Costs of Property Rights: Capturing Rents from Timber Harvests

Colin Doran
George Mason University

Thomas Stratmann
George Mason University

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Abstract: We study the costs of protecting and capturing economic rents from a resource. Our application uses western state timber auction prices. We hypothesize that for state-run timber auctions the winning price decreases when federal or private land, as opposed to only state land, borders the harvest sale area. The lower winning bid price reflects an increase in the expected costs of protecting and capturing rents due to third party borders. We further hypothesize that the costs of protecting and capturing rents increase with conflicting resource uses. We test this hypothesis for various competing uses of harvesting timber, such as recreational use, environmental use, and scenic views. The results from both our border and our conflicting use measures consistently show that when third parties affect a harvest sale, purchasers adjust their valuation according to the expected costs of protecting and capturing rents. As a result, the winning bid price falls.

Keywords: Property Rights, Economic Rents, Resource Use

JEL code: D02, K11, P48, Q24, Q26

I. Introduction

The security and definition of a property right plays a significant role in generating its economic value.[1] When an individual or a firm purchases the rights to a good or service, their valuation derives from the expected net benefit of consuming that right. Therefore, in contexts where the rights are less precise, rights holders may incur additional costs to protect and capture the value of the good or service.[2] These additional costs reduce economic rents, and result in a lower economic value of the property right.

In this paper, we identify institutional settings in three western states—Washington, Oregon, and Idaho—that allow us to quantify the expected costs of protecting and capturing economic rents from a resource, i.e., timber. We identify variations in the property rights to harvest timber, (e.g., third party harvest borders and third party claims) that influence the expected costs of protecting and capturing rents. We use state-run timber auction price data to quantify these expected costs. We then show that purchasers of the harvesting rights adjust their valuation according to the expected costs of protecting and capturing rents, and that this causes the winning bid price to fall.

Our first test analyzes how variations in the ownership of the harvest sale area border affect the costs of protecting and capturing rents from a resource. Here, we use the fact that harvest areas on state trust land may share some, or all, of their harvest borders with third parties. The legal entities bordering harvest areas may include the state (the seller of the right to harvest

[1] See Alchian (1965), Alchian (1974), Demsetz (1967), and Barzel (1997) for a discussion on the economics of property rights. See North and Weingast (1989), North (1990), Allen (1991), Anderson and Lueck (1992), Heller (1998, 1999, & 2008), Kunce et al. (2002), Akee (2009), Libecap and Lueck (2011), Libecap, Lueck, and O'Grady (2011) for a few discussions on the nature of various property right institutions and their impact on economic value. The Anderson and McChesney (2003) volume also discusses various aspects of property rights.

[2] See the discussion in Arrow (1983) on the importance of identifying transaction costs under different contexts, and Barzel (1997) on the importance of positive transaction costs in the study of property rights. While we do not directly call the costs discussed in this paper "transaction costs," they are similar in nature to them. See Demsetz (2003) and Demsetz (2011a) who uses the concept of "positive cost of ownership" to as a way to describe transaction costs.

timber), a private owner, or the federal government. The location of the border is determined either by the layout of the state trust land, or through historical accident (e.g., where the harvest sale area borders follow a straight property line).[3] We hypothesize that when the harvest sale area shares a border with a non-state owner, the costs of protecting and capturing rents from the rights to harvest timber increase. These costs derive from protecting the rents from timber theft and lawsuits, and capturing the rents through negotiation with neighboring owners. Our model predicts that harvest areas that share a border with a non-state property, namely, privately or federally owned land, have lower winning bid prices.

Our second test analyzes how third party property right claims, arising from competing resource uses, increase the expected costs of protecting and capturing rents of the property rights. We identify variations in competing uses to some of the rights to harvest timber on state trust land. Specifically, we identify harvest areas that conflict with recreational use, environmental use, and scenic views, and then quantify how much the conflicts lower rents. Our model predicts that harvest areas that have conflicting uses have lower bid prices as a result of the expected costs from expending resources to protect and capture the highest possible rents. For Washington, we test whether harvesting timber on state recreational districts leads to lower bid prices. For Oregon, we test the effect of a November 2011 Oregon State Land Board-approved plan to increase clearcutting in Elliot State Forest. The approval of this plan changed the legal landscape, resulting in lawsuits and protests to prevent timber companies from executing their purchased rights, as well as preventing auctions from taking place. For Oregon and Idaho, we test whether clearcut timber harvesting that affects a neighbor's viewshed leads to lower prices. We use Geographical Information Systems (GIS) to determine whether an auction is in a neighbor's viewshed. For Idaho, also test our hypothesis on data created by the Federal Government and State of Idaho that

[3] Since some of the trust land was endowed at statehood, this allows for some exogeniety in the ownership.

describes areas based on the quality of their scenic views.

The findings presented in this paper show that property rights to harvesting timber, when affected by third party borders or third party conflicting uses, lower the winning bid price. Overall, the findings are consistent with the hypothesis that timber auction prices vary inversely with the costs of protecting and capturing rents from timber, and that the winning bid prices reflect the increased costs. The results show that the winning bid price decreases in Washington, Oregon, and Idaho when a harvest sale area borders private and federal land. Moreover, the results report evidence that the winning bid price decreases when harvest areas have competing uses, such as recreational, environmental, or scenic value. For example, following an approved plan in Elliot State Forest to increase clearcutting, bid prices for the State Forest decreased by over twenty percent, as environmentalist and conservation groups filed lawsuits and staged public protests to prevent increased clearcutting.

Sections II and III describe the relevant institutions in our study. Specifically, these sections describe the historical development of state land ownership and the state timber auctions. Section IV presents our theory and hypotheses, along with a discussion about the costs associated with capturing and protecting rents from property rights. In Section V, we present our empirical models, and in Section VI, we describe the data. Section VII presents and discusses the empirical findings, and Section VIII presents our concluding remarks.

II. The Origin of State Trust Property Rights

The Land Ordinance of 1785 instituted the origins of the property rights system used today in Western states (Carstensen 1988; Donaldson 1881, 178). The system is known as the rectangular survey system, and it assigned property rights through a system of identical squares—"sections"—numbered 1-36 (Carstensen 1988; Donaldson 1884, 576; Gates 1968, 65; Culp, Laurenzi, Tuell, and Berry 2015, 9).[4] Each section was one square mile, or 640 acres, and a township consisted of the 36 sections forming a six-by-six grid (Donaldson 1884, 178, 576–77; Gates 1968, 65; US Department of the Interior: Bureau of Land Management 1991). The Land Ordinance stated that one section, the 16th section, was to be allocated to the state governments to support their public schools. Later, in 1848, the Oregon Territory Act added Section 36 to the state endowment (Donaldson 1884, 224-26; Gates 1968; 289–90; Culp et al. 2015, 8-9).[5]

The property owned by Western states today consists of a mix of geographically scattered ownership. Along with the federally endowed 16th and 36th sections in each township, these states own larger blocks of land that include multiple adjacent sections that the federal government granted for various other reasons, such as establishing colleges, universities, and public buildings (Donaldson 1884, 228–31; Gates 1968, 336, 804–6).[6] In some state regions, state ownership has assumed a checkerboard pattern due to the federal government—in the Pacific Railroad Acts of 1862, for example—granting land to railroad companies to build railroad tracks (Donaldson 1884, 267; Chavez 1987; Roberts 2011; Billings 2012). As a result of these historical developments, some of the state's trust land remains fragmented.

[4] Most land systems in the original colonies were a system of metes and bounds. The system mainly used today and adopted for the Western states is known as a rectangular survey system (Carstensen 1988; Gates 1968, 64; Culp et al. 2015, 8-9). See Libecap and Lueck (2011) for a comparative institutional study on the two systems.
[5] Some states received sections 2, 16, 32, and 36 (Culp et al. 2015, 9). In our, study the states were endowed sections 16 and 36.
[6] The scattered state-owned land consists mainly but not exclusively of sections sixteen and thirty-six of each township.

States have been attempting to reduce land fragmentation through land exchanges, purchases, and transfers. The purpose of these exchanges is to create larger blocks of ownership (Culp et al. 2015, 32).[7] The stated goal of Oregon's "Land Acquisition and Exchange Plan," for example, is to consolidate its forestland to increase efficiency and revenues derived from state-owned land.[8]

Figure 1a shows a map indicating state trust land in Washington. Figures 1b and 1c show maps of state trust land for Oregon and Idaho. The black areas in all three maps indicate the state trust land.[9] In some areas in Washington, including the eastern side of the state, the state ownership of sections 16 and 36 led to a scattered pattern of ownership, and consequently non-state ownership surrounds each section of state land.[10] In other areas in Washington, such as the northwest, the state owns large blocks of land that include multiple adjacent sections; however, there are still remnants of scattered land in that area. In Oregon, the state only owns about one-fourth of its original trust land due to a state policy that sold the land to private owners following statehood (Culp et al. 2005, 122). The Washington and Idaho maps depict some scattered ownership patterns throughout the state due to their federal endowment of sections 16 and 36. As compared to Washington and Idaho, the state trust land in Oregon that was not sold displays a less scattered pattern due to land exchanges.[11]

[7] See the Washington Department of National Resources trust land map for more information: http://file.dnr.wa.gov/publications/eng_rms_trustlands_map_nu2.pdf.
[8] An example of an Oregon Land Acquisition and Exchange Plan: https://www.oregon.gov/ODF/Documents/AboutODF/WestOregonDistrictExchangePlan.pdf.
[9] The source of the three state's GIS maps are from each state land or forestry department: Idaho's Department of Lands (IDL), Oregon's Department of Forestry (ODF), and Washington State's Department of Natural Resources (WADNR). We created the maps using ArcGIS.
[10] The federal government granted Oregon statehood in 1859, Idaho statehood in 1890, and Washington statehood in 1889. All three state's endowment included sections 16 and 36 (Gates 1968, 308-314; Culp et al. 2015, 53).
[11] The large blocks of land shown on the Western Coast of Oregon are three of their six state forests: Elliot State Forest, Clatsop State Forest, and Tillamook State Forest.

III. Trust Land Uses and Timber Auctions

By state laws, state trust lands are managed to maximize revenue, or maximize long-term financial gains, for the states' residents.[12] States implement these laws by managing their lands for different uses, such as grazing, minerals, timber, conservation, commercial, and farming.[13] In Washington, Oregon, and Idaho, portions of their state trust lands include high-value timber (Culp et al. 2005, 56). All three states hold auctions to sell the rights to harvest timber on their trust lands to the highest bidder, and their timber sales represent the largest portion of their state trust land revenues (Culp et al. 2015, 56-61). For example, in 2013, timber sales amounted to 80.8 percent of Idaho's trust-land revenue.[14]

Timber sales are managed by state departments: Washington State's Department of Natural Resources (WADNR), Oregon's Department of Forestry (ODF), and Idaho's Department of Lands (IDL). The timber sale revenues cover each department's overhead costs; the remainder is earmarked for state activities such as administrating their public school systems.[15] The amount of land managed for timber sales varies by state.[16] The WADNR manages 2.1 million acres of

[12] For Washington see: Wash. AGO 1996 NO. 11 (Wash.A.G.), 1996 WL 463034; For Oregon see: OR CONST Art. VIII, § 5; 46 Or. Op. Atty. Gen. 468 (Or.A.G.), 1992 WL 526802. For Idaho see: ID CONST Art. IX, § 8; https://www.idl.idaho.gov/land-board/lb/documents-long-term/history-endowment-lands.pdf.

[13] This is not an exhaustive list. State agencies lease the land for various other uses (Culp et al., 2015, 16–20).

[14] In Washington the figure is 55.3%, and in Oregon, the figure is 33.5% (Culp et al., 2015, 59 & 61).

[15] Some of the beneficiaries of the revenue from timber-auction revenue include universities, hospitals, penal institutions, and common (public) schools. In Oregon, all additional revenue goes to public and common schools (Culp et al. 2015, 20). Additionally, each of the three states is divided into geographical areas in which state officials manage trust land. The WADNR divides Washington into six regions, ODF divides Oregon into nine forest management areas, and IDL divides Idaho into ten supervisory areas. An institutional difference between the states is that in Washington and Idaho areas are set up to oversee various uses of state land, not just timber auctions. The ODF districts are set up to manage timber.

[16] Information in the current section was gathered through correspondence with officials at the department that runs the state timber auctions, and also through each state's webpage. Idaho: Idaho Department of Lands: https://www.idl.idaho.gov/. Washington: Washington State Department of Natural Resources: http://www.dnr.wa.gov/. Oregon: Oregon Department of Forestry: http://www.oregon.gov/ODF/.

forestland, ODF manages 745,000 acres, and IDL manages 1 million acres.[17] Each state department follows a plan that considers factors such as harvesting time, roadwork, reforestation after the harvest, and other potential uses of the land, such as recreation. At the ODF, for example, state officials draft an annual operations plan, which they send to several resource specialists for review. The resource specialists decide on a case-by-case basis whether to auction the land for harvesting.

Once an auction area is determined, forestry staff administers it. For example, staff cruises the harvest area, designs maps for the auction prospectuses, and determines the harvesting method.[18] Criteria such as yarding distances, timber size, harvesting costs, silvicultural treatments, topographic limitations, existing roads, forest-site disturbance, and the Forest Practices Act help determine the harvesting method proposed by the staff.[19]

The rectangular survey system design, as well as historical accidents — land acquired throughout statehood, early developments (i.e., railroads, canals), and homesteading (Donaldson 1884, 332–56; Gates 1968, 393–95) — means that frequently the harvest area borders non-state property, and the property line cuts through large blocks of trees. Additionally, through deliberate attempts to consolidate land, motivated by the aforementioned state land exchanges and purchases, some timber sales occur in areas surrounded entirely, or generally, by state-owned land. If the harvest borders a non-state property, the forestry staff marks the harvest area,

[17] The state owns 5.1 percent, or roughly 2.4 million acres, of land in Idaho: https://www.idl.idaho.gov and https://www.legislature.idaho.gov. The state manages roughly 5.6 million acres of land in Washington. http://publiclandsinventory.wa.gov.

[18] The two most basic methods are cable-based harvesting and ground-based harvesting. Cable-based harvesting is the preferred method for steep slopes because it pulls logs to a landing area using a stationary machine. In ground-based harvesting, a vehicle pulls the logs to a landing area. The maximum slope for ground harvesting is around 30 percent (Greulich et al. 1999; Visser and Stampfer 2015).

[19] For example, some different silvicultural treatments consist of clearcut, shelterwood, commercial thinning (Greulich et al. 1999; Visser and Stampfer 2015). Yarding distance is the distance a log is hauled from the stump to a collection point. There are three slope classes: 0 to 35 percent 35 to 70 percent, and 70 percent and higher (Greulich et al. 1999)

and occasionally negotiates property line agreements with neighboring parties. For example, at the WADNR, staff tag trees with colors indicating categories such as stream zones, leave-tree areas, and property lines.[20] Although each state has a different method of tagging, the methods are similar in that they attempt to mark the cutting area. Tagging is intended to ensure that trees are cut only within the harvest area boundary and to prevent timber trespass.

After the forestry staff devises the procedures for public auctions and advertises them, the state sells the timber harvest rights at the auctions. The ODF and the WADNR use a sealed bid auction method, while the IDL uses an oral bid method.[21] For the IDL and WADNR, interested parties submit bids for the entire sale, but at the ODF, interested parties bid for the highest-valued tree species.[22]

IV. Theory, Application, and Hypotheses

Well-defined and secure property rights provide the "ability to freely exercise a choice over a good or service" (Allen 1999, 898).[23] If a property right is perfectly secure and perfectly defined, there are no costs to protecting or to defining the right. In this case, the property right is complete.[24] The expected economic rent from ownership is maximized.[25] Consequently, holding

[20] Some property lines have survey monuments and do not need tagging. Others that are not tagged may have cutting-line agreements in which the landowner signs a contract with the bordering state agency agreeing to a tree line. Areas where trees are left standing in a unit are known as leave tree areas. They are designated by the state.
[21] See Athey et al. (2011) on the difference between sealed and open auctions in timber auctions. Their results show that sealed bids attract more small bidders and generate higher revenue.
[22] The ODF appraises tree species values and divides trees types into "bid species" and "non-bid species." Potential purchasers bid on the "bid species" that constitute tree species over twenty percent of the total volume of timber. The rights to both the bid species and non-bid species are awarded to the highest bidder and the total sale price is the combined value of the bid and non-bid species. A few auctions in Washington have a similar structure to Oregon.
[23] See Alchian (1965), Alchian (1974), and Barzel (1997) for similar definitions.
[24] See Allen (1999, 898-899) for a short discussion on "complete property rights."
[25] Some of the costs discussed in this paper can be thought of as "transaction costs," while some may be seen as an additional production cost. See Allen (1999) on how transaction costs can include "any concomitant inefficiencies in production." See Demsetz (2011b) for his discussion on the difference between transaction costs and production cost: "A cost is a cost whether we name it transaction cost or fertilizer cost." See also Demsetz (2003, 290-1) discussing how Frank Knight would treat a transaction cost like any other cost, and Demsetz (2011a, 9-11)

all else equal, a perfectly secure and perfectly defined property right will be valued highest by an individual or a firm. Once the probability of complete ownership decreases, that is, the rights become less secure or less precise, the expected economic rent from the right decreases as the expected costs to protect the right increase. As a result of the higher expected costs, the economic rents decrease, along with the willingness to pay to own the right.

The probability of complete ownership decreases as the threat of third party conflict, or third party claims, increase.[26] A right that is more prone to conflict with others is less valued because it carries higher expected costs to protect and capture the rents. Therefore, rights that are more likely affected by third parties, i.e. resources on a property line border, or resources that have high valued alternative uses, carry higher expected costs to protect and capture the rents. The less likely the rights are to be contested, the higher the willingness to pay. The reason is that the rents derived from ownership are at, or near, their maximum.

IV.1 Harvest Borders and Rents

Timber Trespass

Timber trespass, or timber theft, is a common occurrence in the American west.[27] Timber trespass occurs when a party removes or damages timber without authorization. Public lands are targeted more often than private land, although both are susceptible to trespass (Trick 2012,

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discussing how transaction cost can be embedded in the neoclassical supply, or demand, curve and treated like any other cost. Fennell (2013, 1474-1483) questions the significance of transaction costs, and discusses how Demsetz (2003) argues: "more emphasis should be given to the conditions of ownership."

[26] Barzel (1997, 4) states: "The economic rights people have over assets (including themselves and other people) are not constant; they are a function of their own direct efforts at protection, of other people's capture attempts, occasionally of formal and informal non-governmental protection, and of governmental protection effected primarily through the pole and the courts."

[27] See Trick (2012, 396-405) for a discussion on "The Three Types of Timber Trespass," and for a full discussion of the issue of timber trespass. Also see Trick (2012, 387 & 398) for a discussion of boundary line crossing. Trick (383) states, "Timber theft is a unique and prevalent crime that occurs throughout the Pacific Northwest, a region built upon the natural resources industry that is not significantly depressed." For an overview of federal timber theft and the problems of timber trespass on federal land see Paciello, 2006.

389). Federal lands are more susceptible to timber trespass, in part due to a lack of oversight in the United States Forest Service (Paciello, 2006). In addition to drawing on academic articles documenting timber trespass (Bowser 2000; Paciello 2006; Trick 2012), we contacted forestry specialists in each of the three state agencies in our study to verify the presence of timber trespass. All contacted specialists acknowledged the presence of timber trespass in their state. For example, a timber contract specialist in Washington stated that trespass is more likely to occur when property lines have not been surveyed well, or when the harvest contract did not contain a cutting-line agreement.[28] A land specialist in Oregon noted that most timber trespass is settled out of court, and that timber trespass occurs most frequently when there is a lack of locating and marking of boundary lines prior the timber harvest. Additional evidence that timber theft is a concern comes from the fact that the United States Forest Service dedicates an entire section of its handbook to preventing, and investigating, timber trespass and timber theft.[29]

Washington, Oregon and Idaho statutes recognize the issue of timber trespass,[30] and their statutes award triple damages to the harmed party for willful trespass.[31] In the event of casual or involuntary trespass, the Washington statute awards the stumpage value, the Oregon statute awards double damages to the harmed party, and the Idaho statute awards up to three times the stumpage value.[32]

[28] A Cutting Line Agreement is a short-term contract between the state and the adjacent land holder. See *Plum Creek Timber Co., L.P. v. Hillman,* 95 Wash. App. 1061 (1999) for a timber trespass and boundary dispute case, and *Dick v. Chenette,* 159 Wash. App. 1013 (2011) for an example of a timber trespass case.
[29] FSH 2409.12b
[30] See Bowser (2000) for a complete analysis of timber trespass laws and statutes in Oregon. One case in Washington that helped develop the timber trespass law is *Rayonier, Inc. v. Polson*, 400 F.2d 909 (9th Cir. 1968) in 1968.
[31] Wash. Rev. Code Ann. § 64.12.030; Or. Rev. Stat. Ann. § 105.810; Idaho Code Ann. § 6-202.
[32] FSH 2409.12b; Wash. Rev. Code Ann. § RCW 64.12.040; Or. Rev. Stat. Ann. § 105.815. A recent case upheld treble damages for inadvertent timber trespass in Idaho: *Stevens v. Eyer* (2016). But Eyer ended up paying substantially more than treble damages because they had to pay attorney fees to Idaho Forest Group.

Federal Land

When state timber harvest areas border federal land, timber companies may incur additional costs to protect and capture the value of the rights to harvest timber. First, while the federal government has its own timber trespass statutes, oversight and detection problems persist on public lands, making timber near federal land more susceptible to theft.[33] Second, access through or near federal lands is often difficult to obtain, and some contracts in Washington State, for example, bar timber harvesters from accessing federal roads, and, on average, the federal government charges higher fees to use their roads than state governments and private parties.[34] Third, a large portion of federal land overlaps with endangered habitat areas, such as Northern Spotted Owls and Marbled Murrelet habitat areas.[35]

Occasionally, state harvest areas border federal land with an endangered habitat designation nearby, such as the Northern Spotted Owl. The proximity to the harvest area gives rise to potential conflicts with federal government regulations, or lawsuits and protests by environmental and conservation groups claiming that timber companies are destroying critical habitats nearby.

In fact, the size of the endangered species critical habitats expanded twice during our sample period. In 2008 and 2012, while updating an original ruling from 1992, the United States

[33] 18 U.S.C.A. § 1853, 18 U.S.C.A. § 1852. See *United States v. Freund*, No. 03-20004, 2008 WL 4601802, at *1 (E.D. Mich. Oct. 14, 2008) for an example of a federal timber trespass case.
[34] The source of this information is conversations with forest-bureau administrators.
[35] See 16 U.S.C.A. § 1538: "…it is unlawful for any person subject to the jurisdiction of the United States to remove and reduce to possession any such species from areas under Federal jurisdiction; maliciously damage or destroy any such species on any such area; or remove, cut, dig up, or damage or destroy any such species on any other area in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law." See *Kettle Range Conservation Grp. v. Washington Dep't of Nat. Res.*, 120 Wash. App. 434, 85 P.3d 894 (2003), as amended on reconsideration (Mar. 16, 2004) where grizzly bear habitats were involved in a lawsuit pertaining to logging. See *Oregon Nat. Res. Council Action v. U.S. Forest Serv.,* 445 F. Supp. 2d 1211 (D. Or. 2006) where a natural resource group sued to prevent federal timber sales in Oregon's forests. See *Cascadia Wildlands v. Scott Timber Co.,* 190 F. Supp. 3d 1024 (D. Or. 2016) where an environment group brought action against a logging company for damaging habitats. See *Envtl. Prot. Info. Ctr. v. Simpson Timber Co.,* 255 F.3d 1073 (9th Cir. 2001) for a case involving how cutting timber affects habitats.

Government designated over 5.3 million acres and 9.6 million acres of Federal land, respectively, as a critical habitat for Northern Spotted Owls in three states: Oregon, Washington, and California (73 FR 47325).[36] As of 2012, the critical habitat for Northern Spotted Owls in Washington State covers approximately 2.9 million acres of federal land. In Oregon, similar critical habitat covers approximately 4.3 million acres of federal land (77 FR 71875).[37]

In sum, when a timber harvest area abuts federal lands, costs of cutting timber are higher. The reasons include the lands being more vulnerable to trespass, the costly access to the harvest area through federal land, and the threat of lawsuits, complaints, or protests near sensitive environments. A basic economic model thus predicts that the costs of capturing and protecting the value of harvest rights are higher when the harvest area borders on land owned by the federal government.

Subcontracting and Tailholding

The purchaser of the harvest rights may incur additional costs to protect and capture the rents of the harvest by having to deal directly with neighboring landowners and neighboring property. First, manufacturing and processing facilities, such as lumber or plywood mills, comprising the majority of participants in timber auctions, subcontract the operations work, i.e. the harvesting and hauling of the trees. Subcontracting leads to additional cost near borders, especially when the subcontractor cuts trees along a non-state border.[38] For example, a harvester may inadvertently fell a tree on a neighboring property, or a tree may fall onto neighboring land, damaging the neighbor's property and generating liability for both the purchaser and the

[36] There are roughly 3.6 million acres in Washington and Oregon combined (73 FR 47325).
[37] In the 2012 rule, the United States Government added some state land into the plan, but the figures are small compared to the federal land that covered areas: In Washington, only roughly 8,000 acres of state land, and in Oregon, roughly 200,000 acres. Most of Oregon's Federal Ownership lies in the center and eastern portion, thus the habitats cover a large portion of federal land.
[38] We consulted a forester about whether harvesters are cautious near a property line. The forester responded, "Responsible harvesters are."

subcontractor.[39] Per Oregon's statute on the liability for damaging another owner's trees, the winning bidder who hired the subcontractor "must be joined in the action as a defendant."[40] These types of breaches occur more often when property lines are not surveyed, although they may occur even when property lines are surveyed. For example, in 2011, Potlatch Corporation cut over a border into Federal land.[41]

Second, while state officials negotiate certain road access permits and fees prior to the auction, the winning bidder incurs other negotiation costs. For example, the timber company is responsible for negotiating a contract when harvesting requires a tailhold on private, or federal, property in order to fell trees.[42] Negotiations may also involve neighboring landowners' permission to use their land for access to the harvest area, and possibly to haul out timber.[43]

Pollution, Landslides, and Fires

Timber harvesting may impose costs on neighboring parties through various types of emissions and conflict, and if the rights to impose these costs are unclear, rents may be reduced in order to protect and capture rents. For example, noise occurs from machinery and trucks, air emissions through potential chemical spraying, and landslides can occur onto a neighboring

[39] We acknowledge that inadvertently felled tree could also be state owned. This could lead any border to increase costs, although if the harvest cut border is state land, it generally follows the geographical contours of state land, while if the border is non-state land, it must follow an artificial property line created by the property rights institution. Thus the state has more room to endogenously select borders when they own all of the surrounding land.
[40] Or. Rev. Stat. Ann. § 105.810, subsection 6. In Washington a timber contract reads: "Purchasers' obligations to indemnify, defend, and hold harmless includes any claim by Purchasers' agents, employees, representatives, or any subcontractor or its employees. Purchaser expressly agrees to indemnify, defend, and hold harmless State for any claim arising out of or incident to Purchasers' or any subcontractors' performance or failure to perform the contract."
[41] Article: http://www.idahopress.com/news/state/potlatch-pays-fine-to-settle-forest-trespass-case/article_d5a958da-36a8-5ed7-9107-930c0d5b5c54.html
[42] Tailholding is a practice that uses a tree or stump to support cable logging. In Idaho, occasionally the state negotiates a deal for special access to the timber sale.
[43] Here is an example from an auction packet in Washington: "If Purchaser chooses to tailhold on private property, Purchaser shall obtain permit(s) and assumes responsibility for all costs associated with permit(s). Purchaser must provide the State with a copy of the executed permit(s) or a letter from the private entity indicating that a satisfactory tailhold permit(s) has been consummated between Purchaser and private entity."

property.[44] All three events increase the probability of conflict, and increase the likelihood that the harvester will incur additional costs to protect and capture the value from timber harvest rights.

In Washington State, some timber auction contracts require special "extreme hazard abatement" near property lines, structures, and county roads. These abatement requirements are intended to reduce fire hazards during and after timber cutting operations. Further, the mere existence of such provisions demonstrates that there are risks when harvesting trees near neighboring properties. When a prospectus includes an abatement requirement, this provision clarifies property rights by reducing the probability that a harvester faces lawsuits, as the abatement requirement provides legal certainty by absolving timber harvesters from liability for many possible damages to neighboring properties.[45] Figure A1 in the Online Appendix A shows an example of a provision absolving extreme hazard liability to a timber company.

These institutions motivate the following hypotheses:

H1. When part, or all, of the timber harvest area shares a border with non-state parties, the expected costs of protecting and capturing rents from the property rights increase. The increase in these costs implies a decrease in rents, which are then capitalized in lower winning bid prices.

H2. When a timber harvest contract includes special abatement requirements near property lines, or structures, the winning bid prices increase.

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[44] Here are a few news articles discussing issues that occur near timber harvesting sites: http://www.oregonlive.com/environment/index.ssf/2011/08/protests_of_timber_sales_in_el.html; http://www.opb.org/news/article/oregon-timber-herbicide-exposure-aerial-spraying/; http://www.seattletimes.com/opinion/dnr-must-rethink-logging-and-landslides/
Here are two court cases discussing landslides: *Alpental Cmty. Club, Inc. v. Seattle Gymnastics Soc.,* 154 Wash. 2d 313, 111 P.3d 257 (2005); *Hurley v. Port Blakely Tree Farms L.P.*, 182 Wash. App. 1008 (2014).

[45] RCW 76.04.660.

VI.2 Competing uses

Washington and Recreational Use

Recreational uses, such as camping and hiking trails, create value for many individuals. In Washington State, the state designates areas known as "Washington State Parks and Recreation districts."[46] Washington State identifies these districts based on their scenic and recreational values.[47] The districts sometimes geographically overlap with state trust land that is used for timber harvesting, and have hiking trails that are nearby or that cut through the harvest areas. Harvesting activities may impede the use of these trails and recreation areas, as the harvest reduces the amenities such as the nature views and noise levels. When harvesting activities decrease these amenities, lawsuits, protests, or complaints, may occur and decrease rents.

Elliot State Forest and the Environment

Elliot State Forest is Oregon's first state forest. In 1930, Oregon began acquiring parts of Elliot State Forest through land swaps with the federal government, and continued to acquire remaining parts of the forest through the 1970s.[48] Today, Elliot State Forest contains many endangered species habitats that include the Northern Spotted Owl and Marble Murrelet, as well as providing many amenities such as camping, fishing, and hunting.

Elliot State Forest contains "well-stocked, healthy, and vigorous" forest stands.[49] As of 2011, over half of the conifer trees were more than 85 years old, and among these, the dominant conifer is Douglas fir. The prevalence of Douglas fir is reflected in our data. Of our 36 Elliot State Forest auctions, the average sale has over 90 percent Douglas fir. In addition, the presence of older aged trees provides better habitats for endangered species.

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[46] The GIS data was collected from the Washington State Department of Revenue.

[47] RCW 36.69.010

[48] Information obtained on Elliot State Forest is from www.oregon.gov/ODF/Documents/AboutODF/2011FMPElliott.pdf

[49] See page 3-9: www.oregon.gov/ODF/Documents/AboutODF/2011FMPElliott.pdf

In November 2011, the Oregon State Land Board approved an implementation plan that increased clearcutting in Elliot Forest.[50] The approval led to protests and lawsuits.[51] Some protests went as far as climbing into trees to prevent harvesting, and Cascadia Wildlands and the Center for Biological Diversity filed lawsuits [52] Many of these lawsuits lead to the cancellation of state timber auctions. Some harvest contracts were even cancelled following the auction.

Viewshed

Viewshed conflicts are caused by timber harvest clearcuts, which leave a visible bare patch of land. The bare patch may result in complaints from nearby residents when the clear-cut infringes on their mountain views.[53] Residents might have expected that their mountain views would not change over time when purchasing their homes, and they might consider a clearcut as an infringement on their property.

Moreover, to the extent that mountain views are capitalized in property values, residents have an incentive to oppose clearcuts, as the impaired viewshed reduces their property value. When residents oppose clearcuts, timber companies face an increased likelihood of lawsuits challenging the harvest, as well as negative publicity.

Alternative uses of timber, such as recreational, environmental, and scenic views, increase the costs associated with protecting and capturing rents from the harvest. These considerations motivate an additional hypothesis.

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[50] Oregon Elliot Forest Plan: http://www.oregon.gov/ODF/Documents/AboutODF/2011IPCoos.pdf; Article: http://www.oregonlive.com/environment/index.ssf/2011/10/elliott_state_forest_new_plan.html

[51] This news article discusses a timeline of Elliot Forest: http://www.oregonlive.com/environment/index.ssf/2016/11/proposed_elliott_state_forest.html

[52] Article: http://theworldlink.com/news/local/protesters-arrested/article_d0e35c60-9c9b-5107-b700-203b9c2b8c48.html; https://www.cascwild.org/lawsuit-chops-down-logging-plans-on-the-elliott/; http://audubonportland.org/news/lawsuit-filed-to-protect-threatened-marbled-murrelet-from-logging-on-former-elliott-state-forest

[53] For example, here are a few examples of articles discussing viewshed problems: http://www.capitalpress.com/Timber/20160419/foresters-seek-solution-to-clear-cut-image-problem; http://www.bozemandailychronicle.com/news/environment/residents-environmentalists-concerned-about-logging-near-bozeman/article_cf5613bf-3fca-5c51-8aef-c634b586d110.html

H3. When a timber harvest has claims for competing alternative uses such as recreational, environmental, or scenic views, the expected costs of protecting and capturing rents from the property rights to timber harvesting increase. The increase in these costs implies a decrease in rents, which are then capitalized in lower winning bid prices.

V. Empirical Methods

For each state, we estimate the effect of the expected costs to protect and capture rents of the harvest rights. Our model is

$$Log\left(\frac{Bid\ Price}{Volume}\right)_{it} = \beta \mathbf{A}_{it} + \boldsymbol{X'}_{it}\boldsymbol{\gamma} + \upsilon_t + \varepsilon_{it} \qquad (1)$$

The dependent variable is the log of the real final bid price in real 2010 dollars per thousand board feet (MBF).[54] The unit of observation is auction *i* in year *t*.

The vector **A** includes our border measures. In one specification, this measure is the mileage of the timber harvest sale area that borders a non-state property divided by the total perimeter of the harvest sale area. In another specification, the measures are both the mileage of the timber harvest sale area that borders private property and the mileage that borders federal land, each of which we divide by the total perimeter of the harvest sale area. In an alternative specification, we decompose the total perimeter (in feet) divided by the square root of the acreage of the harvest sale area (measured in square feet).[55] This decomposition generates a measure for each bordering party.

[54] The timber price per MBF is commonly used in the academic literature. For example, see Athey et al. (2011) and Leffler et al (2000).

[55] We estimate our model on three samples in our data. The first set of specifications uses the entire dataset, the second set of specifications uses only the auctions that have a non-state entity bordering the harvest sale, and the third set of specifications uses only the auctions that have the 16th and 36th section in them. If Section 16 or Section 36 were taken at the time of statehood other lands were selected "in lieu". These selections were scattered throughout each state and consisted of various other sections and are not included in this subsample. Also, a small number of auctions have Indian Tribal land, county owned land, or city owned land as part of their border. We

The vector **X** includes control variables. The control variables include the volume of tree species measured in MBF, a measure for the size of development projects or development costs, the perimeter of the harvest area, the number of bids or bidders, harvest methods required by the state agency, harvest type indicators, the forest burn probability, and the timber density of the harvest area.[56] By including the tree species volumes and the density, which is measured as the volume divided by the acreage, we control for the size of the harvest area and possible economies of scale. Also harvest areas with larger perimeters are more likely to border non-state property. Therefore, we control for perimeter length in our border regressions. Development projects or development costs are required work, such as road-construction projects that states require the winning bidder to complete.[57] The development project credit is the amount of dollar credits a timber company receives upon completing the projects. In Idaho, since the auctions are oral, we include in the regressions the number of bidders at the auction.[58] In the other two states, our corresponding measure is number of bids. We account for geographical differences with a variable that measures the burn probability associated with the harvest area.[59] The harvesting

include these in the non-state border measure, but do not include these when decomposing the borders into private or federal, and therefore, they are in the omitted category.

[56] For Washington and Oregon, we use the tree species Douglas fir, Hemlock, Cedar, and Maple. For Idaho we use the tree species Douglas Fir, Hemlock, Cedar, and Lodgepole. Consistent with other papers on timber auctions, we use the level of density. For example, see Haile (2001), Lu and Perrigne (2008), Athey et al. (2011), Preget and Waelbroeck (2012), and Athey et al. (2013). For the harvest type, we use a clear-cut, combination sale indicator, or other type for indicator depending on the state. The use of harvest type is consistent with the literature on timber auctions. For example, see Leffler and Rucker (1991) who uses a harvest type indicator. The Idaho's Department of Lands had data only on the size of the clearcuts in their auctions, and not on any other harvest type used in the auction.

[57] The development costs or projects consist of road construction, deconstruction, maintenance, and other small projects.

[58] Considering "the number of bids" is a similar measure to price in that it shows a "willingness to pay," the use of bids as a control may capture some of the price per MBF, and reduce our estimates.

[59] The source of the Burn Probability: http://tiles.arcgis.com/tiles/4OV0eRKiLAYkbH2J/arcgis/rest/services/Burn_Probability/MapServer, and was created by Craig Thompson at National Park Service and Department of Interior's Office of Wildland Fire. In Oregon, all auctions take place on the Western Coast so there is basically no variation in the burn probability. We therefore use forest district controls to account for geographical differences in Oregon.

method is either cable-based logging or ground-based logging. Depending on the state data, the harvest type is clear-cut, thinning, other, a combination. The term ν_t indicates a year effect.[60]

We estimate four models to test the effect of alternative uses to timber on harvesting rents. In one model, we test the effect of an auction located in a Washington recreational district. For this purpose we re-estimate equation (1), specifying **A** as an indicator whether or not a timber auction is located in a recreational district using only auctions in Washington.

In another model, we test the effect the implementation plan that increased clearcutting in Elliot State Forest. For Oregon, we estimate the difference-in-difference model

$$Log\left(\frac{Bid\ Price}{Volume}\right)_{it} = D_i + \upsilon_t + \beta_3 T_t D_{it} + \boldsymbol{X'_{it}\gamma} + \varepsilon_{it} \qquad (2)$$

Equation (2) uses the variation before and after the Elliot State Forest implementation plan, and whether an auction is in Elliot State Forest or nearby. We define auctions nearby Elliot State Forest in several ways, including based on common topographical features.[61] In equation (2), D_i is an Elliot State Forest indicator and υ_t are year indicators. The variable of main interest is the interaction variable $T_t D_i$, which is product between the Elliot State Forest indicator, and T_t representing the years after 2011. **X** is a vector of control variables that includes tree-species volumes, other significant factors, development projects, harvest methods, and the density of the tract.[62]

The third model estimates the effect of conflicting property right claims for each state:

$$Log\left(\frac{Bid\ Price}{Volume}\right)_{it} = \beta_1 C_{it} + \beta_2 V_{it} + \beta_3 C_{it} V_{it} + \boldsymbol{X'_{it}\gamma} + \upsilon_t + \varepsilon_{it} \qquad (3)$$

[60] The price changes from year to year are uncorrelated with our border variable. We do not control for the price of timber over time since the price changes will be captured in our year controls.

[61] We include auctions that are geographically similar, and therefore, drop the northern state forests and the North Cascade area. See the Online Appendix A, Figure A2, for a map of the subsample. We do not use add forest district controls for this estimate.

[62] The controls are identical to our first model for Oregon other than we use Red Alder as the fourth tree species control rather than Maple. This is due to the fact that Red Alder is a dominant tree species in our geographical subsample as well as red alder is in virtually every auctions in Elliot State Forest while Maple is not.

In this equation (3) the variable C_{it} indicates whether or not the harvest area is a clearcut, and V_{it} is a measure of population size that has a view of the harvest area. The population size is measured by using the US Census centroids that have a view of the auction area.[63] A negative sign on the interaction term $C_{it}V_{it}$ is consistent with the hypothesis that the costs of protecting and capturing rents increase when harvest areas are clearcuts in the view of a population.

The last model tests for the effect of alternative competing uses on rents. Idaho, in conjunction with the Bureau of Land Management, classifies geographic areas into four types, where Class I and Class II are rated highest on "quality of visual (scenic) values".[64] Idaho is the only state in our sample that has data on this designation for state land. In this fourth model, we test whether rents are lower for auction located in Class I and Class II areas. Our model of competing property rights claims predicts that bids prices are lower when there are conflicting uses to timber. To test this hypothesis, we estimate equation (1) for Idaho where variable **A** is an indicator whether or not the auction is located in a Class I or II area.

VI. Data

We study timber auctions in Washington, Oregon, and Idaho over a seven-year period, from January 2008 to December 2014. All three state agencies (WADNR, ODF, and IDL) provided us with data on timber auctions, including a prospectus for each auction. Each prospectus includes a map of the harvest areas and its legal descriptions, allowing us to identify

[63] For a full detailed description of the data collection process for the viewshed analysis, see Online Appendix B.
[64] For a full explanation of each class see: https://www.nps.gov/elca/learn/management/upload/Q%20Appendix%20H%20Visual%20Resource%20Management%20ClassesObjectives.pdf. The data are from the U.S. Department of the Interior (DOI), Bureau of Land Management (BLM), and Idaho State Office, and published in March 2008.

the type of property owner—state, federal, or private—that shared a border with the harvest sale area.[65]

Figures 2A, 2B, and 2C show typical timber harvest-rights sale map in Washington, Oregon, and Idaho, respectively. These maps indicate information about geographical location of the sale and how many different parties share boundaries with the timber harvest area.[66] In the Idaho example, 2C, the map indicates that both private owners and the state share a border with the timber harvest area. To collect our border measures, we used the harvest maps and GIS shapefiles provided by each state agency. The harvest maps and shapefiles provide us with information about the perimeter length of the harvest area. We then measured the share of the total perimeter adjacent to the various parties owning land bordering the harvest area.

For Washington, the black dashed line in Figure 2A represents the perimeter of the harvest sale area. For Oregon, the black dotted line represents the perimeter as shown in Figure 2B. For Idaho, the solid black line in Figure 2C delineates the perimeter of the harvest sale area.[67]

Some maps did not identify whether adjacent land was held by the state, the federal government, or by private owners. Using the geographical location provided by the maps, as well as GIS shapefiles of the timber auctions, we gathered any missing information about who owns

[65] See Online Appendix A, Figures A3-A5 show an example or a typical prospectus for Washington, Oregon, and Idaho, respectively. In Idaho, we use the timber contract page because Idaho did not provide us with prospectuses. The information on the Idaho timber contract page shows what would be on a typical Idaho prospectus.
[66] In Figure 2A, which shows the map of a harvest area in Washington, there is extreme hazard abatement shown on the property lines by neighboring homes.
[67] When two harvest areas for a given auction share borders with each other, we exclude the length of that border from our perimeter measure. For an example, see Idaho figure 2c, where Unit 1 and Unit 2 share boundaries. We exclude those types of boundaries and focus only on timber sale boundaries where timber is not cut. In addition, Washington's institutions and GIS maps differed slightly from those of Oregon and Idaho in that it more often splits its harvest areas by streams as shown in Figure 2A. In contrast, as shown in Figure 2b for Oregon, streams are inside of the harvest units. See Online Appendix A, Figure A6 for an example of an auction with all state borders.

land adjacent to the harvest sale area from the state county's geographical information system maps.[68]

For all three states, we exclude from our analysis salvage sales and blown-down timber sales.[69] This assures that our data include timber sales that are similar and have undamaged tree species. Moreover, with this exclusion, all of our timber sales have been advertised for a similar length of time. For example, in Idaho, salvage sales that are appraised contain less than 1,000 MBF, and are only advertised for only one week. In contrast, other state timber auctions in Idaho have larger appraisal value, contain more MBF, and are advertised for four weeks. To compare similar auctions, we exclude mixed-log sales cedar poles or other poles sales, because poles are an entirely different tree stand size class. In Oregon, we exclude the Klamath-lake district, whose auctions contain different tree species, and thus are not comparable to auctions in other areas.

Figures 3A, 3B, and 3C show the location of the timber harvest areas included in our data set for each state, with the location of the auction indicated in black. Figure 3B shows that Oregon's timber auctions are concentrated solely on the western portion of the state.

Table 1 provides the descriptive statistics for the variables used in our regression analysis, separately for each state. Figure 3A shows the location of the timber auctions in Washington. Figures 3B and 3C shows the same for Oregon and Idaho, respectively. The average bid price per MBF in Washington and Oregon is approximately $280, while it is about $190 in Idaho. The volumes of the timber sales are similar across the states at about 4,000 MBF. Twenty percent of the borders in Idaho are adjacent to non-state parties, followed by Oregon with 12 percent, and Washington with nine percent. In Washington, 80 percent of the auctions are variable retention harvests or regeneration cuts, in Oregon, 50 percent are clearcuts, and in

[68] Each county in Idaho, Oregon, and Washington has a GIS map that identifies the owners of each parcel of land. We use the county GIS when state agency maps did not provide the adjacent owner(s).
[69] Salvage sales include timber that is at risk due to fire damage, insect damage, and wind damage.

Idaho, five percent are clearcuts.[70] Our viewshed variable, which measures the population that can view a harvest area, ranges from an average 214 in Idaho to 73 in Oregon.

VII. Results

Table 2 shows the results of testing equation (1). The first three columns show three specifications for Washington, followed by three specifications for Oregon, and the last three columns shows three specifications for Idaho. In the first six specifications, the percentage of the non-state border variable has a negative sign and is statistically significant at the five percent level. In Idaho, the non-state border variable is also negative but statistically significant at the ten percent level in the first two specifications, and at the five percent level in last column. The estimates are consistent with the hypothesis that rents fall with increased costs to protect and capture property values. In the specifications that include our full set of controls, we find that for every ten-percentage point increase in a non-state border, there is a corresponding decrease in the winning bid price by 2.2 percent in Washington, 2.5 percent in Oregon, and 1.8 percent in Idaho (Columns 3, 6 and 9).[71] Translating the point estimates into dollar amounts shows that a ten-percentage point increase in the non-state border, leads to roughly $27,000 decrease in the winning bid price in both Washington and Oregon, and roughly $14,000 in Idaho. In Idaho and Washington, the point estimates between the most parsimonious (Columns 1 and 7) and most extensive (Column 3 and 9) are similar. This lends support to our assumption that our percent of non-state border variable is exogenous, and thus not correlated with observables. Only in Oregon the point estimate increases from -0.35 to -0.25, amounting to a thirty percent drop.

[70] For the purposes of our tables, we define variable retention harvests and regeneration cuts as clearcuts.
[71] The use of "bid price" represents price ($) per volume (MBF).

Table 3 is organized in the same way as Table 2 and decomposes the non-state border into a private border variable and federal border variable. In all specifications, the point estimates on the federal border are negative and statistically significant, indicating that winning bid prices are lower when a harvest area borders federal property. The estimates show that for every ten-percentage point increase in the border shared with the federal government, there is approximately a four percent lower winning bid price in all three states. As hypothesized, all point estimates on private borders are negative, ranging between 1.4 and 2.4 percent for every ten-percentage point increase in the private border. The point estimates on private borders in the specifications with more extensive controls are statistically significant, while they are not in some of the more parsimonious specifications. In Tables 2 and 3, among the control variables in Washington and Oregon, harvest areas with higher density increase prices. Further, in both of these states, clearcuts are associated with higher prices, and cable harvesting is associated with lower prices. However, in Idaho, where only five percent of all the auctions are clearcuts, the coefficient on the clearcut indicator is negative and not statistically significant. While the density in Idaho is negative in Column 9 in both tables, the sign reverses to positive and statistically significant when excluding the hemlock and cedar tree species.

Both Table 2 and 3 support our prediction that the abatement requirements in Washington increase bid prices. The absolving of future liability associated with abatement requirements increases the bid price by approximately 6 percent. This lends support that legal certainty decreases the costs of protecting and capturing rents.

Tables 4 and 5 test the robustness of our previous results. Table 4 shows the results from two subsamples. The first subsample includes only auctions where at least part of the harvest sale area is located in section 16 or 36 (Columns 1, 3 and 5). The use of this subsample is motivated

by the fact that sections 16 and 36 were granted by the federal government at statehoods, thus making at least part of the timber ownership exogenous. In all three states, the estimated effect of federal borders has a negative sign and is statistically significant. The estimated effect of private borders in Washington is negative and statistically significant at the five percent level, while in Oregon and Idaho, the point estimates on private borders are not statistically significant.

The other subsample in Table 4 excludes all sales that have solely state borders, that is, sales that do not share a border with any non-state property. This restriction allows us to identify the border effect on an intensive margin. For Idaho, the estimated effect of private and federal borders are very similar to the previously-reported estimates, and for Washington and Oregon, the estimated coefficients in Table 4 are roughly 20 percent larger. Overall, the results of our robustness tests in Table 4 provide support for our hypothesis.

Table 5 presents an additional robustness test. Here we divide the perimeter length of each bordering party — state, federal, and private — by the square root of the harvest area.[72] This perimeter-to-area measure is an alternative way to compare border lengths. It adjusts each border length by the acreage of the harvest area. Overall, the results in Table 5 are consistent with our previous results. In all specifications, the coefficients on the federal and private perimeter-to-area measures have negative signs. Further, the state perimeter-to-area measure is negative. With the exception of one specification, the pattern shows that the coefficients are smallest in absolute value for state borders, followed by private borders, and then by federal borders.[73]

[72] The perimeter is measured in feet in this specification. There are a few auctions that border American Indian property or a different state owner than the agency managing the timber auctions. If we add a control for these, the results are unaffected.

[73] In the most parsimonious specifications for Oregon and Idaho (Columns 3 and 5), the coefficients on the federal perimeter-to-area measures are statistically significantly larger than the coefficient on our state perimeter-to-area measure. Further, the coefficients on the private perimeter-to-area measure are statistically significantly larger than the coefficient on state borders in Washington.

The interpretation of the federal point estimates show that a one standard deviation increase on the federal perimeter-to-area measure, decreases the bid price by roughly 2.5 percent in Washington, five percent in Oregon, and three percent in Idaho. These effects are similar to the estimated effects of a one standard deviation change in the federal borders in Table 3.

In Column 2, the coefficient on the federal border measure in Washington misses the ten percent level of statistical significance. If we drop the number of bids from that specification, the federal perimeter-to-area estimate is negative, statistically significant at the five percent level, and has a similar magnitude to the corresponding coefficient in Column 1.[74]

Table 6 tests the effect of competing property right claims to the use of timber in Washington and Oregon. The results for Washington are in the first three columns, and the results for Oregon are in the last three.

In the Washington specifications, the recreational district indicator has a negative sign and is statistically significant at the five percent level. Our estimate that includes the full set of controls shows a 5.7 percent decrease in the winning bid price when the timber harvest occurs in a designated recreational district.[75] The result lends support to the hypothesis that when there is a competing use for the timber, there are higher costs to protect and capture rents.

In our regressions for Oregon, the control group for Elliot State Forest timber auctions are auctions in the surrounding area of Elliot State Forest that are geographically similar and have similar tree species. All auctions in Elliot State Forest contain some high grade, large diameter trees. Therefore, to have comparable auctions to those in Elliot State Forest, we include in the control group only auctions that are not entirely low grade, small diameter Douglas fir

[74] The number of bids are positively correlated with the bid price. In our Washington data, when a harvest area borders federal property bid prices are lower and the number of bids are lower. This explains why the coefficient on federal border increases when we omit the number of bids from our regression.

[75] The estimate is equal to $\exp(\beta) - 1$, where β is our indicator coefficient. This correction is made for all interpreted indicators (Halvorsen and Palmquist, 1980).

trees.[76] In all three specifications in Table 6, the point estimates on the interaction between the Elliot State Forest indicator and the 2011 approved plan indicator are negative, statistically significant at the five percent level, and range between 2.5 and 3.4 percent. The estimated magnitude on the interaction effect in Column 6 implies that the Oregon plan that increased clearcutting is associated with a 23 percent decrease in winning bid prices in Elliot State Forest.

Table 7 presents results from testing the hypothesis that bid prices are lower when clearcuts are in viewsheds of local residents.[77] We do not include timber harvests in Washington State in this analysis because in 2008 Washington State's WADNR adopted a new policy virtually eliminating clearcuts. With the new policy, the most aggressive harvesting type allowed for Washington State timber was a "variable retention harvest" which requires the winning bidder to leave trees in the harvest area, with the objective to minimize the aesthetic and environmental impact of cutting timber.[78]

Table 7, Column 1 and 2 present the estimation results for Oregon, and Columns 3 and 4 present the results for Idaho. The harvest areas can differ in the size of the area that is permitted for clearcutting. The larger the harvest areas are subject to clearcutting, the larger the aesthetic impact. To focus on harvests where the aesthetic impact of clearcut is largest, in one specification, we define a clearcut when at least 90 percent of the harvest area is subject to

[76] Protests of environmentalists tend to focus on old-growth and large diameter trees. These trees are more likely to have species habitats and thus environmental value. In total, there are seven auctions that contain zero high-grade Douglas fir in the entire data set and three in our subsample.

[77] In the auction prospectuses, Oregon labels its most common form of clearcutting as a "modified clearcut", while Idaho uses term "clearcut" in their auction prospectuses. For our regressions, we define a "modified clearcut" in Oregon as a "clearcut."

[78] See the Forest Management Certification Public Summary report for the change: https://www.dnr.wa.gov/publications/frc_fsc_certificate.pdf. Also, according to an official in the WADNR office, foresters will adjust the sale to address any aesthetic issues, because of their state environmental policy act (SEPA, Chapter 43.21c RCW). Washington is one of sixteen states to have adopted a state environmental policy (https://ceq.doe.gov/laws-regulations/states.html). The change in policy is evidenced by Washington's Progress Report for the Sustainable Forestry Initiative that states that Washington reduced the number of clearcuts from 10,966 acres in 2008 to 392 acres in 2009 (https://www.dnr.wa.gov/).

clearcutting (Table 7, Columns 1 and 3). In the second specification, we define a clearcut when the entire harvest area is subject to clearcutting (Table 7, Columns 2 and 4).

The coefficients of interest are those on the interaction effects between clearcuts and the population residing in viewsheds. Our hypothesis predicts that winning bid prices are lower for clearcuts that are in viewsheds. We find that all four of the estimated coefficients on the interaction effects have a negative sign and are statistically significant.

The size of the estimated coefficients on the interaction effects imply that when the number of individuals residing in viewshed doubles, bid prices are roughly 2.5 percent lower in Oregon, and five to seven percent lower in Idaho. In our data, the mean population within a viewshed in Idaho is about twice the size of the corresponding population in Oregon. The fact that the interaction point estimates for Oregon are about half the size of those in Idaho, imply that in both states the number of residents in clearcut viewsheds have quantitatively similar negative effects on bid prices.

In addition to the first four columns of Table 7, the last two columns of Table 7 provide further evidence for our hypothesis that competing alternative uses to timber reduce winning bid prices due to the higher costs of capturing rents from the timber. In these last two columns, we test the effect of harvest areas in Idaho being located in Class I and Class II areas. In both specifications, the point estimates on these areas are negative and statistically significant, indicating that winning bids are roughly 32 percent lower for timber harvest areas in locations with scenic views.

VIII. Conclusions

Our results point to an increase in the costs of protecting and capturing rents to timber when the harvest sale area shares a border with a third party. These higher costs derive from potential timber theft, lawsuits, or negotiation. The results in all states show that winning bid prices fall by roughly two percent, or $22,500, when there is a corresponding ten-percentage point increase in a non-state owner sharing a border with the harvest area. In all three states, a federal border lowers the winning bid by roughly four percent and a private border by roughly two percent.

The findings presented in this paper also show that the property rights to harvesting timber, when affected third party competing uses, increase the costs of protecting and capturing rents from the timber. The competing uses may be recreational, environmental, or scenic. Our results testing competing uses show that in all three states, winning bid prices fall when timber has uses that compete with harvesting. In Elliot State Forest, winning bid prices decreased by roughly 23 percent following the 2011 approved Elliot State Forest plan that increased clearcutting. We also find that prices decrease in Oregon and Idaho when a clearcut harvest is in the viewshed of nearby residents.

The effect third parties have on the rents to natural resources is not limited to timber harvesting. For example, when leasing land for fracking, the costs of protecting and capturing rents from the natural gas depend on who owns the neighboring land. Anticipated claims of neighboring individuals who claim water pollution might lower lease prices. The lower prices reflect an anticipated decrease in rents due to protecting and capturing rents from the lease rights. Thus, the costs of protecting and capturing rents, which are shaped by the security of property rights, are an important determinant of prices.

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Figure 1A: Map of State Ownership in Washington

Figure 1B: Map of State Ownership in Oregon

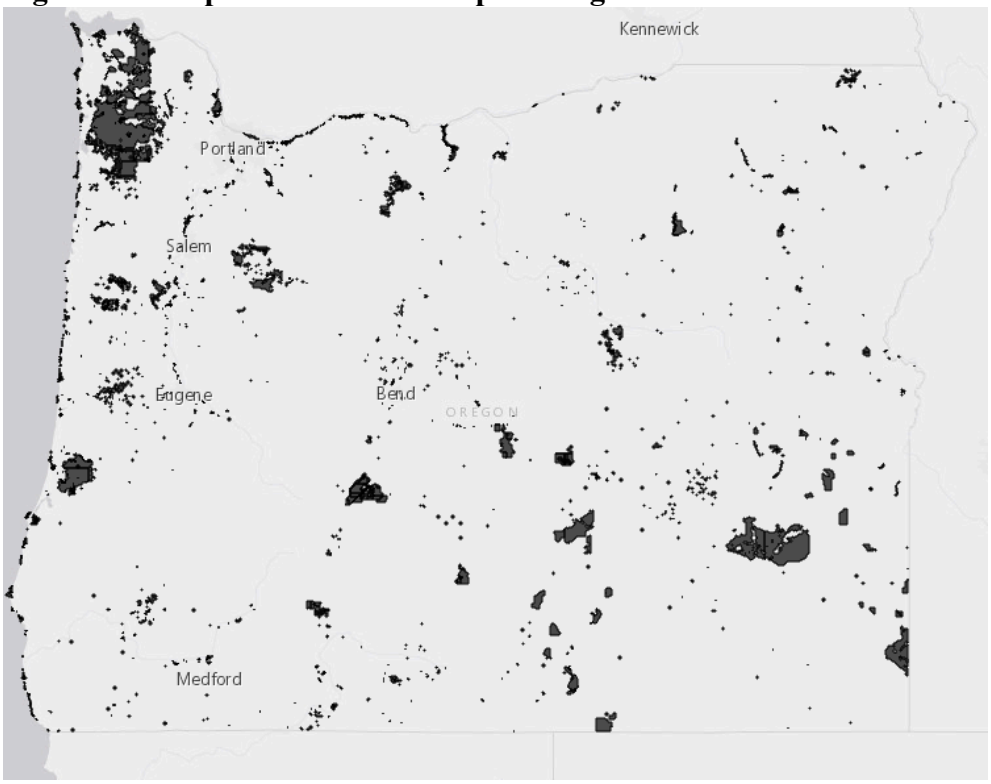

Figure 1C: Map of State Ownership in Idaho

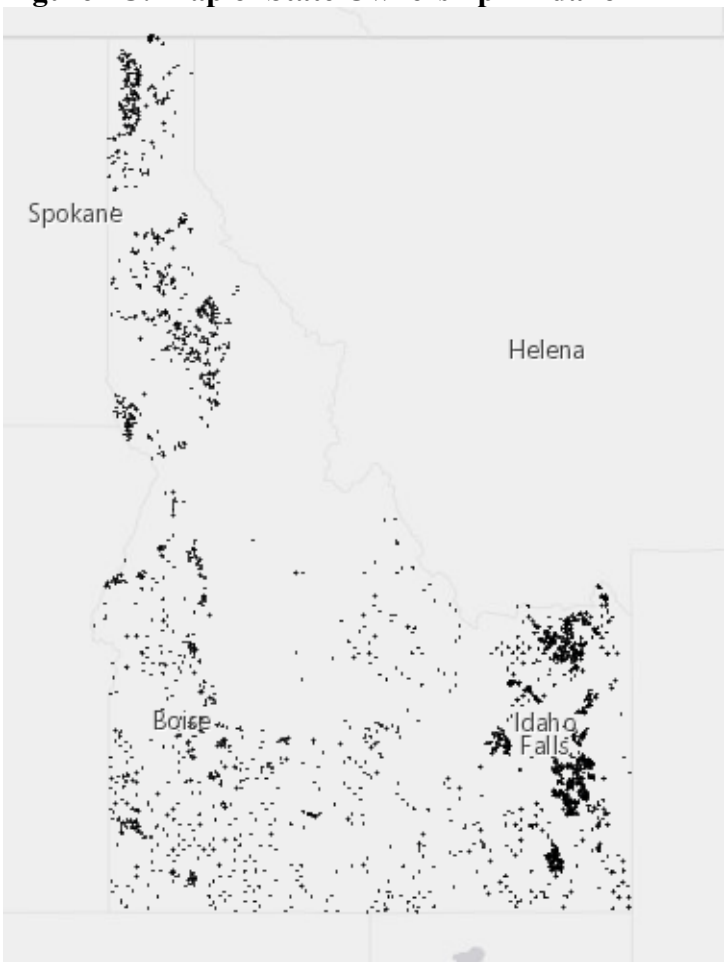

Figure 2A: Example of timber auction prospectus in Washington

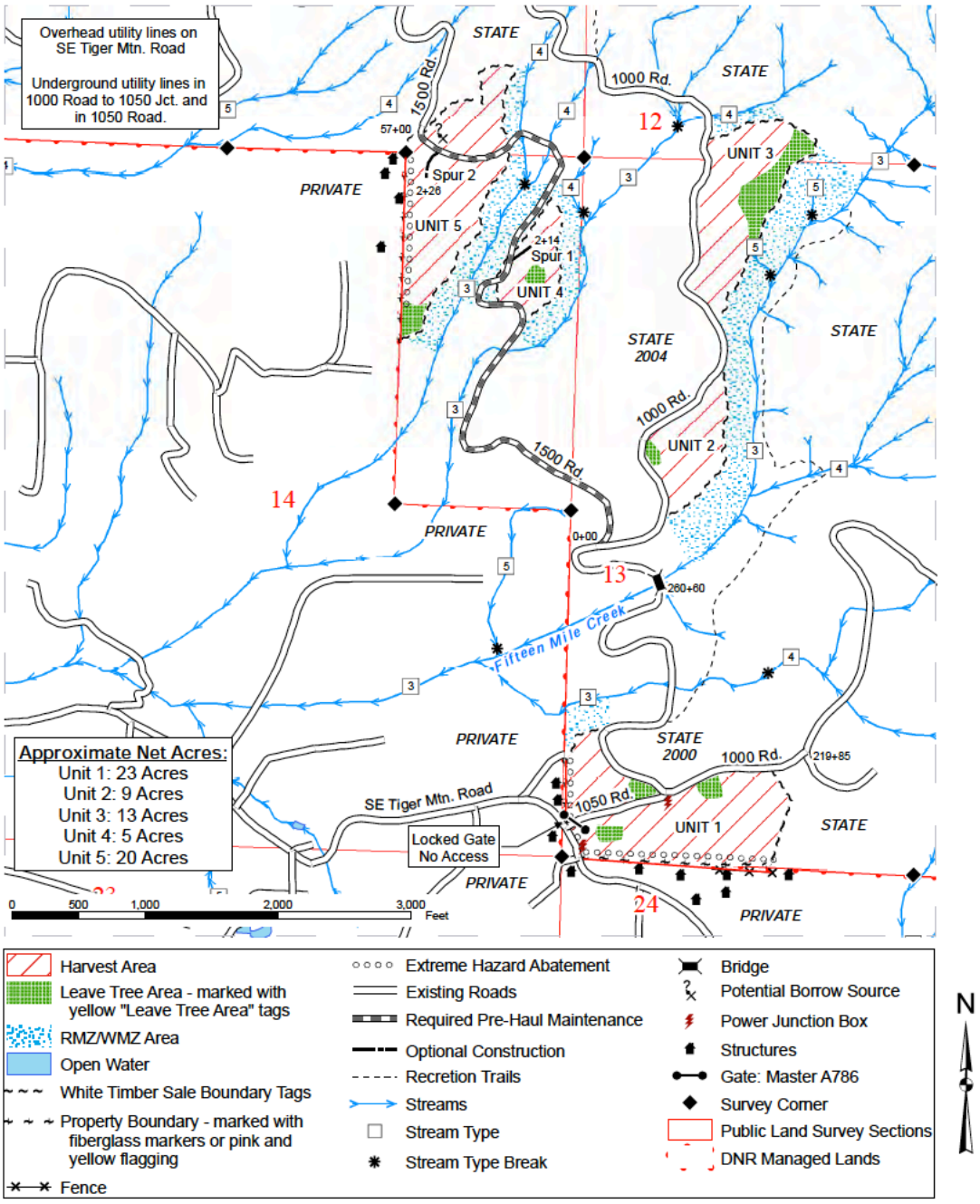

Figure 2B: Example map of timber auction in Oregon

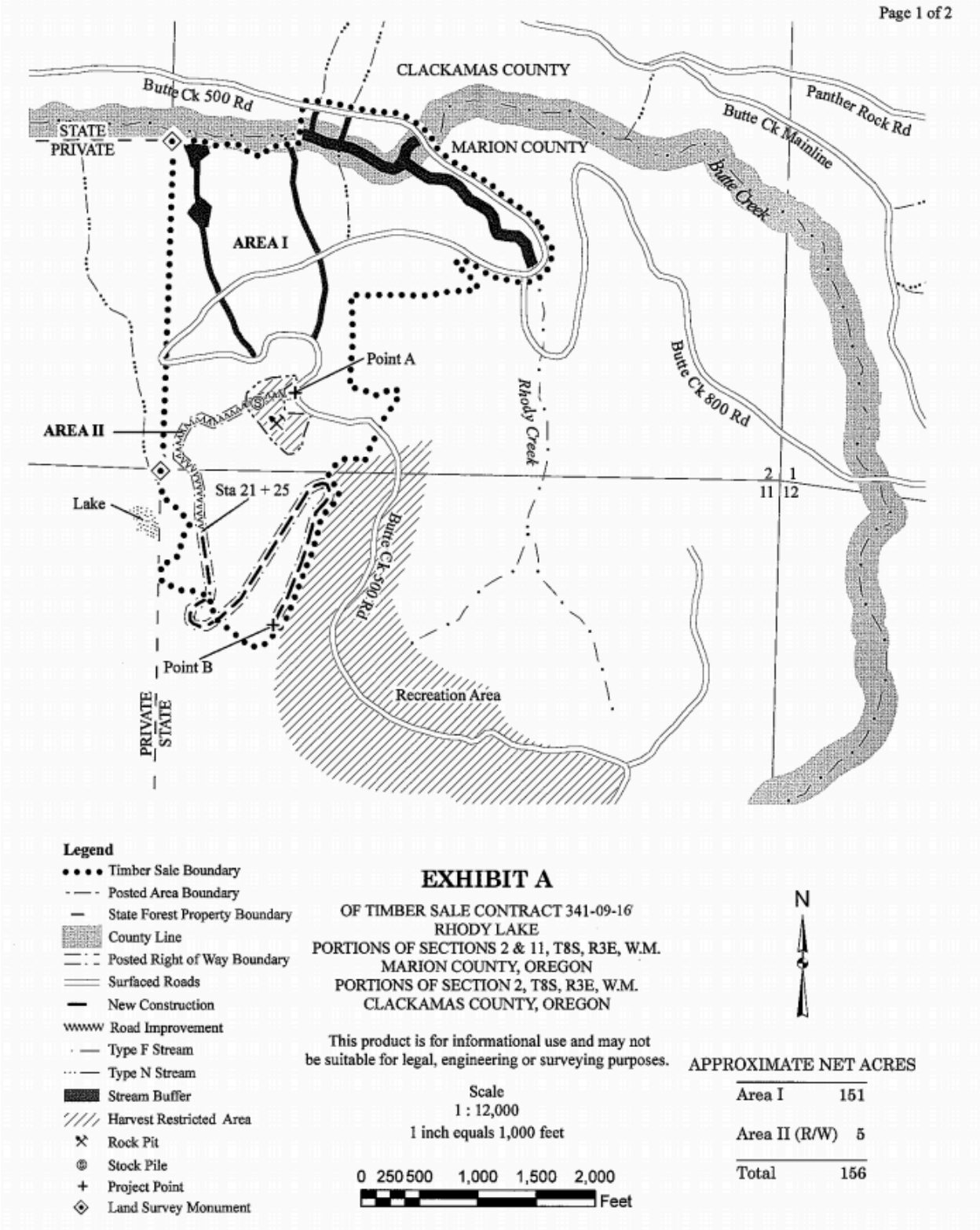

Figure 2c: Example of timber auction map in Idaho

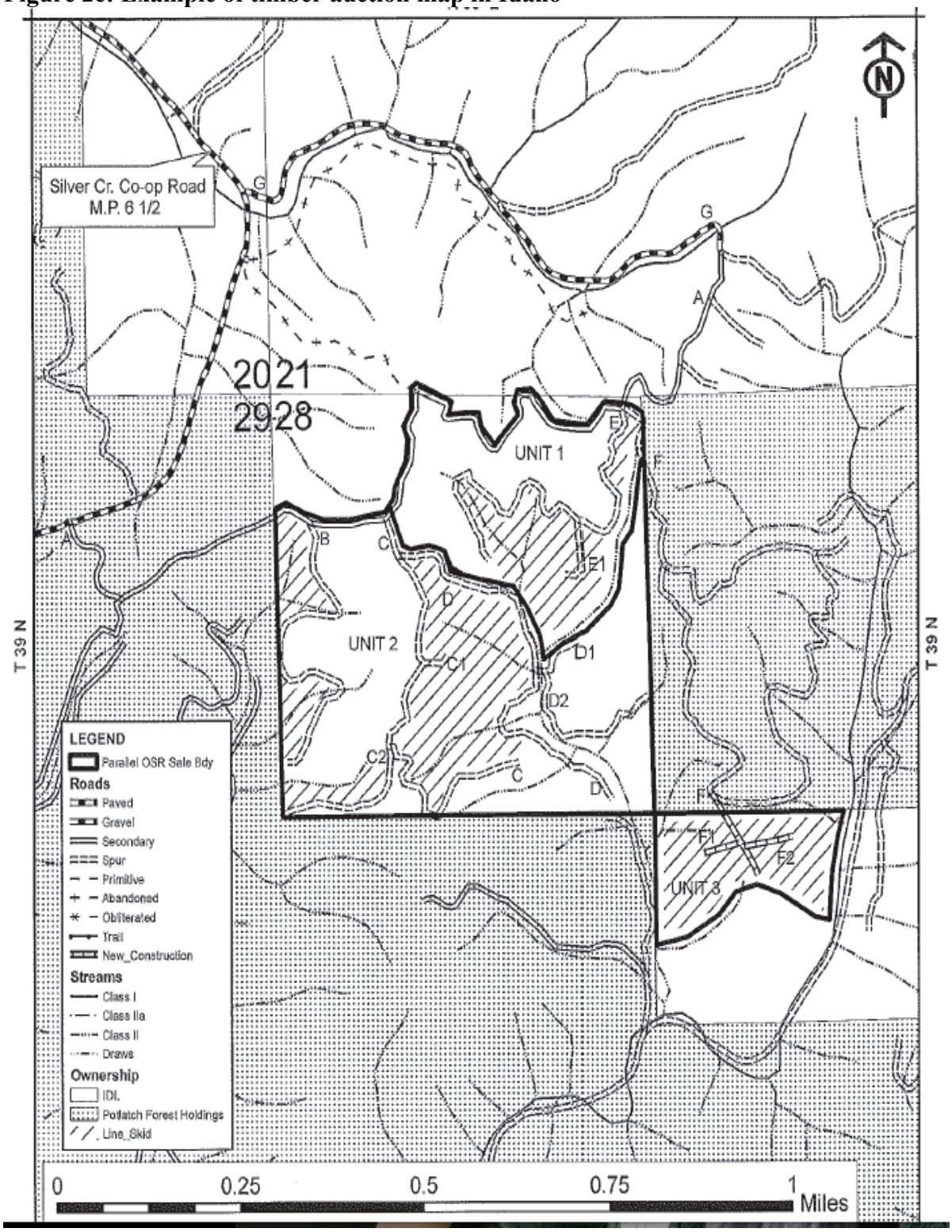

Figure 3A: Timber Auctions in Washington

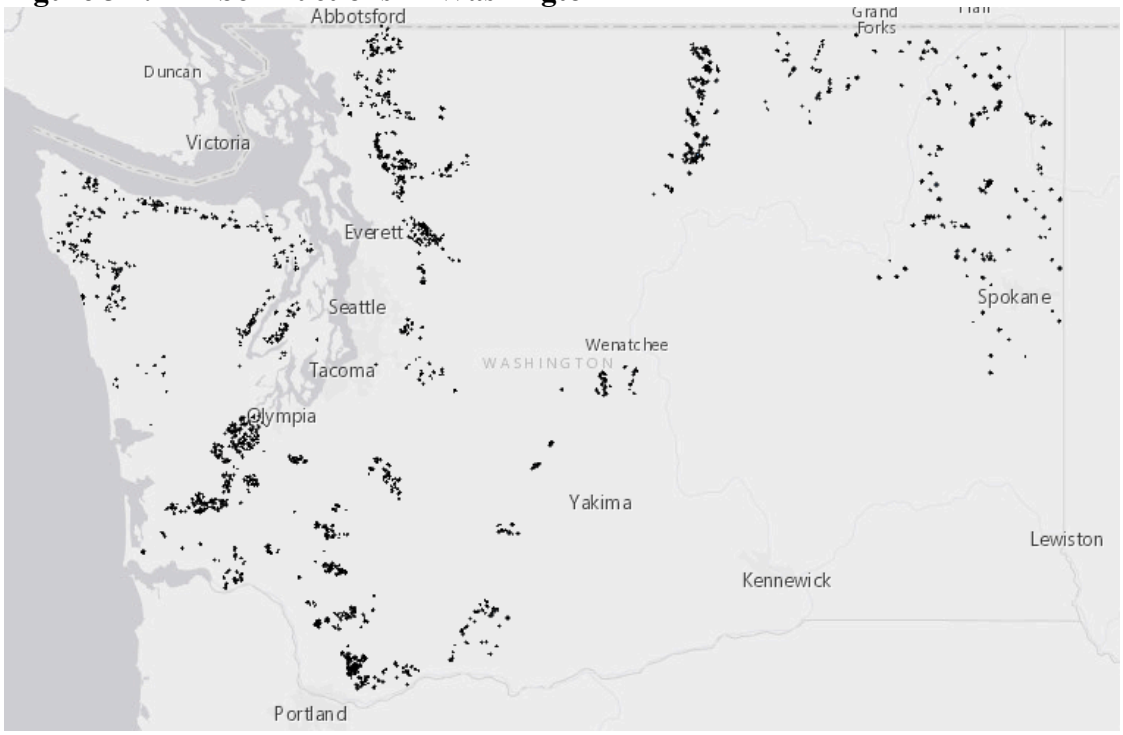

Figure 3B: Map of Timber Auctions in Oregon

Figure 3C: Map of Timber Auctions in Idaho

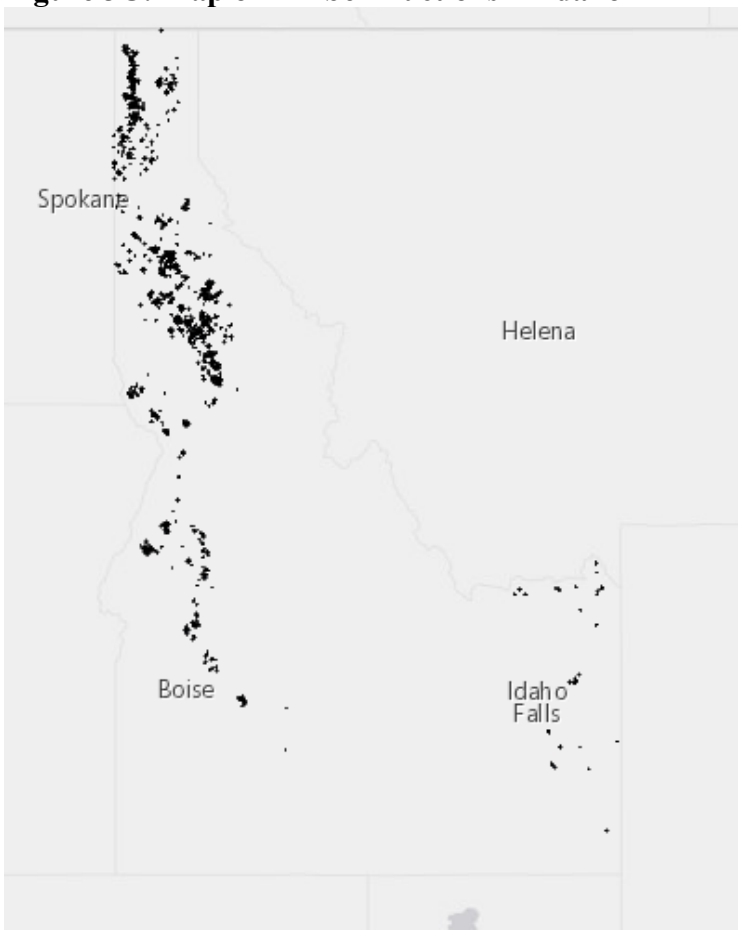

Table 1: Summary Statistics

Variable	Description	Washington	Oregon	Idaho
Bid Price/MBF	Final bid price adjusted for inflation (base year 2010) divided by total volume in the sale measured in 1,000 board feet (MBF)	286.61 (90.7)	282.25 (104.39)	186.17 (63.56)
% Total Miles Bordering	Total distance (miles) of harvest area border adjacent to non-state property divided by perimeter length (miles)	0.09 (0.11)	0.12 (0.17)	0.20 (0.23)
% Federal Miles Bordering	Total distance (miles) of harvest area border adjacent to federal property divided by perimeter length (miles)	0.01 (0.05)	0.03 (0.10)	0.03 (0.07)
% Private Miles Bordering	Total distance (miles) of harvest area border adjacent to private property divided by perimeter length (miles)	0.08 (0.10)	0.09 (0.14)	0.17 (0.22)
Federal Perimeter-to-Area	Total distance (ft) of harvest area border adjacent to federal property divided by square root of the area (acres)	22.68 (121.08)	38.06 (121.01)	44.87 (112.23)
Private Perimeter-to-area	Total distance (ft) of harvest area border adjacent to private property divided by square root of the area (acres)	162.07 (216.80)	131.35 (185.60)	258.13 (300.59)
Perimeter Length	Total distance (miles) of harvest area border	5.2 (3.2)	3.0 (2.9)	5.6 (2.9)
Douglas Fir MBF	Total MBF of Douglas fir tree species, the most commonly auctioned species	2,686.4 (1,869.9)	3,100.5 (2,261.7)	1,336.8 (955.5)
Volume	Total volume (MBF)	4,315 (2,047.1)	3,832.1 (2,423.4)	4,299.1 (2,544.3)
Bids/Bidders	Total number of bids (WA or OR) at the auction or Total number of bidders (ID)	3.0 (1.7)	3.6 (1.9)	3.0 (1.3)
Development Credit Size	Amount the winning timber company will be credited if they complete all assigned projects. Measures the size in dollars of the projects	-	121,542.2 (126,973.7)	88,536.7 (99,378.9)
Cable	Percentage of the harvest that must use cable-logging techniques	0.32 (0.30)	0.61 (0.31)	0.32 (0.30)
Density	Total volume divided by acreage	34.40 (14.60)	26.6 (14.57)	16.16 (8.72)
Burn Probability	A measure of the forest burn probability (Intensity measured from 0 to 9)	0.1 (0.45)	-	0.76 (0.92)
Clearcut Harvest	=1 if the sale is a full clearcut harvest type (variable retention harvest/regeneration in WA)	0.82 (0.38)	0.49 (0.5)	0.05 (0.21)
Combination Harvest	=1 if the sale is a combination of clearcut and thinning (or other) harvest types (data unavailable in ID)	0.12 (0.33)	0.37 (0.48)	-
Extreme Hazard Abatement	= 1 if extreme hazard abatement is required near a property line or county road, otherwise = 0	0.12 (0.33)	-	-
Required Road Construction	Total stations required to be completed (Includes construction, reconstruction)	40.67 (67.44)	-	-
Required Road Maintenance	Total stations where maintenance is required to be completed	131.37 (191.9)	-	-

Accessing Road Revolving Fund	Fee paid based on volume purchased in WA. Pre-2014: $13.25 times the volume on the day of the sale and $9 times the volume upon removal. In 2014, the day-of-sale rate became $17.75 times the volume.	98,475.86 (47,448)	-	-
Recreational District	= 1 if auction is located in a recreational district in WA, otherwise = 0	0.12 (0.33)	-	-
Viewshed Population	Number of individuals who can see the auction (based off US census centroids)	-	72.7 (403.82)	214.3 (1,831.3)
Observations		682	382	327

Table 2: Costs of Non-State Border

	Dependent Variable: Log Price Divided by Total Sale Volume								
	Washington			Oregon			Idaho		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% Non-State Border	-0.246**	-0.280***	-0.222**	-0.347***	-0.322***	-0.254***	-0.192*	-0.145*	-0.178**
	(0.111)	(0.0992)	(0.0921)	(0.122)	(0.102)	(0.0974)	(0.101)	(0.0857)	(0.0806)
Log Perimeter Length (Tract Size)	-0.407***	-0.325***	-0.150***	-0.296***	-0.416***	-0.211***	-0.145***	-0.170***	-0.168***
	(0.0313)	(0.0306)	(0.0436)	(0.0477)	(0.0561)	(0.0544)	(0.0494)	(0.0506)	(0.0560)
% Cable Harvesting	-0.164***	-0.263***	-0.222***	-0.288***	-0.328***	-0.212***	-0.208***	-0.430***	-0.347***
	(0.0413)	(0.0356)	(0.0334)	(0.0684)	(0.0623)	(0.0568)	(0.0594)	(0.0543)	(0.0497)
Log Douglas Fir (MBF)	-	0.0706***	0.0589***	-	0.147***	0.0696***	-	0.0553***	0.0558***
		(0.0120)	(0.0133)		(0.0284)	(0.0241)		(0.0210)	(0.0204)
Clearcut Indicator	-	0.299***	0.270***	-	0.231***	0.136**	-	-0.114	-0.0441
		(0.0843)	(0.0876)		(0.0675)	(0.0619)		(0.0834)	(0.0785)
Combination Cut Indicator	-	0.220**	0.211**	-	0.214***	0.171***	-	-	-
		(0.0883)	(0.0897)		(0.0684)	(0.0639)			
Burn Probability	-	-0.138***	-0.105***	-	-	-	-	-0.0383	-0.0207
		(0.0416)	(0.0356)					(0.0248)	(0.0232)
Density (Volume/Acres)	-	-	0.00432***	-	-	0.00707***	-	-	-0.00528**
			(0.00107)			(0.00124)			(0.00262)
Bids (Total Bidders: ID)	-	-	0.0525***	-	-	0.0633***	-	-	0.0764***
			(0.00570)			(0.00863)			(0.0141)
Log Required Construction	-	-	-0.0137***	-	-	-	-	-	-
			(0.00509)						
Log Required Maintenance	-	-	-0.0175***	-	-	-	-	-	-
			(0.00408)						
Extreme Hazard Abatement	-	-	0.0622**	-	-	-	-	-	-
			(0.0309)						
Log Access Revolving Road Fund	-	-	-0.0728*	-	-	-	-	-	-
			(0.0386)						
Log Development Credit ($)	-	-	-	-	-	-0.00655	-	-	-0.0345***
						(0.00462)			(0.00811)
Constant	6.254***	5.344***	5.714***	6.065***	4.958***	4.939***	5.471***	4.963***	5.100***
	(0.0636)	(0.128)	(0.334)	(0.111)	(0.191)	(0.150)	(0.0993)	(0.173)	(0.153)
Observations	682	682	682	382	382	382	327	327	327
R-squared	0.473	0.613	0.679	0.564	0.695	0.758	0.420	0.579	0.645
Year Indicator	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. In the second and third estimates for each state, we control for the logarithm of Hemlock and Cedar tree species. We also control for Maple MBF (WA), Red Alder MBF (OR), and Lodgepole MBF (ID) in the second and third estimates. In Idaho, we control for the use of aerial harvesting in the second and third estimates. To control for geographical differences in Oregon, we use forest districts, and for Washington and Idaho, we use the forest burn probability. In Washington, we control for an "other" category for harvest type. The final auction price is adjusted for inflation using the Producer Price Index (PPI) (Base year: 2010). *** Statistical significance at 1% level, ** at the 5% level, * at the 10% level

Table 3: Costs of Private and Federal Border

	Dependent Variable: Log Price Divided by Total Sale Volume								
	Washington			Oregon				Idaho	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% Private Border	-0.148	-0.238**	-0.230**	-0.214*	-0.204*	-0.175*	-0.129	-0.127	-0.161*
	(0.118)	(0.111)	(0.102)	(0.130)	(0.104)	(0.0947)	(0.0997)	(0.0941)	(0.0879)
% Federal Border	-0.733***	-0.530***	-0.287*	-0.680***	-0.653***	-0.471**	-0.759**	-0.455*	-0.398**
	(0.264)	(0.194)	(0.172)	(0.216)	(0.204)	(0.206)	(0.320)	(0.233)	(0.198)
Log Perimeter Length (Tract Size)	-0.407***	-0.326***	-0.149***	-0.294***	-0.419***	-0.215***	-0.144***	-0.171***	-0.167***
	(0.0313)	(0.0306)	(0.0434)	(0.0475)	(0.0554)	(0.0545)	(0.0502)	(0.0508)	(0.0563)
% Cable Harvesting	-0.168***	-0.263***	-0.223***	-0.291***	-0.330***	-0.216***	-0.201***	-0.424***	-0.343***
	(0.0411)	(0.0354)	(0.0334)	(0.0674)	(0.0612)	(0.0553)	(0.0591)	(0.0541)	(0.0495)
Log Douglas Fir (MBF)	-	0.0708***	0.0587***	-	0.148***	0.0711***	-	0.0562***	0.0556***
		(0.0119)	(0.0133)		(0.0282)	(0.0242)		(0.0208)	(0.0201)
Clearcut Indicator	-	0.295***	0.271***	-	0.228***	0.134**	-	-0.106	-0.0407
		(0.0849)	(0.0879)		(0.0665)	(0.0610)		(0.0831)	(0.0789)
Combination Cut Indicator	-	0.214**	0.211**	-	0.217***	0.173***	-	-	-
		(0.0890)	(0.0901)		(0.0682)	(0.0640)			
Burn Probability	-	-0.137***	-0.105***	-	-	-	-	-0.0391	-0.0222
		(0.0414)	(0.0355)					(0.0246)	(0.0230)
Density (Volume/Acres)	-	-	0.00437***	-	-	0.00706***	-	-	-0.00501*
			(0.00107)			(0.00124)			(0.00261)
Bids (Total Bidders: ID)	-	-	0.0523***	-	-	0.0617***	-	-	0.0761***
			(0.00577)			(0.00890)			(0.0141)
Log Required Construction	-	-	-0.0138***	-	-	-	-	-	-
			(0.00509)						
Log Required Maintenance	-	-	-0.0174***	-	-	-	-	-	-
			(0.00408)						
Extreme Hazard Abatement	-	-	0.0620**	-	-	-	-	-	-
			(0.0308)						
Log Access Revolving Road Fund	-	-	-0.0739*	-	-	-	-	-	-
			(0.0385)						
Log Development Credit (OR, ID)	-	-	-	-	-	-0.00658	-	-	-0.0341***
						(0.00465)			(0.00808)
Constant	6.249***	5.348***	5.728***	6.054***	4.950***	4.935***	5.469***	4.968***	5.102***
	(0.0643)	(0.128)	(0.334)	(0.111)	(0.190)	(0.150)	(0.100)	(0.168)	(0.151)
Observations	682	682	682	382	382	382	327	327	327
R-squared	0.478	0.614	0.680	0.568	0.699	0.760	0.430	0.582	0.647
Year Indicator	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. In the second and third estimates for each state, we control for the logarithm of Hemlock and Cedar tree species. We also control for Maple MBF (WA), Red Alder MBF (OR), and Lodgepole MBF (ID) in the second and third estimates. In Idaho, we control for the use of aerial harvesting in the second and third estimates. To control for geographical differences in Oregon, we use forest districts, and for Washington and Idaho, we use the forest burn probability. In Washington, we control for an "other" category for harvest type. The final auction price is adjusted for inflation using the Producer Price Index (PPI) (Base year: 2010). *** Statistical significance at 1% level, ** at the 5% level, * at the 10% level

Table 4: Subsamples of Costs of Borders

	Dependent Variable: Log Price Divided by Total Sale Volume					
	Washington		Oregon		Idaho	
	Part of Sale in Section 16 or 36	Remove Only State Border	Part of Sale in Section 16 or 36	Remove Only State Border	Part of Sale in Section 16 or 36	Remove Only State Border
	(1)	(2)	(3)	(4)	(5)	(6)
% Private Border	-0.451**	-0.342***	0.0805	-0.260**	0.0787	-0.150
	(0.186)	(0.128)	(0.257)	(0.116)	(0.140)	(0.110)
% Federal Border	-0.552*	-0.359**	-0.544*	-0.525**	-1.240**	-0.446**
	(0.290)	(0.163)	(0.292)	(0.213)	(0.522)	(0.210)
Log Perimeter Length (Tract Size)	-0.0775	-0.114**	-0.207*	-0.275***	-0.233**	-0.115
	(0.0876)	(0.0561)	(0.123)	(0.0811)	(0.0933)	(0.0729)
% Cable Harvesting	-0.328***	-0.310***	-0.282**	-0.158*	-0.440***	-0.327***
	(0.0736)	(0.0458)	(0.137)	(0.0835)	(0.109)	(0.0589)
Log Douglas Fir (MBF)	0.0431*	0.0625***	0.0668	0.0746*	0.108*	0.0363
	(0.0241)	(0.0192)	(0.0603)	(0.0426)	(0.0589)	(0.0276)
Clearcut Indicator	0.247**	0.278***	0.197	0.146	0.158	0.0139
	(0.0992)	(0.0996)	(0.139)	(0.0891)	(0.166)	(0.0829)
Combination Cut Indicator	0.0865	0.229**	0.314***	0.246***	-	-
	(0.119)	(0.102)	(0.115)	(0.0934)		
Burn Probability	-0.0492	-0.0707*	-	-	-0.0241	-0.0278
	(0.0442)	(0.0403)			(0.0395)	(0.0277)
Density (Volume/Acres)	0.00802***	0.00636***	0.0106**	0.00883***	-0.0146**	-0.00229
	(0.00255)	(0.00161)	(0.00435)	(0.00214)	(0.00601)	(0.00321)
Bids (Total Bidders: ID)	0.0501***	0.0540***	0.0537**	0.0621***	0.0182	0.0854***
	(0.0107)	(0.00762)	(0.0257)	(0.0115)	(0.0304)	(0.0177)
Log Required Construction	-0.0204**	-0.0141**	-	-	-	-
	(0.0102)	(0.00636)				
Log Required Maintenance	-0.0161*	-0.0191***	-	-	-	-
	(0.00831)	(0.00517)				
Extreme Hazard Abatement	0.113*	0.0703**	-	-	-	-
	(0.0577)	(0.0326)				
Log Access Revolving Road Fund	-0.166**	-0.156***	-	-	-	-
	(0.0837)	(0.0502)				
Log Development Credit (OR, ID)	-	-	-0.00119	-0.00896	-0.0121	-0.0388***
			(0.00694)	(0.00635)	(0.0128)	(0.00986)
Constant	6.725***	6.564***	4.641***	4.939***	4.949***	5.129***
	(0.740)	(0.428)	(0.341)	(0.241)	(0.370)	(0.198)
Observations	206	412	63	217	64	239
R-squared	0.716	0.720	0.880	0.767	0.834	0.642
Year Indicator	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. In all estimates, we control for the logarithm of Hemlock and Cedar tree species. We also control for Maple MBF (WA), Red Alder MBF (OR), and Lodgepole MBF (ID) in all estimates. In Idaho, we control for the use of aerial harvesting. To control for geographical differences in Oregon, we use forest districts, and for Washington and Idaho, we use the forest burn probability. In Washington, we control for an "other" category for harvest type. The final auction price is adjusted for inflation using the Producer Price Index (PPI) (Base year: 2010). *** Statistical significance at 1% level, ** at the 5% level, * at the 10% level

Table 5: Robustness Check on Costs of Borders (Perimeter-to-area)

	Dependent Variable: Log Price Divided by Total Sale Volume					
	Washington		Oregon		Idaho	
	(1)	(2)	(3)	(4)	(5)	(6)
State Perimeter-to-Area/1000	-0.0887***	-0.0155	-0.187***	-0.0900***	-0.0622**	-0.0289
	(0.0178)	(0.0154)	(0.0388)	(0.0310)	(0.0306)	(0.0284)
Private Perimeter-to-Area/1000	-0.218***	-0.111**	-0.304***	-0.194**	-0.108	-0.107*
	(0.0634)	(0.0512)	(0.0865)	(0.0765)	(0.0722)	(0.0630)
Federal Perimeter-to-Area/1000	-0.229**	-0.0932	-0.526***	-0.311**	-0.340**	-0.295**
	(0.102)	(0.0607)	(0.148)	(0.137)	(0.156)	(0.132)
% Cable Harvesting	-0.221***	-0.221***	-0.347***	-0.210***	-0.417***	-0.331***
	(0.0370)	(0.0332)	(0.0678)	(0.0593)	(0.0543)	(0.0497)
Log Douglas Fir (MBF)	0.0507***	0.0608***	0.101***	0.0402**	0.0334	0.0349*
	(0.0105)	(0.0134)	(0.0201)	(0.0173)	(0.0204)	(0.0190)
Clearcut Indicator	0.439***	0.298***	0.332***	0.147**	-0.0917	-0.0573
	(0.0941)	(0.0909)	(0.0665)	(0.0626)	(0.0842)	(0.0797)
Combination Cut Indicator	0.298***	0.233**	0.229***	0.166**	-	-
	(0.1000)	(0.0937)	(0.0713)	(0.0653)		
Burn Probability	-0.212***	-0.116***	-	-	-0.0527**	-0.0381
	(0.0472)	(0.0351)			(0.0248)	(0.0233)
Density (Volume/Acres)	-	0.00658***	-	0.00899***	-	-0.00152
		(0.000931)		(0.00115)		(0.00219)
Bids (Total Bidders: ID)	-	0.0536***	-	0.0643***	-	0.0773***
		(0.00589)		(0.00885)		(0.0148)
Log Required Construction	-	-0.0142***	-	-	-	-
		(0.00512)				
Log Required Maintenance	-	-0.0176***	-	-	-	-
		(0.00410)				
Extreme Hazard Abatement	-	0.0560*	-	-	-	-
		(0.0309)				
Log Access Revolving Road Fund	-	-0.154***	-	-	-	-
		(0.0310)				
Log Development Credit (OR, ID)	-	-	-	-0.00974**	-	-0.0387***
				(0.00457)		(0.00812)
Constant	5.024***	6.294***	4.952***	4.962***	4.930***	5.047***
	(0.133)	(0.296)	(0.183)	(0.152)	(0.175)	(0.156)
Observations	682	682	382	382	327	327
R-squared	0.552	0.674	0.659	0.751	0.572	0.638
Year Indicator	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. In all estimates, we control for the logarithm of Hemlock and Cedar tree species. We also control for Maple MBF (WA), Red Alder MBF (OR), and Lodgepole MBF (ID) in all estimates. In Idaho, we control for the use of aerial harvesting. To control for geographical differences in Oregon, we use forest districts, and for Washington and Idaho, we use the forest burn probability. In Washington, we control for an "other" category for harvest type. The final auction price is adjusted for inflation using the Producer Price Index (PPI) (Base year: 2010). *** Statistical significance at 1% level, ** at the 5% level, * at the 10% level

Table 6: Competing Uses for Timber in Washington and Oregon

	Dependent Variable: Log Price Divided by Total Sale Volume					
	Washington (Recreational Districts)			Oregon (Elliot State Forest)		
	(1)	(2)	(3)	(4)	(5)	(6)
Recreational District Indicator	-0.103**	-0.0701**	-0.0584**	-	-	-
	(0.0477)	(0.0352)	(0.0285)			
Elliot State Forest* Approved Plan	-	-	-	-0.344**	-0.252**	-0.267**
				(0.164)	(0.117)	(0.107)
Elliot State Forest	-	-	-	0.344**	0.138	0.193**
				(0.145)	(0.0981)	(0.0928)
Log Perimeter Length (Tract Size)	-	-	-0.135***	-	-	-0.0340
			(0.0425)			(0.159)
% Cable Harvesting	-0.0377	-0.203***	-0.215***	0.0969	-0.237	-0.0102
	(0.0455)	(0.0366)	(0.0331)	(0.317)	(0.165)	(0.161)
Log Douglas Fir (MBF)	-	0.0535***	0.0594***	-	0.151***	0.0537
		(0.00997)	(0.0130)		(0.0528)	(0.0581)
Clearcut Indicator	-	0.451***	0.262***	-	1.013***	0.578***
		(0.103)	(0.0862)		(0.171)	(0.219)
Combination Cut Indicator	-	0.290***	0.203**	-	0.606***	0.487***
		(0.109)	(0.0880)		(0.176)	(0.174)
Burn Probability	-	-0.248***	-0.109***	-	-	-
		(0.0482)	(0.0351)			
Density (Volume/Acres)	-	-	0.00488***	-	-	0.00865***
			(0.00105)			(0.00244)
Bids (Total Bidders: ID)	-	-	0.0533***	-	-	0.0535***
			(0.00569)			(0.0171)
Log Required Construction	-	-	-0.0144***	-	-	-
			(0.00511)			
Log Required Maintenance	-	-	-0.0160***	-	-	-
			(0.00409)			
Extreme Hazard Abatement	-	-	0.0497*	-	-	-
			(0.0299)			
Log Access Revolving Road Fund	-	-	-0.0767**	-	-	-
			(0.0383)			
Log Development Credit	-	-	-	-	-	-0.0276*
						(0.0155)
Constant	5.490***	4.785***	5.687***	5.233***	3.688***	4.374***
	(0.0367)	(0.134)	(0.330)	(0.301)	(0.428)	(0.488)
Observations	682	682	682	96	96	96
R-squared	0.293	0.520	0.678	0.266	0.672	0.751
Year Indicator	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. There are 36 auctions in Elliot State Forest. Twenty-one are before the approved plan and 15 are after it. All harvests in Elliot State Forest are full clearcuts. In all estimates, we control for the logarithm of Hemlock and Cedar tree species. We also control for Maple MBF (WA) and Red Alder MBF (OR) in the last two estimates for each state. In Washington, we control for an "other" category for harvest type. The final auction price is adjusted for inflation using the Producer Price Index (PPI), (Base year: 2010). *** Statistical significance at 1% level, ** at the 5% level, * at the 10% level

Table 7: Competing Uses - Viewshed

	Dependent Variable: Log Price Divided by Total Sale Volume					
	Oregon		Idaho		Idaho	
	Clearcut Definition		Clearcut Definition			
	>=90%	=100%	>=90%	>=100%	Scenic	Scenic
	(1)	(2)	(3)	(4)	(5)	(6)
Log Viewshed Population*Clearcut Indicator	-0.0286**	-0.0265*	-0.0475*	-0.0696**	-	-
	(0.0136)	(0.0135)	(0.0280)	(0.0348)		
Log Viewshed Population	0.0294**	0.0280**	0.0308***	0.0312***	-	-
	(0.0114)	(0.0114)	(0.00807)	(0.00800)		
Clearcut Indicator	0.213***	0.201***	0.0214	0.0386	-	-0.0893
	(0.0696)	(0.0689)	(0.0711)	(0.0762)		(0.0794)
Class I or II Indicator	-	-	-	-	-0.404***	-0.384***
					(0.134)	(0.130)
% Cable Harvesting	-0.165***	-0.162***	-0.309***	-0.311***	-0.428***	-0.349***
	(0.0595)	(0.0597)	(0.0519)	(0.0517)	(0.0567)	(0.0525)
Log Douglas Fir (MBF)	0.0374*	0.0357*	0.0153	0.0152	0.0411**	0.0367**
	(0.0193)	(0.0193)	(0.0197)	(0.0194)	(0.0191)	(0.0181)
Combination Cut Indicator	0.161**	0.165**	-	-	-	-
	(0.0642)	(0.0641)				
Burn Probability	-	-	-0.0341	-0.0325	-0.0663***	-0.0523**
			(0.0230)	(0.0229)	(0.0252)	(0.0236)
Density (Volume/Acres)	0.00943***	0.00964***	0.00133	0.00127	-	0.000418
	(0.00122)	(0.00122)	(0.00219)	(0.00216)		(0.00215)
Bids (Total Bidders: ID)	0.0722***	0.0728***	0.0789***	0.0787***	-	0.0723***
	(0.00874)	(0.00868)	(0.0147)	(0.0146)		(0.0137)
Log Development Credit (OR, ID)	-0.00851*	-0.00874*	-0.0382***	-0.0383***	-	-0.0398***
	(0.00487)	(0.00486)	(0.00776)	(0.00774)		(0.00700)
Constant	4.706***	4.716***	4.950***	4.946***	4.907***	5.103***
	(0.171)	(0.172)	(0.148)	(0.147)	(0.164)	(0.152)
Observations	382	382	327	327	327	327
R-squared	0.749	0.749	0.649	0.651	0.591	0.660
Year FE	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. There are seventeen auctions that are located in Class I and II landscape classifications, and at least 90 percent of the harvest area is not. In all estimates, we control for the logarithm of Hemlock and Cedar tree species. We also control for Red Alder MBF (OR) and Lodgepole MBF (ID) in all estimates. In Idaho, we control for the use of aerial harvesting. To control for geographical differences in Oregon, we use forest districts, and for Idaho, we use the forest burn probability. The final auction price is adjusted for inflation using the Producer Price Index (PPI). *** Statistical significance at 1% level, ** at the 5% level, * at the 10% level