The Annals of Regional Science
https://doi.org/10.1007/s00168-020-00975-7

ORIGINAL PAPER

Do factors contributing to appearance and success of conservation referenda in the West differ from those found in other regions of the United States?

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Received: 22 February 2019 / Accepted: 14 January 2020

Abstract

As urban growth and competition for natural resources heighten, the attention to preserving such resources, including land, is also growing. As one example, the appearance and passage of conservation referenda represents a high-profile, grassroots political effort across the USA. In this study, factors influencing the appearance and passage of ballot initiatives in Colorado are compared to previous literature, identifying potential regional variation in such drivers. Results suggest that, while some place-based characteristics like total population and educational attainment have a consistent effect, the role of income and households with children does not. It appears support for conservation is much more broadly distributed across the population in the West and that residents view conservation as an ongoing activity, not a singular event. Likewise, there is some evidence that Western voters view agriculture and conservation as mutually exclusive. Although fundamental results do not change, accounting for spatial effects alters the magnitude and significance of factors affecting both appearance and passage of conservation referenda.

JEL Classification C21 · Q24-Q26 · Q38 · D72 · P48 · R11 · R58

This paper was chosen by the WRSA Graduate Student Reading Committee to receive the Tiebout Prize at the 2019 WRSA conference in Napa, CA.

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Published online: 22 January 2020

1 Introduction

The rise of conservation-oriented ballot referenda in the USA is important to policymakers for a number of reasons. First, with sufficient public support, it allows voters to offer new alternatives to existing policies, a strong signal that current policy objectives do not match evolving voter preferences. In order for a referendum to appear on a ballot, 5% of a jurisdiction's voters must submit signatures in support (CRS 2016). This requires the development of a coalition of voters willing to expend both time and energy, indicating to policymakers that voter preferences are not satisfied. Second, citizen-motivated ballot initiatives tend to be stricter and more difficult to change (Gerber and Phillips 2005). In comparison with long-term strategic growth plans, the appearance and potential passage of referenda are quite rapid. Policymakers who do not adequately anticipate such events may find their long-term growth goals suddenly disrupted by unexpected growth or development restrictions. Third, referenda can significantly impact jurisdictional budgets. For example, the largest county and municipal fiscal allocations in Colorado during the period of the study presented below exceed $450 million and $130 million, respectively.

Previous research on conservation referenda focuses exclusively on the Northeastern region of the USA (e.g., Kotchen and Powers 2006), yet Western US states are home to numerous natural resources such as the headwaters of many major rivers, significant stands of timber, and large tracts of federal lands allocated to ranchers for grazing cattle. Given the large amount of publicly owned land, vastly different geographic and geological characteristics, status as a destination for in-migrating outdoor enthusiasts and recreationalists (Loudenback 2016), and the allocation of nearly four times as much money to conservation as New Jersey,[1] Colorado makes an ideal case study for comparison of the American West to the more densely populated Northeastern USA.

The specific goals of this study are to carefully replicate the techniques used elsewhere in the literature across a similar time period in an attempt to accurately identify which factors are associated with the appearance and passage of conservation referenda in Colorado, as well as how these vary by region. As such, this research is not intended to produce any new theoretical or methodological approaches, but instead focuses on supplying policymakers, particularly those in the West, with a better understanding of factors driving support for conservation among their constituents. Additionally, it is meant to identify regional variation in such support, providing a better context from which future research by regional economists can refine and more effectively consider place-based context within future theoretical and methodological approaches to modeling voter preferences for conservation.

The research presented in this paper has four objectives. First, it identifies socioeconomic factors associated with the appearance of conservation referenda on voter ballots, informing policymakers of community characteristics associated with

[1] More referenda have been held in New Jersey than any other US state. In part this is due to New Jersey's Green Acres Planning Incentive Initiative, a statewide program incentivizing open space preservation (see page 4).

support for conservation. Second, it provides an analysis of referenda characteristics associated with passage of conservation measures, further delineating specific aspects of conservation efforts Colorado voters are more likely to support. Third, because most conservation referenda target open space, this study investigates how bundling different natural resources together affects the likelihood of passage (e.g., it explores the relationship between referenda collectively targeting wildlife habitat and open space conservation and the likelihood of passage). Fourth, it identifies and accounts for impacts of spatial spillovers in support for conservation between proximate communities. Such patterns have only been investigated in one other study (Heintzelman et al. 2013), a statewide analysis of New Jersey. Findings presented below suggest spillovers are present across different regions of the USA and should be considered in future studies.

1.1 Land conservation policy

Development sprawl and its impacts on air and water quality, energy consumption, and land use have become an important environmental issue in the USA (Wilson and Chakraborty 2013). This is demonstrated by several decades of sustained public interest in preserving resources such as open space, soil, wildlife habitat, and water along urban fringes, particularly in states facing the greatest population and development pressure (Kline 2006). A prime example is Colorado, where more than 80% of residents are concentrated along the Front Range,[2] an area encompassing 16 of the state's 64 counties in 2000 (those labeled in blue in Fig. 1). As is the case with metro areas throughout the West, development pressure exists along the Front Range as a result of rapid development and increased sprawl.

This pressure and associated concern about loss of wildlife habitat, wetlands, and open space generated a vast increase in citizen-driven conservation efforts starting in the early 1990s. Between 1990 and 2010, 154 conservation referenda appeared on ballots in Colorado (TPL 2017) driven by grassroots conservation efforts targeted at resources residents felt were not adequately protected by current policies. These referenda allocated approximately $4.4 billion to protect open space, agricultural land, water quality, and wildlife habitat, among other things. Although no statewide programs targeting referenda are present in Colorado, more densely populated states have policies and programs aimed at conserving resources such as open space through the passage of referenda. For instance, in 1997 New Jersey implemented the Green Acres Planning Incentive Program which incentivizes communities throughout the state to adopt open-space property taxes (Kotchen and Powers 2006). As a result, Garden State voters allocated $1.3 billion to conservation efforts between

[2] The Front Range is also known as the Front Range Urban Corridor. In 2000, it included all counties labeled in blue in Fig. 1 except Broomfield, which did not become a county until 2002. At the time of the 2000 Census, the 16 counties constituting the Front Range, as it is known, were home to approximately 3.6 of the 4.3 million Colorado residents (~83.85%). The United States Office of Budget and Management divides Colorado's Front Range into seven Core-Based Statistical Areas (CBSA's) which include the following major cities: Fort Collins, Greeley, Boulder, Denver, Colorado Springs, Cañon City, and Pueblo.

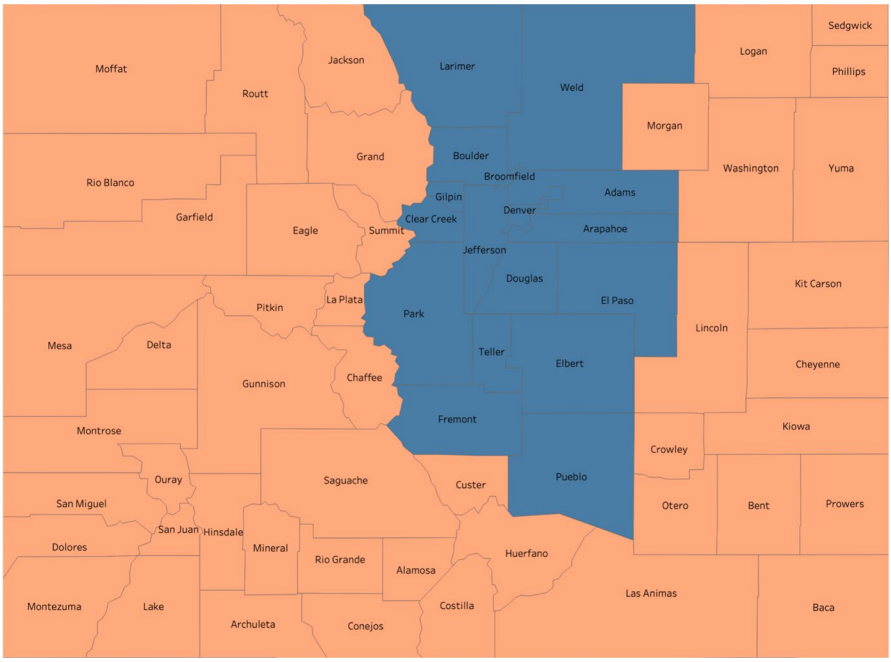

Fig. 1 Colorado Counties. *Note* The 17 counties in blue constitute Colorado's front range urban corridor and contained approximately 84% of the state's population in 2000

1989 and 2009 (Heintzelman et al. 2013). The fact that referenda-driven expenditures in Colorado exceeded those incentivized by state governments on the east coast by a factor of more than three further motivates the need for a comparative study of referenda characteristics, impacts, and outcomes in the American West.

The next section introduces the literature laying the groundwork and framing the expectations for this study. This is followed by a discussion of data and methods used for the analysis. Results are then presented and discussed, including the impacts of spatial spillovers and an assessment of regional variation in findings relative to past literature. The paper concludes with a summary of policy and research implications.

2 Background

Numerous studies explore the relationship between conservation referenda and voter characteristics associated with support for preservation of environmental public goods. Deacon and Shapiro (1975) published the seminal piece linking individual preferences for public goods to environmental referenda outcomes. Kahn and Matsusaka (1997) extended their work by exploring environmental referenda in California using a simplified version of Deacon and Shapiro's model. The latter conclude the vast majority of variation in county voting data is explained by a small set of

standard economic variables, an observation that proves useful for analyzing the relatively small number of Colorado referenda.

Early research focused on conservation referenda is best exemplified by the work of Howell-Moroney (2004a) in the Delaware Valley (near Camden, New Jersey) which analyzed referenda appearance at the municipality level. Kotchen and Powers (2006) were the first to investigate both appearance and outcome of referenda, with careful attention to the potential for selection bias (whereby jurisdictions that pass referenda are also more likely to hold them). Following Kahn and Matsusaka (1997), they limit variables at the county and municipal levels and use Heckman's two-step process (1977) to identify and control for potential selection bias.

In their nationwide analysis, Nelson et al. (2007) explore open-space referenda at the municipal level. In contrast to Kotchen and Powers (2006), dozens of independent variables are added with little increase in explanatory power, further validating Kahn and Matsusaka. Unlike Kotchen and Powers, Nelson et al. find weak evidence of selection bias. Banzhaf et al. (2010) analyze the success of holding referenda and, in spite of results indicating referenda appear on ballots where the likelihood of passage is higher, outcomes from the formal two-step model find no such selection bias. These studies provide the motivation for this research. A more recent publication (Heintzelman et al. 2013) raises questions about the role of spatial dependence by mimicking the work of Kotchen and Powers (2006) and identifying the presence of spatial autocorrelation. Correcting for autocorrelation increases explanatory power and alters significance levels, justifying the need to address spatial spillovers.

One paper (Shanahan 2010) explores open-space referenda in the West, including all contiguous Rocky Mountain, desert, and West Coast states except California (excluded due to its urban nature). Several of her results conflict with previous regional work (e.g., while education and income are positively correlated with support for conservation in the Northeast, Shanahan's results suggest the opposite is true in the West). The identification of these potential differences justifies this additional regional study.

3 Data and methodology

3.1 Sources

Data for this study are compiled from two primary and several secondary sources. The Trust for Public Lands (TPL) maintains a database of conservation referenda held in the USA since 1988 (TPL 2017). This research utilizes referenda at the county and municipal levels for the state of Colorado from 1995 to 2005. During this time period, a total of 112 referenda appeared before voters. Fifteen of these were held in special districts. In Colorado, these districts are formed to offer specific services which county or municipal governments cannot provide (CDOLA 2019) such as parks and recreation or wastewater treatment. All special districts holding referenda between 1995 and 2005 were parks and recreation districts. Because these types of specialized governments focus solely on parks and recreation, rather than the full suite of services offered by local governments, factors

Table 1 Colorado conservation referenda characteristics

Total observations	371	
Total municipalities	266	71.70%
Total counties	63	16.98%
Repeat observations*	42	11.32%
Total measures	97	
Repeated measures	42	
Unique measures	55	
Measures passed	71	73.20%
County measures	36	37.11%
Municipal measures	61	62.89%
Open space measures mentioning:		
Farm/ranch/agriculture	7	7.22%
Water/watershed	8	8.25%
Wildlife	12	12.37%
Total open space measures	77	79.38%
Funding mechanisms		
Measures proposing a tax	74	76.29%
Measures proposing a bond	23	23.71%

Compiled from the TPL conservation referendum database. Jurisdictions that held more than one referendum show up more than once

*Some counties and municipalities held more than one referendum during the time period studied. In these cases, the referenda characteristics differ, but the place-based ones do not

impacting the appearance and success of referenda in such places are likely to fundamentally differ from those at the county or municipal level. Thus, such observations are removed from the data set analyzed below. Summary statistics for the referenda analyzed are presented in Table 1. The time period of interest centers around the 2000 Census, the primary source of demographic data (USCB 2013). Additional data come from several sources including the National Conservation Easement Database (NCED 2017), Colorado Open Lands (COL 2017), the Colorado Department of Local Affairs (CDOLA 2017a, b), and the Western Rural Development Center (WRDC 2009).

In addition to the descriptive statistics provided in Table 1, a map of referenda aggregated at the county level is presented (Fig. 2). This map identifies counties where at least one jurisdiction passed more than one conservation referendum, counties where only one such measure passed, counties that held but did not pass any conservation initiatives, and counties where these referenda did not appear during the time period analyzed. Most counties along the Front Range (see Fig. 1) held at least one referendum. However, there is not a clear pattern of support, as some passed multiple conservation measures, while others passed none. A similar trend is present in the central Rocky Mountains, stretching south from Routt through Gunnison County. With the exception of counties along the lower Arkansas River watershed (Crowley and Otero counties east through Prowers), all counties which passed conservation referenda are either in high amenity areas

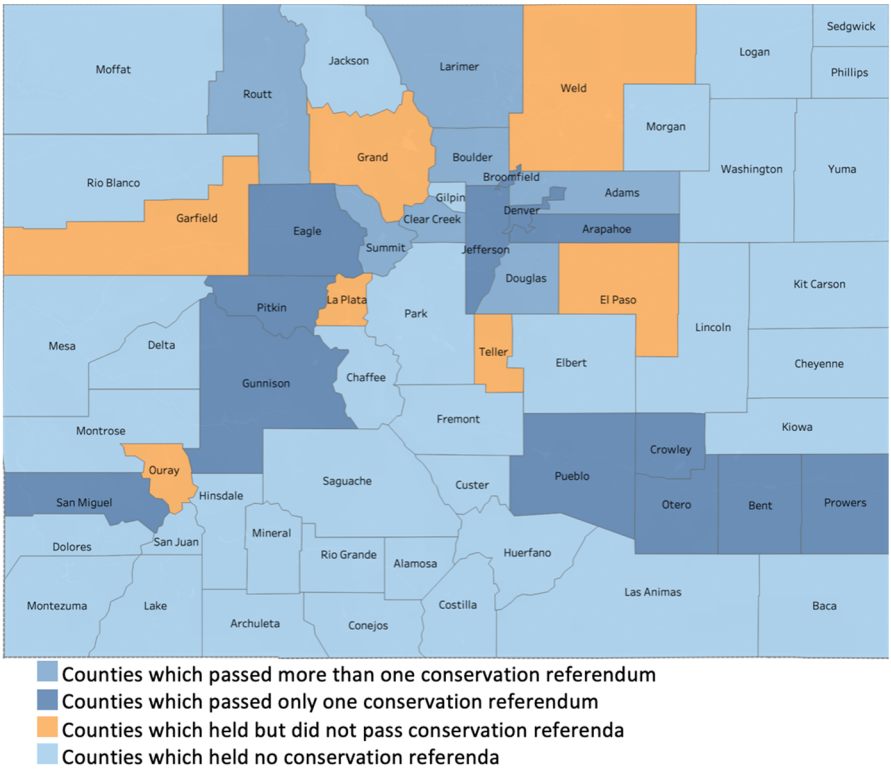

Fig. 2 Conservation referenda in Colorado counties. *Note* Counties which held county-level or municipal-level conservation referenda, 1995–2005

(pressure from tourism and vacation homes[3]) or are densely populated (pressure from urban growth[4]).

3.2 Variables

One goal of this research is the identification of regional differences (if they exist) in the factors affecting support for conservation referenda. By analyzing the same approximate time period as Kotchen and Powers (2006), Nelson et al. (2007), Banzhaf et al. (2010), and Heintzelman et al. (2013), the comparative lessons drawn from this study are particularly germane, especially regarding spatial impacts, a mostly unexplored topic in the literature.

[3] As indicated by the following county-ski resort pairings: Routt-Steamboat Springs, Eagle-Vail, Summit-Breckenridge, Pitkin-Aspen, Gunnison-Crested Butte, San Miguel-Telluride.

[4] Nearly all counties holding referenda outside the central Rockies and lower Arkansas watershed are along the Front Range.

3.2.1 Appearance model

In order to verify potential differences, we use previous studies to identify controls and drivers of referenda appearance and success. Control variables are addressed first. A number of studies suggest support for referenda varies with community population (Howell-Moroney 2004a; Kline 2006; Kotchen and Powers 2006; Nelson et al. 2007; Shanahan 2010) and population density (Kline 2006; Kotchen and Powers 2006; Nelson et al. 2007; Heintzelman et al. 2013). We include both, assuming they are proxies for perceived development pressure.

Another concern is whether pre-existing differences in levels of support for conservation affect outcomes. To account for this, support prior to the time period studied is analyzed. The Trust for Public Lands referendum database (TPL 2017), the National Conservation Easement Database (NCED 2017) and conservation easement data from Colorado Open Lands (COL 2017) allow for the development of an indicator variable identifying any type of conservation support, in the form of previous referenda or conservation easements, existing prior to the time period considered. Since demand for open lands should theoretically decrease as supply increases, a variable measuring the proportion of county land owned by the federal government (WRDC 2009) appears as well.

Research also indicates governance type impacts the appearance of referenda (Banzhaf et al. 2010; Beaghen 2013). Data on jurisdictional governments from the Colorado Department of Local Affairs (CDOLA 2017b) identify the two primary forms of local government. Statutory Rule limits Colorado jurisdictions to exercising powers specifically designated to them by state law. Home Rule jurisdictions, on the other hand, may adopt their own laws regarding municipal matters, so long as they do not violate state or federal statutes. During the time period analyzed, Statutory Law required a referendum to be accompanied by a petition signed by at least 5% of the registered voting population in order to be eligible for ballot inclusion (CRS 2016). Home Rule jurisdictions may vote to change this threshold, influencing the likelihood of referendum appearance in the process. In 2000, 98 jurisdictions (more than 1 in 4) had a Home Rule Charter. Thus, a control for governance type also appears in the analysis.

The variables discussed above (total population, population density, pre-existing support, an indicator identifying whether or not a jurisdiction is under Home Rule charter or statutory law, and the proportion of federally owned land) serve as controls for the appearance model. Of interest to policymakers are the socioeconomic factors relating to support for conservation, how this support changes over time, and what referenda characteristics are associated with support.

First, because referenda allocate public funds toward conservation, it is possible families with children perceive such efforts as competing with education programming, potentially leading to lower levels of support in places with a larger proportion of children. Several nationwide studies identify such results (Kotchen and Powers 2006; Banzhaf et al. 2010). However, in New Jersey, Heintzelman et al. (2013) find the opposite effect, highlighting the need to better understand how these impacts vary by region. Studies also indicate higher proportions of white voters decrease support for open-space referenda (Banzhaf

et al. 2010). In the Rocky Mountain West, Shanahan (2010) found the same, but Howell-Moroney (2004b) identified an opposite effect in the Delaware Valley outside Philadelphia.

In terms of unemployment, the nationwide study by Nelson et al. (2007) finds higher levels of support are associated with lower levels of unemployment. Several national studies also indicate higher levels of support in communities with higher levels of educational attainment (Kline 2006; Nelson et al. 2007; Banzhaf et al. 2010), findings reinforced by regional studies from the Northeast (Solecki et al. 2004; Heintzelman et al. 2013). Interestingly, Shanahan (2010) uncovers the opposite effect in the Rocky Mountain West.

Nationally, Nelson et al. (2007) identify a positive correlation between higher levels of income and higher likelihood of referendum appearance. Kahn and Matsusaka (1997) and Kline (2006) provide evidence the environment is perceived as a normal good, though it becomes inferior at the highest levels of income. This is likely because the wealthy are able to satisfy their preferences for goods such as open space through private ownership and access. In the Rocky Mountain West, Shanahan (2010) finds support and income levels are positively correlated, as does Kotchen and Powers (2006) in Massachusetts.

Kotchen and Powers (2006) also find referenda are more likely to appear in jurisdictions which experienced recent population growth. Given that Colorado voters responded to their state's increasing development pressure by allocating nearly 4 times the dollar amount to conservation via referenda (compared to New Jersey), population growth is also integrated. The share of publicly owned lands may also affect appearance, but the expectation is ambiguous: (1) If there are already high supplies of public lands, diminishing marginal utility suggests low interest in conserving more, or (2) those drawn to living in areas with public lands may signal interest in supporting further conservation of land.

The appearance model also includes socioeconomic characteristics of a jurisdiction including the proportion of children, the proportion of white residents, unemployment rate, the proportion of residents with a 4-year college degree, median household income, and population growth rate. These variables and the controls discussed above are summarized in Table 2.

Finally, following the work of Heintzelman et al. (2013) identifying both the existence and impact of spatial spillover effects between proximate jurisdictions, an indicator variable equal to one if any other jurisdiction in a given county passed a referendum during the time period analyzed is included. Due to the nested nature of the geographies in this study (municipalities inside counties), it is not feasible to utilize a traditional spatial econometric model. Instead, the indicator variable captures spatial spillovers by identifying whether or not jurisdictions in counties where other conservation referenda have passed are more likely to hold and pass referenda. While this technique comes with limitations (e.g., it does not capture spillovers across county lines), it can account for spillovers between non-neighboring jurisdictions.

Table 2 Variables in appearance model

	Mean	SD	Min	Max
Dependent variable (1 if referendum appeared in jurisdiction, 0 otherwise)	0.26	0.44	0	1
Variables of interest				
Proportion children*	0.25	0.06	0.07	0.39
Proportion non-Hispanic white*	0.88	0.10	0.47	1
Unemployment rate*	0.03	0.02	0	0.13
Proportion of residents with 4-year college degree*	0.17	0.11	0	0.48
Median household income ($000's)	41.22	17.94	14.21	190.81
Population growth rate (1990–2000)	0.37	0.36	−0.23	1.93
Control variables				
Total population (000's)	30.41	84.38	0.01	554.64
Population density (000's/sq. mi.)	1.18	1.16	0.00	8.24
Prior policy support indicator (1 for existence of *any* referendum *or* conservation easement prior to time period analyzed, 0 otherwise)*	0.16	0.36	0	1
Proportion publicly owned land	0.41	0.27	0.00	0.96
Governance type (Statutory Law = 1, Home rule = 0)	0.66	0.47	0	1
Spatial variable				
Within county support indicator (1 if *any* jurisdiction within the same county passed a referendum at *any* point during the time period analyzed, 0 otherwise)	0.48	0.50	0	1

*Variables also included in passage model

3.2.2 Passage model

To properly investigate likelihood of passage, several overlapping and unique socio-economic characteristics require consideration. Following Heintzelman et al. (2013), proportion of children, proportion of white voters, educational attainment level, unemployment rate, and pre-existing support all impact support for conservation. Banzhaf et al. (2010) noted there may be fundamental differences in voting patterns between county and municipal jurisdictions, so an indicator variable for municipal referenda is included. Finally, the TPL database indicates only 22 referenda appear on Colorado ballots between 1988 and 1995. By contrast, between 1995 and 2005, 112 such referenda appear. To control for the fact that some support for these referenda may be solely due to their increasing popularity, a time trend variable, assigned a monotonically increasing value from 1995 on, is included.[5]

As indicated in Table 1, the majority of Colorado referenda between 1995 and 2005 focus, at least in part, on open space conservation, and such designation may

[5] Ideally, we would also control for the money allocated through referendum. Whereas the TPL database contains full information on the characteristics discussed below, it does not contain all cost estimates. Although a concern, previous research (Nelson et al. 2007) found that outcomes were not affected by the cost of the referendum.

affect passage. While this indicates strong support for open space, it is less clear how the addition of other, commonly bundled amenities such as agricultural land, water, or wildlife affect support. Thus, three indicator variables denoting inclusion of the word(s) 'wildlife,' 'ranch'/'farm'/'farmland,' and 'water'/'watershed,' respectively, in ballot wording are created to investigate bundling of these amenities with open space. For example, if a referendum mentions preserving open space by purchasing development rights for a ranch, then the 'ranch'/'farm'/'farmland' interaction variable equals one. If the referendum merely mentions purchasing the ranch without identifying open space preservation as an objective, or if a referendum solely mentions conserving open space without addressing agriculture uses, the variable is zero. Additionally, an indicator variable is included identifying all referenda failing to mention open space. The excluded category includes more generic open-space referenda not specifically mentioning agriculture, wildlife, or water. Because most referenda mentioning open space passed, a delineation of other bundled attributes may uncover more nuanced motivators of support for conservation referenda.

Results from several nationwide studies indicate funding mechanisms matter: Referenda funded by bonds, as opposed to tax increases, are more likely to pass (Nelson et al. 2007; Banzhaf et al. 2010). Thus, an indicator variable identifying bond-funded initiatives is included. Finally, two additional indicator variables will capture changes in likelihood of passage over time. The first denotes any jurisdiction holding, whether it passed or not, any prior conservation referenda during the time period analyzed. The second denotes any jurisdiction passing a prior referendum (Kotchen and Powers (2006); Heintzelman et al. (2013)). Finally, a spatial indicator accounting for impacts of spillovers in support for conservation between jurisdictions in the same county is included. Table 3 displays a description of all variables incorporated into the passage model.

4 Methods

Using the data described above, Colorado jurisdictions holding conservation referenda are compared with those that did not to determine factors associated with appearance of such referenda. It is not possible to identify the actual probability of a jurisdiction holding a referendum; it is only possible to observe whether or not one was held. The dependent variable in the appearance model is assigned a one-for-all jurisdiction holding a referendum and a zero otherwise. Assuming the error terms are normally distributed, the probability the jurisdiction puts an initiative on the ballot can be written as follows:

$$\Pr(X = 1|\mathbf{Y}) = \boldsymbol{\Phi}(\beta^{T}\mathbf{Y})$$

Here, $\Phi(\bullet)$ is the cumulative normal distribution function, X is a vector whose entries are one if a jurisdiction holds a referendum and zero otherwise, $\mathbf{Y}$ is a matrix of descriptive variables presented in Table 2, and β is a vector of estimated coefficients. This is the first hurdle a referendum must clear: In order to be voted on, it must first appear on a ballot.

Table 3 Variables in the passage model

	Mean	SD	Min	Max
Dependent variable (log-odds: natural log of yes votes divided by one minus yes votes)	0.25	0.50	−1.16	1.44
Variables of interest				
Bond indicator (1 if referendum is bond funded, 0 for *any* other funding mechanism)	0.24	0.43	0	1
Wildlife × Open Space Indicator (1 if referendum wording includes both 'wildlife' *and* 'open space,' 0 otherwise)	0.12	0.33	0	1
Farm × Open Space Indicator (1 if referendum wording includes both 'farm'/'farmland'/'ranch' *and* 'open space,' 0 otherwise)	0.07	0.26	0	1
Water × Opens Space Indicator (1 if referendum wording includes both 'water'/'watershed' *and* 'open space,' 0 otherwise)	0.06	0.24	0	1
No open space indicator (1 if referendum does not mention 'open space,' 0 otherwise)	0.21	0.41	0	1
Repeat referendum indicator (1 if the jurisdiction held *any* prior referenda during the time period analyzed, 0 otherwise)	0.38	0.49	0	1
Prior passage indicator (1 if *any* prior referendum held in the jurisdiction passed, 0 otherwise)	0.27	0.45	0	1
Control variables**				
Jurisdiction (1 if jurisdiction is municipal, 0 if county)	0.63	0.49	0	1
Time trend	5.47	2.99	1	11
Spatial variable				
Within County Support Indicator (1 if *any* jurisdiction within the same county passed a referendum at *any* point during the time period analyzed, 0 otherwise)	0.48	0.50	0	1

**Controls also include all starred variables in Table 2

The second hurdle is passage. Factors affecting passage are determined using the log-odds model (derived from Deacon and Shapiro 1975):

$$\mathcal{L}_i = \ln\left(\frac{P_i}{1-P_i}\right)$$

where P_i is the proportion of yes votes the ith referendum received. The model takes the following form:

$$\mathcal{L} = \gamma^{\mathrm{T}}\mathbf{Z} + \varepsilon$$

Here, $\mathbf{Z}$ is a matrix of independent variables including those starred in Table 2 and all in Table 3, γ is a vector of estimated coefficients, and ε is the vector of residuals. These models are estimated both independently and jointly. The latter, known as the Heckman two-step process, accounts for potential selection bias (discussed below). In this case, $\mathbf{Z}$ contains an additional variable known as the Inverse Mills Ratio (IMR). Each model is estimated both with and without the spatial dependence variable.

Following Kotchen and Powers (2006), Nelson et al. (2007), and Banzhaf et al. (2010), the Heckman two-step process is used to link the probit and OLS models to account for the potential linkage between jurisdictions holding and passing conservation referenda. To account for this potential bias, an IMR is estimated from the first-stage probit results. The IMR provides a measure of where each jurisdiction in the state falls along a likelihood of appearance continuum, and controls for variability between selecting and non-selecting jurisdictions; it also determines whether selection bias is statistically significant. Both stages also build on the work of Heintzelman et al. (2013), exploring the existence and implications of spatial spillover effects between jurisdictions. Because some geographies are nested (municipalities inside counties), spatial accounting controls for variability over larger geographies (counties) through a dummy variable, an approach recently adopted in regional work (Conroy and Weiler 2015).

Finally, all estimates discussed below are obtained using White's Heteroscedasticity Consistent standard errors. Multicollinearity is addressed by calculating variance inflation factors (VIF's). The general rule of thumb is any variable with a VIF less than 10 retains sufficient explanatory power. None of the VIF's in any of the three preferred models exceed 5.

5 Results

5.1 Outcomes

The appearance and passage models are estimated under three specifications. The first specification (Model #1) is the Heckman two-step process (discussed above) where the spatial variable is not included. No selection bias is found, indicating the two stages can be estimated independently. Because marginal effects are much easier to interpret in a linear setting, in the next two specifications (Model #2 and

Model #3) appearance is modeled using a linear probability model (LPM) rather than a probit model. In both cases, because selection bias is not present, the IMR is not included as an explanatory variable. The second specification (Model #2) simply repeats the Heckman two-step model but with the LPM and without the IMR. To control for spatial spillover effects, Model #3 includes the spatial variable in both stages but is otherwise identical to Model #2. Each model is divided into two stages. The appearance stage is labeled with an 'a' (e.g., Model #1a) and the passage stage with a 'b' (e.g., Model #1b). As a robustness check, these models are estimated under a battery of other specifications (see "Appendix" for discussion). Tables 4 and 5 compare results from the three specifications.

The pseudo-R^2 in Model #1a is on par with the explanatory power of previous models. With the exception of income, replacing the probit with an LPM (Model #2a) makes the impact of each variable of interest more positive. Inclusion of the spatial variable (Model #3a) increases explanatory power and diminishes the effect of the proportion of white voters (below the 10% level). The magnitudes fluctuate slightly, but direction and sign of most variables of interest remain relatively steady. Only education appears to have a large and significant impact on conservation referendum appearance. Weaker results related to race are consistent with previous studies finding the proportion of white voters is negatively correlated with appearance (Banzhaf et al. 2010; Heintzelman et al. 2013). Additionally, it is important to note the strong significance of the spatial variable, though small in impact: The likelihood of a referendum appearing in a county where another jurisdiction held a similar referendum is 0.19% higher than if no previous initiative appeared.

Policymakers should be aware that communities in the West whose racial composition is becoming more diverse, especially if highly educated, appear more likely to support conservation ballot initiatives. However, upon accounting for spatial spillovers, the impact of racial composition becomes insignificant, indicating there may be a more nuanced story to uncover.

Though control variables are not a key focus, it is worth noting larger communities are (slightly) more likely to hold referenda. Prior policy support also has a positive impact on likelihood of appearance, suggesting some communities may have strong and persistent preferences for conservation. Finally, confirming Banzhaf et al. (2010), it appears Home Rule charter decreases the likelihood of referenda appearance in the state of Colorado.

Results from the passage model are in Table 5. The model's explanatory power jumps more than 8% upon accounting for spatial dependence (Model #3b). Coupled with the spatial variable's high level of significance, this suggests spillover effects play an important role in explaining conservation referendum support. Here, addressing open space and farmland via conservation referenda no longer plays a significant role in determining outcomes, counter to Heintzelman et al.'s (2013) findings in New Jersey. Since the base comparison for referenda characteristics is all open-space referenda not specifically mentioning 'agricultural land,' 'water,' or 'wildlife,' findings suggest addressing linkages with water and open space reduces likelihood of passage, while directing them toward wildlife and open space increases it. Results from the spatial specification also indicate specifically focusing efforts

Table 4 Appearance model marginal effects

	Model #1a	Model #2a	Model #3a
Model	Probit	LPM	LPM
	(2-Step)	(Independent)	(Spatial)
$p > \text{Chi}^2$, $p > F$	0.000	0.000	0.000
(Pseudo) R-squared	0.4524	0.4524	0.4782
Variables of interest			
Proportion children	−0.2038	−0.1409	−0.15
	(0.3966)	(0.3752)	(0.3773)
Proportion white	−0.4278*	−0.305*	−0.2674
	(0.2411)	(0.1644)	(0.1646)
Unemployment rate	−1.4042	−0.7703	−0.7741
	(1.3779)	(0.9007)	(0.9615)
Proportion with 4-year college degree	1.1322***	1.5064***	1.2112***
	(0.2577)	(0.3238)	(0.3323)
Median household income	−0.0004	−0.0005	−0.0012
	(0.0012)	(0.0019)	(0.0018)
Population growth rate	−0.0115	0.0088	0.0158
	(0.0503)	(0.0586)	(0.0581)
Control variables			
Total population	0.0012***	0.0017***	0.0016***
	(0.0002)	(0.0003)	(0.0003)
Population density	0.0007	0.0073	−0.0059
	(0.0161)	(0.0184)	(0.0195)
Prior policy support	0.1018**	0.1768**	0.1491*
	(0.0476)	(0.0754)	(0.0767)
Proportion publicly owned land	−0.0375	−0.0619	−0.058
	(0.0782)	(0.0671)	(0.0651)
Governance type	−0.0965**	−0.1303***	−0.109**
	(0.0386)	(0.0457)	(0.0463)
Spatial variable			
Within county support	–	–	0.185***
	(–)	(–)	(0.0492)

White's robust standard errors in parentheses

*p value < 0.1, **p value < 0.05, ***p value < 0.01

on something other than open space increases likelihood of passage relative to more generic open-space referenda.

There are a few other results worth mentioning with regard to the passage. First, in spite of previous work suggesting bond-funded referenda are more likely to pass (Nelson et al. 2007), in the state of Colorado, the financing mechanism does not impact outcomes. Second, whereas previous work (Kotchen and Powers 2006) identified a strong relationship with prior support, this is not the case in Colorado. Third,

Table 5 Passage model marginal effects

	Model #1b	Model #2b	Model #3b
Model	OLS	OLS	OLS
	(2-Step)	(Independent)	(Spatial)
Prob > *F*	0.0077	0.0044	0.000
R-Squared	0.2503	0.2500	0.337
Variables of interest			
Bond funded	0.1276	0.1251	0.1071
	(0.1204)	(0.1209)	(0.121)
Wildlife × Open space	0.5967***	0.5962***	0.5213***
	(0.1749)	(0.1744)	(0.1667)
Farm × Open space	−0.269*	−0.2658*	−0.026
	(0.1418)	(0.1412)	(0.1965)
Water × Open space	−0.6824***	−0.686***	−0.7548***
	(0.2374)	(0.2317)	(0.2589)
Open space not mentioned	0.1561	0.1657	0.2285**
	(0.1499)	(0.1291)	(0.113)
Prior referendum held (1995–2005)	0.1335	0.1329	0.1334
	(0.1461)	(0.1446)	(0.1453)
Prior referendum passed (1995–2005)	0.0022	−0.0052	−0.0773
	(0.1666)	(0.1561)	(0.1504)
Control variables			
County-municipal indicator	−0.035	−0.0309	−0.023
	(0.1132)	(0.112)	(0.1047)
Time trend	0.0292	0.0304*	0.0381**
	(0.0178)	(0.0164)	(0.0163)
Proportion children	−0.9967	−0.9864	−0.6692
	(1.1952)	(1.1805)	(1.0789)
Proportion white	−1.7932	−1.6451*	−0.6268
	(1.3547)	(0.9605)	(1.0004)
Unemployment rate	−2.3585	−2.2532	1.5989
	(6.3823)	(6.3326)	(6.0944)
Proportion with 4-year college degree	1.3697	1.2781	0.9131
	(1.0571)	(0.8232)	(0.7782)
Prior policy support	−0.0503	−0.062	−0.0688
	(0.1461)	(0.1335)	(0.1229)
Inverse mills ratio	−0.0549	–	–
	(0.3532)	(–)	(–)
Spatial variable			
Within county support	–	–	0.649***
	(–)	(–)	(0.1827)

White's robust standard errors in parentheses

*p value < 0.1, **p value < 0.05, ***p value < 0.01

support appears unaffected by income level. Regarding control variables, the proportion of children does not impact referenda outcomes. Finally, variables significantly impacting likelihood of appearance, such as education and latent support, do not appear to affect outcomes once initiatives reach voters.

Additionally, both the lack of significance of the Inverse Mills Ratio in Model #1b and the stability of estimates between this and Model #2b corroborate previous research indicating selection bias is not likely present in the data (i.e., jurisdictions holding referenda are not fundamentally differ from those that do not). While Banzhaf et al. (2010) found incorporating IMR altered the impact of funding mechanism, this was not the case in Colorado.

5.2 Discussion

A number of these outcomes are relevant to policymakers and interested parties. First, referenda are more likely to appear in larger communities with higher levels of educational attainment and which have a policy history of supporting conservation efforts. Higher levels of education are only associated with a greater likelihood of appearance and do not seem to affect passage. This is not necessarily indicative of support for conservation, per se, but clearly indicates those who have completed a 4-year degree assign a greater value to having the entire community involved in conservation decisions. In their closing remarks, Banzhaf et al. (2010) suggest referenda may not lead to economically efficient outcomes as mean and median voter outcomes do not always align when it comes to protecting the environment (Bell et al. 2009). If so, policymakers in highly educated communities may be able to circumvent part, or all, of the referenda process by bolstering trust through transparent policy- and decision-making practices.

With regard to the specifics of referenda, this paper contributes to the existing literature by moving beyond the analysis of assuming uniform open-space referenda language (Kotchen and Powers 2006; Nelson et al. 2007; Banzhaf et al. 2010; Heintzelman et al. 2013). Referenda directing funds toward some factors complementing open space see better results (e.g., referenda geared toward conservation of wildlife habitat and open space have a higher success probability than do more general open space measures), while others (e.g., focusing jointly on water and open space) are less likely to pass. This research also finds weak evidence that referenda focused on both agriculture and open space are less likely to pass.

A number of the West's major rivers have their headwaters in Colorado including the North Platte, South Platte, Arkansas, Rio Grande, and Colorado. Thus, Colorado snowmelt provides water to 12 different states, creating some inter-state tensions. As an example, the Supreme Court has issued seven decisions (Gold 2002) regarding water disputes between Colorado and Kansas along the Arkansas River. The combined importance, complexity and reach of Colorado water may partially explain why its inclusion in a referendum decreases the likelihood of passage.[6] Results

[6] It is also worth noting that the stated purpose of many referenda addressing water conservation was 'watershed preservation.' This sort of vague wording may make outcomes less obvious to voters, especially when compared with more straightforward projects such as 'trail restoration' which have clear and tangible impacts.

suggest voters are less likely to allocate money to the conservation of agricultural land as a means of preserving open space (perhaps because of perceived private gains). It is also possible this is due to a perceived link between ranching and water,[7] leading to similar responses to both at the polls.

Regarding passage, Coloradans appear more interested in making sure conservation efforts occur and are less concerned with how they are funded. This implies decision-makers should focus on outcomes rather than the exact financing mechanism. Second, it appears voters are less interested in allocating funds to help conserve resources related to human land use (i.e., water and agricultural land), and more interested in conserving the natural world (i.e., wildlife habitat). Policymakers should keep this in mind when framing conservation efforts. Additionally, focusing conservation efforts on specific outcomes, beyond the generic open space focus, garners more support, so efforts of decision-makers who carefully and intentionally target their conservation programs are more likely to be effective.

5.3 Regional differences

This research also identifies a number of regional differences between the Rocky Mountain West and the Northeast. Previous research in Delaware Valley counties in both Pennsylvania and New Jersey identifies a positive relationship between the proportion of white voters in a jurisdiction and support for conservation: The opposite effect is found in Colorado jurisdictions. Studies of both New Jersey (Solecki et al. 2004) and Massachusetts (Kotchen and Powers 2006) residents find a positive relationship between income levels and support for conservation, but in Colorado no such effect appears to exist. Results from Heintzelman et al. (2013) indicate support for conservation increases with proportion of children in a community, and again, no such effect is found in Colorado. In other words, Colorado voters appear to support conservation efforts regardless of household income level and any perceptions that open-space referenda compete with educational funding does not systematically shift these preferences.

Further, multiple studies in the Northeast indicate support for these referenda attenuates as more initiatives appear on a given jurisdiction's ballot (Kotchen and Powers 2006; Heintzelman et al. 2013). In addition to being uniform across the income spectrum, support in the Rocky Mountain West also appears to persist more strongly over time. In general, Colorado voters seem to view conservation as an ongoing effort and not a one-off event.

Although both Heintzelman et al. (2013) and Duke and Aull-Hyde (2002) find support for allocating conservation funds toward wildlife, as is also found in Colorado, most other characteristics affecting referendum passage differ between the two regions. For instance, in the Northeast, Duke and Aull-Hyde (2002), Kotchen and Powers (2006), and Heintzelman et al. (2013) determine that directing conservation funds toward agriculture increases the likelihood of passage, and the opposite was

[7] Most Colorado agriculture relies on water fed through systems of diversion canals and the state's farmers own in excess of $6 billion dollars in water rights (Graff et al. 2013).

found in Colorado. Similarly, Duke and Aull-Hyde identify support for conservation as a means of preserving water quality, but the inclusion of such language has a strongly negative effect in Colorado. Finally, this study identifies the existence and impact of spatial spillovers in the Rocky Mountain West, a pattern already identified in the Northeast (Heintzelman et al. 2013). While it is likely this pattern carries across the entire country, this remains to be confirmed at the national scale.

6 Conclusion

This paper sheds light on some of the socioeconomic and specific referenda characteristics associated with appearance and passage of conservation initiatives in Colorado between 1995 and 2005. There are four primary goals to this research. First, it provides policymakers in the Rocky Mountain West with a better sense of the community characteristics associated with the appearance of conservation referenda on ballots. Second, because the vast majority of these referenda focus on open space, this study takes the unique approach of investigating the interaction of other amenities bundled with open space to paint a more nuanced picture of specific natural resources Colorado voters are interested in conserving. Third, the research contributes to the academic understanding of referenda analysis by identifying and confirming the presence and impact of spatial spillovers in Colorado: Only one previous study (Heintzelman et al. 2013), focused solely on New Jersey, investigates such patterns. Additionally, this paper contributes to the regional economics literature by providing a comparison of how drivers underlying the support for land conservation referenda in the Western USA compare to the Northeast.

The primary finding is that conservation referenda in the West are more likely to appear in larger, better educated communities, where support already exists in the form of other conservation policies. Of the referenda that appear, those with the highest likelihood of success focus on the combination of open space and wildlife habitat or they address specific conservation issues not related to open space. Referenda least likely to pass focus on conservation issues related to water and agriculture. Additionally, accounting for spatial spillovers indicates jurisdictions in counties where any other jurisdiction passed a referendum during the time period analyzed are more likely to see and pass conservation referenda.

Numerous regional differences are also brought to light by this study. In the Northeast, prior research indicates communities with a higher proportion of children exhibit lower levels of conservation support, while those with higher levels of income tend to show more support. Further, each additional initiative appearing on a ballot in the Northeast has a lower likelihood of passing than the previous one. In Colorado, by contrast, jurisdictions place similar value on conserving natural resources regardless of demographic composition.

Whereas targeting the conservation of water or agricultural land appears to increase support for referenda in the Northeast, it does the opposite in the West. Voters in Western states like Colorado may believe the agricultural lobby is strong enough to support farmers and deem further measures unnecessary. In the Northeast, on the other hand, there is limited open space and limited land suitable for

farming. Residents of this region, therefore, may be inclined to focus the how these issues complement one another and deliver their support accordingly. In any case, given the importance of agriculture to both the West's economy and culture, this relationship should be the focus of further research. Continued research in this area should also focus on regional differences. A more robust understanding of regional variation in public support for conservation better enables policy makers and advocates achieving the greatest impact possible by optimally using their limited policy making and programming resources.

Population growth and changing demographics in Colorado, and the Rocky Mountain West, show no sign of slowing. Interest in conservation of resources such as open space, soil, wildlife and water remains high. Thus, it is as important as ever for policymakers to remain finely attuned to the public's support for conservation efforts, especially in rapidly growing urban areas. This research offers an initial look at factors affecting appearance and passage of conservation referenda on ballots across Colorado and identifies the need for further research in this area.

Appendix: Robustness checks

The model was run under a battery of different specifications in order to determine the stability of its results. Eight different primary specifications were chosen, and the preferred models are presented above. Both spatial and a non-spatial versions of the Heckman two-step process were estimated. Neither indicated selection bias. These were followed by the exact same estimation, but without the use of the IMR (i.e., estimated independently). Following this, the spatial variable was introduced only into the appearance model and both models were again estimated independently. In the last three specifications, a binary variable was introduced that controlled for all jurisdictions which passed three or more referenda during the time period analyzed. This was estimated once using the Heckman two-step process with the spatial variable included, once estimating both appearance and passage independently with the spatial variable included, and once estimating both independently without the spatial variable included.

Under each specification, the model was estimated once as it is presented above. It was also estimated with the existing prior support variable dropped from the appearance model. It was then estimated a final time with the repeat passage and prior passage variables dropped from the passage model. These variations were estimated to see whether latent, higher, or lower support levels in a given jurisdiction affected the likelihood of appearance or passage. The results presented above are stable under nearly every specification in significance level, magnitude, and sign.

References

Banzhaf HS, Oates WE, Sanchirico JN (2010) Success and design of local referenda for land conservation. J Policy Anal Manag 29(4):769–798

Beaghen SP (2013) Selection and passage of county land preservation voter referendum: The Role of Government. FIU Electronic Theses and Dissertations. 887
Bell Jason, Huber Joel, Kip Viscusi W (2009) Voter-weighted environmental preferences. J Policy Anal Manag 28(4):655–671
CDOLA (2017a) Colorado Department of Local Affairs. Components of change-county. https://demography.dola.colorado.gov/births-deaths-migration/data/components-change/. Accessed 26 Apr 2017
CDOLA (2017b) Colorado Department of Local Affairs. Active Colorado municipalities. https://dola.colorado.gov/lgis/municipalities.jsf. Accessed 2 May 2017
CDOLA (2019) Colorado Department of Local Affairs. Special districts. https://www.colorado.gov/pacific/dola/special-districts-0. Accessed 20 Aug 2019
COL (2017) Colorado Open Lands. Conservation easements. http://coloradoopenlands.org/conservation-easements/. Accessed 6 Jun 2017
Conroy T, Weiler S (2015) Where are the women entrepreneurs? Business ownership growth by gender across the American urban landscape. Econ Inq 53(4):1872–1892
CRS (2016) Colorado revised statutes. Title I. Article 40. http://www.lexisnexis.com/hottopics/colorado/. Accessed 2 May 2017
Deacon R, Shapiro P (1975) Private preference for collective goods revealed through voting on referenda. Am Econ Rev 65:943–955
Duke JM, Aull-Hyde R (2002) Identifying public preferences for land preservation using the analytic hierarchy process. Ecol Econ 42(1–2):131–145
Gerber Elisabeth R, Phillips Justin H (2005) Evaluating the effects of direct democracy on public policy: California's urban growth boundaries. Am Polit Res 33(2):310–330
Gold HD (2002) Supreme Court struggles with damage assessment in water dispute as interstate compact breaks down. Ecol LQ 29:427
Graff G et al (2013) The value chain of Colorado agriculture. Department of Agricultural and Resource Economics and the Office of Engagement, Colorado State University
Heckman JJ (1977) Sample selection bias as a specification error (with an application to the estimation of labor supply functions). No. w0172. National Bureau of Economic Research
Heintzelman MD, Walsh PJ, Grzeskowiak DJ (2013) Explaining the appearance and success of open space referenda. Ecol Econ 95:108–117
Howell-Moroney M (2004a) What are the determinants of open-space ballot measures? An extension of the research. Soc Sci Q 85(1):169–179
Howell-Moroney M (2004b) Community characteristics, open space preservation and regionalism: Is there a connection? J Urban Aff 26(1):109–118
Kahn ME, Matsusaka JG (1997) Demand for environmental goods: evidence from voting patterns on California initiatives. J Law Econ 40(1):137–174
Kline JD (2006) Public demand for preserving local open space. Soc Nat Resour 19(7):645–659
Kotchen MJ, Powers SM (2006) Explaining the appearance and success of voter referenda for open-space conservation. J Environ Econ Manag 52(1):373–390
Loudenback, T (2016). 25 Beautiful US cities to live in if you love spending time outdoors. Business insider. http://www.businessinsider.com/best-places-to-live-if-you-love-the-outdoors-2016-6/. Accessed 13 Jul 2017
NCED (2017) National conservation easement database. NCED Easements. http://conservationeasement.us/projects. Accessed 19 Jun 2017
Nelson E, Uwasu M, Polasky S (2007) Voting on open space: What explains the appearance and support of municipal-level open space conservation referenda in the United States? Ecol Econ 62(3–4):580–593
Shanahan EA (2010) The paradox of open space ballot initiatives in the American West: A New West-Old West Phenomenon? Stud Sociol Sci 1(1):22
Solecki WD, Mason RJ, Martin S (2004) The geography of support for open-space initiatives: a case study of New Jersey's 1998 Ballot Measure. Soc Sci Q 85(3):624–639
TPL (2017) The trust for public land. Land vote database. http://www.Landvote.org. Accessed 20 Feb 2017
USCB (2013) United States Census Bureau. Census 2000. http://www.census.gov/main/www/cen2000.html. Accessed 17 Apr 2017
Wilson B, Chakraborty A (2013) The environmental impacts of sprawl: emergent themes from the past decade of planning research. Sustainability 5(8):3302–3327

WRDC (2009) Wester Rural Development Center. Colorado population data. https://wrdc.usu.edu/files/uploads/Regional%20Data/CO/Colorado__CountyData.pdf. Accessed 25 April 2017