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Forest conservation effects of Brazil's zero deforestation cattle agreements undermined by leakage

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ABSTRACT

Supply chain interventions, which include certification schemes and zero-deforestation commitments that aim to produce environmentally and socially beneficial outcomes, are increasingly common, but evidence of their efficacy is scarce. We quantified avoided deforestation from Brazil's zero-deforestation cattle agreements by exploiting variation in the policy's rollout and the acquisition of slaughterhouses by the agreements' signatories from 2007 to 2015 in the Amazonian states of Mato Grosso and Pará. We found no average impact of the agreements on forest cover in the regions surrounding signatory slaughterhouses by the end of 2014. Our results show avoided deforestation of about 6% from the agreements on properties that enrolled early in the rural environmental land registry. However, forest loss increased commensurately on those properties that registered later, thus washing out the positive conservation effects from the early registrants. Our results also highlight that slaughterhouses bought plants in regions with higher deforestation both before and after the agreement, suggesting that companies are not avoiding these important hotspots. We conclude that the agreements have led to some avoided deforestation on registered properties, whose boundaries are transparent and publicly accessible, but that more robust reductions in deforestation will require additional action. The agreements could be made more effective by expanding monitoring to include all properties in the supply chain, as well as ensuring that all slaughterhouses monitor.

1. Introduction

Deforestation contributes 10% of global anthropogenic greenhouse gas emissions, and avoiding deforestation has the potential to provide as much as 40% of the emissions cuts needed to mitigate climate change (Baccini et al., 2012; Harris et al., 2012). The main drivers of tropical deforestation are conversion of land to agricultural and pastoral uses, and it has been suggested that a large part of this deforestation is driven by export demand (Rudel et al., 2009; DeFries et al., 2010; Gibbs et al., 2010; Henders et al., 2015). In response to pressure from consumer groups and non-governmental organizations (NGOs), a variety of private sector interventions were developed that intend to provide goods with certified environmental quality - among these are wood, palm oil, biofuels, soy, and beef (Walker et al., 2013; Newton et al., 2013; Lambin et al., 2014). These certification schemes, deforestation moratoria, commodity roundtables, and public company commitments all rely on some type of market pressure to help ensure more forest conservation or sustainable land use. Despite increased international attention and high levels of investment over the past decade, little is known about how these supply-chain interventions impact forests (Lambin et al., 2017). Most previous studies have been qualitative, and few have assessed forest conservation outcomes using rigorous counterfactuals. The current study estimates the impact of Brazil's zero deforestation cattle agreements, which have the potential to significantly impact global deforestation.

After peaking in the mid-2000s, Brazil's deforestation rate has dropped in recent years, but it remains the second highest country in absolute deforestation, and some evidence indicates that rates are again increasing (Watts, 2015; INPE, 2016). Expansion of cattle pasture continues to be associated with up to 80% of Brazil's deforestation, particularly in the states of Mato Grosso and Pará (INPE/EMBRAPA, 2012; De Sy et al., 2015), which were responsible for 60% of beef production in the Amazon region as of 2007 (IBGE, 2015). Even though 80% of its beef is consumed domestically, Brazil is currently the second largest exporter of beef in the world (FAS/UDSA, 2016), and exports of cattle from the Legal Amazon have risen 18 fold since 2000.

For the past decade, Brazil's government has expanded environmental policies and enforcement. Strategies have included updating the

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federal Forest Code in 2012, the use of satellite-based deforestation monitoring, expanded incentives for environmental registration, and permits to conduct economic activities in rural areas (Barreto and Araújo, 2012; Nepstad et al., 2014). However, effectiveness has been limited by uneven enforcement of laws and limited cooperation across government agencies (Gibbs et al., 2015b). These challenges have drawn the attention of international environmental organizations and other stakeholders, who have developed innovative policies that attempt to influence all actors in the beef supply chain.

In July 2009, in response to increasing pressure from the Brazilian government and international NGOs, individual meatpacking companies in the Amazonian state of Pará began signing legally binding "Terms of Adjustment of Conduct" ("MPF-TAC") agreements to stop purchasing from properties with deforestation above legal limits (Ministério Público Federal, 2009, 2013a,b). In October 2009, the largest meatpacking companies in Brazil – Marfrig, Minerva, JBS, and Bertin (subsequently bought by JBS) additionally signed the "G4" zero-deforestation agreement with Greenpeace (Greenpeace International, 2009). These agreements spread through other Amazonian states, and currently cover over 75% of the federally inspected slaughterhouses (SIFs) that are legally allowed to export beef from the Legal Amazon (67 out of 88 SIFs as of July 2016). The potential scope for impact from the activities of these companies is large: in 2015, Marfrig, JBS, and Minerva owned over half of the federally inspected slaughterhouses in the two states that we study (Gibbs et al., 2015a). JBS alone is responsible for 50% of the cattle slaughtered in the Legal Amazon.

Both agreements mandate meatpacking companies to block sales from properties with deforestation occurring after 2009, with accusations of slave labor, with embargoes for illegal deforestation, and those not eventually registered in the Rural Environmental Registry (CAR by its Portuguese acronym), a state registry which stores a map containing geo-referenced property boundaries for satellite monitoring (State of Pará, 2006, 2008, 2016; State of Mato Grosso, 2008). To date, they both govern only those properties that sell directly to slaughterhouses, and have not yet expanded governance to those properties that might have housed cattle during earlier stages of the production process.

The agreements differ, however, in their allowable deforestation limits and in their implementation rules. The MPF-TAC follows the Brazilian Forest Code in defining illegal deforestation as exceeding 20% of a property's forest area (Ministério Público Federal,2013), while the G4 prohibits any clearing. Furthermore, the G4 agreement requires signatories to set up monitoring systems, which they have done using deforestation maps produced by the Brazilian government (Instituto Nacional de Pesquisas Espaciais, 2014), while those companies that have signed only the "MPF-TAC" have just recently begun setting up deforestation monitoring systems, and only for some companies.

Our paper is the first to rigorously evaluate the avoided deforestation impact of these supply chain commitments. Our estimation strategy included unit and time fixed effects and exploited both the overall rollout of the agreements as well as the gradual acquisition of slaughterhouses owned by signatories of the agreements in order to identify their impact on deforestation in the Amazonian states of Mato Grosso and Pará. We measured the effect of the agreements on forest cover between 2007 and 2014. Our counterfactual was the deforestation trend before the policy was applied in slaughterhouse supply zones that were eventually affected by the agreements. This strategy helped to minimize the confounding effects of both firm-level decisions to sign agreements, as well as cattle-supplier decisions to sell to signatory processors. It also means that our impact estimates take account of localized leakage.

Our work speaks most directly to previous studies on a related policy – forest certification (Auld et al., 2008). Analysis of the impacts of certification have been mixed: from apparently ineffective in Mexico (Blackman et al., 2015) to relatively effective in Indonesia (Miteva et al., 2015) and Chile (Heilmayr and Lambin, 2016). Our work differs from these studies in both focus, since we examine a different type of supply-chain intervention, and in methodology, since by using only land that was eventually affected by the policy, we propose a different approach to addressing the problem of unobservable factors driving policy impacts.

Although no other papers have analyzed the avoided deforestation effects of the cattle agreements, previous work on the agreements in Pará estimated that JBS slaughterhouses incentivized CAR registration and began to block purchases from ranchers with deforestation following the implementation of the G4 and the MPF-TAC (Gibbs et al., 2015). However, this analysis also noted the possibility of leakage to unmonitored properties. The present paper quantifies this local displacement, and thus contributes to the scant empirical assessments of deforestation displacement in developing countries. To date, the work on deforestation leakage has focused on protected areas (Robalino, 2007; Arriagada et al., 2012; Robalino et al., 2017) and payments for ecosystem services programs (Alix-Garcia et al., 2012). The present paper is unique in its assessment of leakage emanating from a supply-chain agreement.

2. Methods

2.1. Study area and sample

Our analysis focused on the state of Pará and the portion of Mato Grosso that falls in the Amazon biome. These two states constituted more than half of all the forest in the Legal Amazon from 2004 to 2014 (INPE, 2016). Production in these areas is increasingly oriented toward export – mostly of soy and beef, but occasionally other crops. Farms tend to be large, with median registered property sizes of 93.9 ha in Mato Grosso and 63.1 in Pará as of 2014. They are also among the states with the biggest increase in cattle production since 2000 (McManus et al., 2016).

We created a stratified random sample of points, with equal numbers of points in both states, resulting in slight oversampling in Mato Grosso. Our unit of analysis was the point, and all estimations were weighted by the proportion of the study area that falls in each state, allowing us to interpret our results as population averages. Since points lack area, we assigned characteristics of the layers on which they fell to each point.

We avoided two challenges by using the point as the analysis unit rather than an entire property or a grid cell of arbitrary size. The first was that results could be interpreted directly as the average effect across the landscape rather than the effect for a property with average characteristics, without re-weighting by property size. This was useful for assessing the full avoided deforestation impacts rather than property-level responses to policy. The second advantage came in the assignment of property boundaries to the points – each point had an easily attributable first year of application to the CAR. This is not the case with properties, which can potentially have shifts or overlaps in boundaries over time that make it difficult to assign a unique date of first application to a property.

2.2. Outcome

The outcome of interest was if a point remained forested at the end of the year. To measure forest cover, we used Landsat-based PRODES deforestation maps created by the Brazilian Institution for Space Research (INPE). Annual data exists from 2001 to present, though for our study, we examined program impact during the years 2007–2014, and used earlier years to examine pre-trends. Because PRODES drops areas once deforested, it could not be used to measure afforestation or re-clearing of secondary forest. We dropped points that were not forested in 2007 from our main analysis. In addition, after points were identified as deforested, subsequent values were set to missing. This created an unbalanced panel but avoided augmenting the sample size with data that contained no meaningful variation.