Extended Abstract
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Paper/Poster Title	Does land tenure security reduce deforestation? Evidence for the Brazilian Amazon

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Abstract	***200 words max***
We evaluate the extent to which rural properties with secure land rights are less prone to deforestation and more likely to comply with the Forest Code in the Brazilian Amazon. We use a unique dataset with property-level information for the entire population of private rural properties registered in the state of Acre, Brazil. Land tenure security is defined by the absence of overlapping property rights, which means that for each rural plot, only one land title attests to whom the legal ownership belongs. We evaluate the impacts of secure land right on the (i) property's share of the deforested area and (ii) the likelihood that farmers comply with the Brazilian Forest Code, which defines a limit of 20% of the deforested area in each property. The non-randomness between the treatment (land security) and control (land insecurity) groups is controlled using the inverse probability weighting regression adjustment. Our results highlight that land tenure security reduces the deforested area and increases compliance with the Forest Code.	

Keywords	Land governance, Land tenure security, Deforestation, Brazilian Amazon
JEL Code	Land Ownership and Tenure – Q15 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***

The Brazilian Amazon is characterized by a weak rule of law, and land tenure rights are subject to widespread uncertainties. The region still presents a relevant share of untitled public lands, and land grabbing is common. The Brazilian government has facilitated individual land titling to improve land security and reduce deforestation. However, studies have suggested that individual land titling alone, without coordination with other policies, may not yield the expected environmental benefits. Landholders with property titles may still have incentives to deforest when undertaking agricultural activities or through real estate speculation and land grabbing. Broader land tenure security institutions, which refer to effective protection of land rights, should provide more effective ways to contain deforestation in the region.

Our central hypothesis is that deforestation results from institutional failures associated with land governance in the Brazilian Amazon. These institutional failures would encourage land grabbing in public or private areas, mainly motivated by real estate market speculation, producing a generalized environment of tenure insecurity in the region. Even properties with individual titles would be subject to more

deforestation because the guarantees that the land rights will be enforced are fragile. In other words, in an environment with institutional failures, the title itself may not be enough to reduce new deforestation and irregular occupations.

Methodology	***100 – 250 words***

We use a sample of 35,067 private rural properties registered at the *Cadastro Ambiental Rural* (CAR) from the state of Acre. Our outcome variables are (i) the share of the deforested area between 2009 and 2018, and (ii) a binary variable for compliance with the Forest Code (up to 20% of the deforested area).

We define the treatment groups (land tenure security) based on the absence of overlapping property rights. We test two definitions: no overlapping; overlapping limited to up to 10%, 5%, or 3% of the total area, depending on the property size. The latter criterium is based on the recommendation of the CAR. Control variables include characteristics of the property (size, distance to the city, agricultural aptitude, deforestation before 2009) and region (productivity, stocking rate, land price).

We use different empirical strategies to estimate the average treatment effect on the treated (ATT): linear and Tobit models, when the outcome is the share of the deforested area; Probit models, when the outcome is compliance with the forest code. We control sample selection bias using the Inverse Probability Weighting Regression Adjustment (IPWRA), a two-stage estimation strategy based on propensity score matching.

We segment analyses into three land categories: legal property title, when the land is officially registered at the competent judicial institution; conditional land title, when the property is subject to some form of condition before land can be registered at the competent judicial institution; and occupied land, when the land occupation is illegal.

Results	***100 – 250 words***

The first stage of the IPWRA estimates the selection models for the probability of having land tenure security. Properties are less likely to have land security in regions with high cattle herd per hectare, and more likely to have land security in regions with a high agricultural aptitude and land prices.

The estimates of the ATT in the outcome models for the share of deforested areas are significant at 0.1% using all empirical strategies: land tenure security significantly reduced the property's share of deforested areas. The share of the deforested area in the period 2009-2018 was between 0.9 and 2.2 percentage points (p.p) lower in properties with land tenure security. These estimates represent between 13% and 31% of the total deforestation increase in the period. Land tenure security also increased the probability of compliance with the Forest Code by between 2.9 and 7.6 p.p.

The estimates of the ATT segmented by land categories indicate that land security plays a more critical role in reducing deforestation and increasing compliance in legal

properties and properties with conditional land titles. Land tenure security increased the probability of compliance with the Forest Code by between 5.2 and 13.1 p.p. in properties with individual legal titles and between 4.4 and 16.5 p.p. in properties with conditional land titles. The ATT estimates in illegally occupied lands are mostly insignificant.

Discussion and Conclusion	***100 – 250 words***

The main contribution of this study is to provide evidence that land tenure security reduces deforestation and increases compliance with the Forest Code in the Brazilian Amazon. We developed our hypotheses assuming that the failures of land governance in the Brazilian Amazon promote significant uncertainties regarding the security of tenure, with direct impacts on deforestation.

Our results demonstrate that deforestation between 2009 and 2018 should be significantly lower under more effective land governance. These results reinforce the idea that institutional failures play a major role in the deforestation of the Amazon. The impacts of land tenure security on deforestation and compliance with the Forest Code are higher in legal prosperities than in illegally occupied lands. In other words, individual land titling may not generate the expected impacts on deforestation and compliance with the Forest Code if the land tenure rights are not guaranteed by good land governance.

We also bring empirical contributions to the literature. First, we use a unique dataset with georeferenced farm-level information for the whole population of private properties officially registered in the state of Acre. Second, we propose new indicators of land tenure security based on the lack of overlapped property rights. To the best of our knowledge, this is the first study to use an indicator of land tenure based on governance rather than individual land titling. Land tenure overlaps may be linked to agrarian conflicts arising from the dispute for land. Land tenure overlaps may also be due to contentious social processes for irregular land occupation. Agrarian conflicts and irregular land occupations can also be associated with real estate speculation and land-grabbing crimes on public or private lands.