ihs Eq. Tax Rate	-0.2576***
	(0.0682)
Ihs Δ NGO Prot # Tax Base # Tax Base Growth # % Area Prot # % Vac. Homes # Income Pcile # Lagged Ihs Eq. Tax Rate	0.0000
	(0.0000)
Ihs Δ Municipal Prot	0.9539***
	(0.2998)
Ihs Δ Municipal Prot # Tax Base	-0.0022

	(0.0018)
Ihs Δ Municipal Prot # Tax Base Growth	-0.0070 (0.0065)
Ihs Δ Municipal Prot # % Vac. Homes	-0.0021 (0.0030)
Ihs Δ Municipal Prot # % Area Prot	-0.0074* (0.0043)
Ihs Δ Municipal Prot # Income Pcile	-0.0013 (0.0015)
Ihs Δ Municipal Prot # Lagged Ihs Eq. Tax Rate	-0.1781** (0.0706)
Ihs Δ Municipal Prot # Tax Base # Tax Base Growth # % Area Prot # % Vac. Homes # Income Pcile # Lagged Ihs Eq. Tax Rate	0.0000 (0.0000)
Ihs Δ Easement Prot	0.2177** (0.1005)
Ihs Δ Easement Prot # Tax Base	-0.0000 (0.0007)
Ihs Δ Easement Prot # Tax Base Growth	-0.0069** (0.0027)
Ihs Δ Easement Prot # % Area Prot	-0.0022 (0.0014)
Ihs Δ Easement Prot # % Vac. Homes	-0.0021*** (0.0008)
Ihs Δ Easement Prot # Income Pcile	-0.0008 (0.0006)
Ihs Δ Easement Prot # Lagged Ihs Eq. Tax Rate	-0.0167 (0.0305)
Ihs Δ Easement Prot # Tax Base # Tax Base Growth # % Area Prot # % Vac. Homes # Income Pcile # Lagged Ihs Eq. Tax Rate	0.0000 (0.0000)
Ihs Δ State/Fed Prot	0.3956** (0.1942)
Ihs Δ State/Fed Prot # Tax Base	0.0003 (0.0010)

Ihs Δ State/Fed Prot # Tax Base Growth	-0.0051
	(0.0044)
Ihs Δ State/Fed Prot # % Area Prot	0.0032*
	(0.0018)
Ihs Δ State/Fed Prot # % Vac. Homes	-0.0038**
	(0.0016)
Ihs Δ State/Fed Prot # Income Pcile	-0.0013
	(0.0011)
Ihs Δ State/Fed Prot # Lagged Ihs Eq. Tax Rate	-0.0990**
	(0.0502)
Ihs Δ State/Fed Prot # Tax Base # Tax Base Growth # % Area Prot # % Vac. Homes # Income Pcile # Lagged Ihs Eq. Tax Rate	-0.0000
	(0.0000)
Observations	9581
R^2_{adj}	0.4503
LaborMarketControls	Yes
StateYearFE	Yes
CBSATrends	Yes

Notes: The outcome variable is the Ihs transformation of the change in equalized property tax rate. This table presents estimates of the multiple interaction model described in Sections 5.3 and 5.4. The model is estimated using a variation of Equation 3 that includes multiple interactions between change in protected land and measures of local economic conditions. Marginal effects estimates from this model are plotted in Figure 5 and summarized in Table A6. The "#" indicates an interaction term. Control variables include the Ihs transformations of the prior period average change in labor force per acre, unemployment rate and the average level of prior period equalized tax rate. Additional controls include average prior period tax base growth, state by year fixed effects and linear CBSA specific time trend. Standard errors are shown in parentheses, clustered by township. *p<0.1; **p<0.05; ***p<0.01

Table A6: Coefficient (Elasticity) Values from Multiple Interaction Model Plots

	Interaction Term Value	NGO	Municipal	Ease	State/Federal
Average Effect		-0.0317	0.103**	0.0481**	0.0317
	N/A	(0.0381)	(0.0512)	(0.0236)	(0.0279)
Tax Base					
10th Pcile	10	0.00955	0.190*	0.0496	0.0210
		(0.0656)	(0.0994)	(0.0334)	(0.0416)
30th Pcile	30	-0.0110	0.147**	0.0488*	0.0263
		(0.0470)	(0.0705)	(0.0258)	(0.0297)
50th Pcile	50	-0.0316	0.103**	0.0481**	0.0317
		(0.0381)	(0.0513)	(0.0236)	(0.0278)
70th Pcile	70	-0.0522	0.0596	0.0474*	0.0370
		(0.0453)	(0.0535)	(0.0281)	(0.0375)
90th Pcile	90	-0.0728	0.0161	0.0466	0.0423
		(0.0632)	(0.0754)	(0.0369)	(0.0528)
Tax Base Growth					
10th Pcile	-5.12%	0.0380	0.148**	0.0954***	0.0724
		(0.0539)	(0.0694)	(0.0316)	(0.0450)
30th Pcile	-2.06%	0.00767	0.128**	0.0748***	0.0547
		(0.0447)	(0.0594)	(0.0269)	(0.0358)
50th Pcile	0.87%	-0.0215	0.109**	0.0551**	0.0377
		(0.0390)	(0.0527)	(0.0241)	(0.0293)
70th Pcile	4.92%	-0.0616	0.0837*	0.0278	0.0143
		(0.0390)	(0.0502)	(0.0240)	(0.0271)
90th Pcile	10.56%	-0.118**	0.0478	-0.0102	-0.0184
		(0.0526)	(0.0606)	(0.0306)	(0.0381)

Table A6 Continued: Coefficient Values from Multiple Interaction Model Plots

	Interaction Term Value	NGO	Municipal	Ease	State/Federal
% Town Area Protected					
10th Pcile	0.99%	0.00801	0.206**	0.0786**	-0.0121
		(0.0592)	(0.0954)	(0.0316)	(0.0403)
30th Pcile	5.77%	-0.00549	0.171**	0.0682**	0.00282
		(0.0490)	(0.0779)	(0.0277)	(0.0346)
50th Pcile	11.11%	-0.0206	0.132**	0.0566**	0.0194
		(0.0408)	(0.0608)	(0.0246)	(0.0298)
70th Pcile	18.44%	-0.0413	0.0780*	0.0408*	0.0422
		(0.0387)	(0.0465)	(0.0238)	(0.0276)
90th Pcile	33.68%	-0.0843	-0.0338	0.00775	0.0896**
		(0.0653)	(0.0730)	(0.0335)	(0.0398)
% Vacation Homes					
10th Pcile	0.25%	0.0573	0.133**	0.0800***	0.0913***
		(0.0519)	(0.0563)	(0.0266)	(0.0351)
30th Pcile	1.44%	0.0503	0.130**	0.0775***	0.0866**
		(0.0504)	(0.0547)	(0.0261)	(0.0341)
50th Pcile	6.70%	0.0194	0.120**	0.0664***	0.0659**
		(0.0444)	(0.0496)	(0.0246)	(0.0303)
70th Pcile	21.23%	-0.0658*	0.0914	0.0359	0.00891
		(0.0374)	(0.0587)	(0.0241)	(0.0294)
90th Pcile	43.06%	-0.194***	0.0484	-0.00996	-0.0768
		(0.0574)	(0.108)	(0.0325)	(0.0502)

Table A6 Continued: Coefficient Values from Multiple Interaction Model Plots

	Interaction Term Value	NGO	Municipal	Ease	State/Federal
Median Income					
10th Pcile	10	-0.00703	0.152*	0.0799**	0.0853*
		(0.0682)	(0.0834)	(0.0345)	(0.0486)
30th Pcile	30	-0.0194	0.128**	0.0640**	0.0586*
		(0.0496)	(0.0625)	(0.0269)	(0.0336)
50th Pcile	50	-0.0317	0.103**	0.0482**	0.0318
		(0.0381)	(0.0512)	(0.0236)	(0.0278)
70th Pcile	70	-0.0440	0.0783	0.0323	0.00505
		(0.0405)	(0.0556)	(0.0263)	(0.0361)
90th Pcile	90	-0.0563	0.0536	0.0164	-0.0217
		(0.0548)	(0.0729)	(0.0335)	(0.0521)

Note: This table presents the variation in the marginal impacts of land protection across protection types, and 10^{th}-90^{th} percentiles of heterogeneity dimensions that we examine in our multiple interaction model in Sections 5.3 and 5.4. These coefficients are plotted in Figure 5, based on estimates from the multiple interaction model shown in Table A5. Standard errors in parentheses, clustered by township.
*p<0.1; **p<0.05; *** p<0.01