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Public policies can reduce tropical deforestation: Lessons and challenges from Brazil

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ABSTRACT

Reducing carbon emissions from deforestation and forest degradation now constitutes an important strategy for mitigating climate change, particularly in developing countries with large forests. Given growing concerns about global climate change, it is all the more important to identify cases in which economic growth has not sparked excessive forest clearance. We address the recent reduction of deforestation rates in the Brazilian Amazon by conducting a statistical analysis to ascertain if different levels of environmental enforcement between two groups of municipalities had any impact on this reduction. Our analysis shows that these targeted, heightened enforcement efforts avoided as much as 10,653 km^2 of deforestation, which translates into 1.44×10^{-1} Pg C in avoided emissions for the 3 y period. Moreover, most of the carbon loss and land conversion would have occurred at the expense of closed moist forests. Although such results are encouraging, we caution that significant challenges remain for Brazil's continued success in this regard, given recent changes in the forestry code, ongoing massive investments in hydro power generation, reductions of established protected areas, and growing demand for agricultural products.

Introduction

Although tropical deforestation and degradation have long been a concern of the academic community and the general public for a wide variety of reasons, attention has begun to focus increasingly on carbon emissions because of their contribution to global warming (Myers et al., 2000; Wright, 2005). Land use changes for 2000–2007, primarily tropical deforestation, account for an estimated 1.10 ± 0.70 Pg C y^{-1}, or 14–20% of global greenhouse gas emissions (Pan et al., 2011), and will probably remain substantial in coming decades (Sitch et al., 2005). As a consequence, the United Nations has spear-headed an initiative to reduce emissions from deforestation and forest degradation (REDD), and numerous efforts are underway worldwide to achieve such forest-based reductions. Countries like Norway have donated millions of dollars to support $REDD^+$ forest conservation projects, which altogether now account for 9% of voluntary carbon offsets (BNDES, 2013; Peters-Stanley and Hamilton, 2012).

Given growing investment in REDD/$REDD^+$ activities, and their importance to climate change mitigation, it is important to identify situations where REDD-oriented policies appear to be successful but not at the expense of human welfare. That said, developing sustainable relationships between natural and human systems are not easily achieved, and successful cases are few and far between (Nunes et al., 2012). Brazil, which made deforestation reduction a central piece of its climate change policy in 2009 (Brasil, 2009), appears to present one such success story. Thus, the article's objective is to examine the impact of recent environmental policy applications in Brazil, in the interest of finding a pathway to sustainable development for countries with large extents of native vegetation.

The article pursues its objective as follows. First, it considers deforestation rates in the Brazilian Amazon over the past several decades, and addresses the relationship between agricultural expansion in the basin and changes in forest area. Second, it gives an overview of environmental policy directed at Brazil's northern region, particularly its Amazonian Biome, the closed moist forest ecosystem that once covered ~4,000,000 km^2. Next, the article presents statistical analyses that reveal the extent to which

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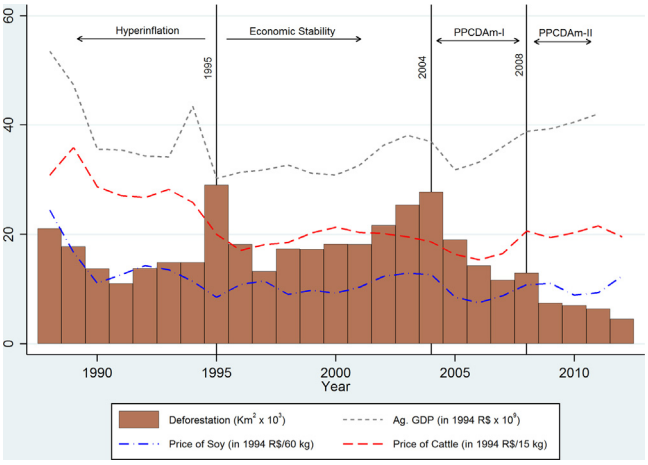

Fig. 1. Amazonian deforestation rates, price of soy, price of cattle, and agricultural GDP from 1988 to 2012, Brazil.
Sources: IEA, SP and IBGE.

recent policy measures have reduced Amazonian deforestation. It also translates these statistical results into carbon reduction values, and into ecosystem specific magnitudes of conservation. The article concludes with a brief discussion of implications of the findings for sustainable development both in Brazil and other tropical countries with valuable forest resources.

Background

Deforestation trends and agriculture

Since 1988, when Brazil's Space Agency (INPE) began monitoring Amazonian deforestation with satellite imagery, deforestation rates have varied from a record high of 29,059 km^2 in 1995 to a low of 4571 km^2 in 2012 (Fig. 1). After 2004, when 27,772 km^2 were deforested, rates have tended to decline. The sharpest percent drop occurred between 2008 and 2009, when annual forest loss plummeted from 12,911 km^2 to 7464 km^2. Given that the global economy entered serious recession in 2008, this drop might be explained by declining demand for Brazilian agricultural commodities (Walker, 2011). This is a reasonable conjecture, given the role that agriculture has played in Amazonian forest loss, particularly ranching. Planted and abandoned pastures account for 80% of all cleared lands, and annual crops, mostly soybeans, another 5% (EMBRAPA and INPE, 2011).

An alternative explanation resides in effective policy, following Brazil's recent adherence to principles of the UN-REDD program in 2009. That low rates of deforestation persisted after the recession, which ended in 2009, appears consistent with a policy-based explanation for the decline in forest loss. Correlations between deforestation and the agricultural sector are high starting with monetary reform and macroeconomic stability in 1994 and Brazil's entry into world markets as a major supplier of soybeans and beef. From 1995 until 2007, deforestation correlates with lagged soybean ($r = 0.721$) and cattle prices ($r = 0.720$), which together explain more than 75% of the total variation in rates of forest loss for the period 1995–2007. Such relationships weaken considerably after 2007. Although deforestation rates remain positively related to soybean prices for the period 2008–2011, they decouple from cattle prices, and actually reverse for agricultural GDP, with a strong negative relationship.

Thus, the decline in Brazil's deforestation rate possesses two possible explanations, namely the stagnation in global demand for agricultural goods, or the enforcement of an effective policy regime. The goal of the article is to resolve this issue, and to measure the effectiveness of a specific policy instrument that was brought to bear on the Brazil's portion of the Amazon Basin during the millennial decade.

Policy context

The institutional background. Before proceeding, we briefly consider the policy concept that motivates the article. In this regard, we take a broadly institutional perspective, with policy encompassing both explicit legislation and government programs aimed at achieving specific outcomes, typically through the promotion of positive incentives (Jepson, 2006). Also included are actions by government that produce positive environmental externalities, such as the creation of indigenous reserves. Finally, we take policy enforcement to be part of our conceptual picture, in which case the social resources (e.g. power) capable of applying law or implementing programs form part of a policy *regime*. For the Brazilian case, environmental policy germane to this article originates with the first forestry code in 1934 (Simmons, 2002), although explicit concern for the Amazonian Biome only emerged with federal highway construction in the 1970s. As the Brazilian federal government transitioned from a military regime to democracy in the mid-1980s, awareness grows both in Brazil and internationally that Amazonian forest loss, while allowing for economic development, also presented a number of environmental harms. The timing of this awareness was fortuitous given the political transition to democracy and associated institutional changes including a free press, the emergence of a politically independent judiciary, and the elaboration of human rights that included the right to sustain indigenous identities (Simmons, 2002).

Amazonian environmental policy originating in the 1980s has involved protected areas, including indigenous territories and conservation units, and modifications of the forestry code in response to the Amazonian situation. Up until the 1988 Constitution, Brazil followed an assimilation policy vis-à-vis its substantial native population, which anticipated the ultimate disappearance of native cultures and their gradual absorption into Brazilian society. The declaration of indigenous rights opened the door to territorial reserves that now cover ~20% of the land within Amazonia Legal (AML), or "The Legal Amazon." This is matched and even exceeded by lands now under some form of environmental protection by both federal and state governments that comprise ~25% of AML (Walker et al., 2009). Adaptations to the forestry code for Amazonia in 1965 increased the amount of land ranchers and farmers were required to keep as a forest reserve from 20 to 50% (Simmons, 2002). In 1996, Brazil's Space Agency, INPE, announced the largest deforestation magnitude in history, with 29,000 km^2 of the forest lost in 1995. President Fernando Henrique Cardoso took executive action and increased the forest reserve to 80%, a number that remains in place with the recently approved forestry code, although exemptions from reforesting previously deforested areas were granted depending on the size of the property and the year that deforestation occurred.

Recent policy intensifications

Although the record high deforestation rate in 1995 was followed by two years of decline (1996–1997), the trend reversed and deforestation increased consistently for the period 1998–2004, returning to the high levels of the mid-1990s. This prompted the federal government's first Action Plan to Prevent and Control Deforestation in the Amazon (PPCDAm-I), implemented between 2004 and 2007. Under this plan, Brazil's environmental enforcement agency (IBAMA) was restructured and began using INPE's 'real time' deforestation detection (DETER) to target its enforcement efforts in the field (Abdala, 2008). Another important component of the