



# A Key Ingredient in Deforestation Slowdowns? A Strong Brazilian Economy

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For much of the past two decades, the scientific and policy community has sought to reduce forest loss through well-targeted public policy and enforcement measures and private sector engagement. Unfortunately, recent increases in forest loss in the Amazon have raised new concerns over the drivers of deforestation in the region, and the durability of the policies designed to mitigate it. Here we argue that recent deforestation trends are a partial reflection of Brazil's economic trajectories. In this article we show that poor economic conditions, nationally, will increase micro-level incentives for forest clearing. Conversely, economic growth, nationally, will suppress prices and land clearing incentives. Ultimately, we argue that, at the national-scale, economic growth may be closely aligned with, and possibly a pre-condition to, the attainment of international or national-level environmental goals.

**Keywords:** deforestation, amazon, economic growth, soybeans, environmental policy

## INTRODUCTION

Forest loss in the Brazilian Amazon poses an enduring challenge for environmental policymaking. Ranchers, land speculators, farmers, miners and public works projects continue to drive land use change in the region, and deforestation in the Amazon remains an important source of global greenhouse gas emissions. With an aim toward slowing forest loss in the Amazon, in the late 2000's the Government of Brazil, and a consortium of private companies and environmental interests, have aggressively sought to reshape the region with an innovative array of environmental policies and protections (Nepstad et al., 2009). Their efforts have been widely credited with reducing forest loss rates (Nepstad et al., 2014; Assunção et al., 2015). Unfortunately, a recent surge in forest loss has raised questions about the durability of the environmental policies put into place during the late 2000's, or their continued ability to suppress forest loss in the region. As researchers and environmental interests evaluate these policies they must recognize that many of these policies were instituted during a macroeconomic climate highly unfavorable for export products. In recent years, however, shifting macroeconomic conditions have led to a dramatic increase in micro-level forest clearing incentives and contributed to a rise in forest loss observed in the Brazilian Amazon.

Over the past two decades, the rate of exchange between the Brazilian real and the dollar has closely followed the strength of the Brazilian economy. When the economy is strong, the real strengthens against the dollar. When economic growth is weak or negative, the real loses value against the dollar. The value of the real, in turn, directly affects land clearing incentives. Over the past 5 years, slow economic growth and a weakened currency have occurred simultaneously with rising levels of forest loss in the Amazon.

The strong relationship between the macro-level health of Brazil's economy and micro-level clearing incentives suggests that national economic growth in Brazil is well-aligned with, and potentially a precursor to, the attainment of environmental goals. It also suggests that environmental policymakers should recognize the influence of macro-level economic swings on the impact of environmental policies, and then design new policies for maximum resilience to economic cycles.

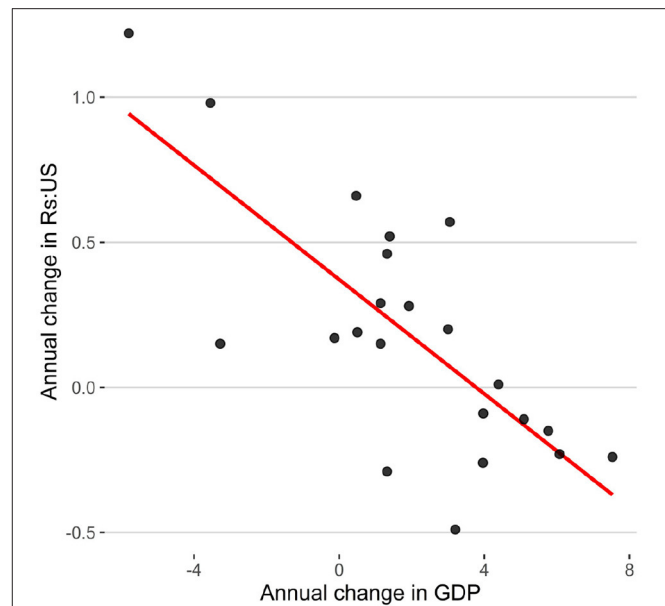
## DEFORESTATION INCENTIVES IN THE BRAZILIAN AMAZON

Land use change in the Amazon reflects the prices or profits associated with what lies under the forest: arable soils and mineral concentrations. Before land is cleared intentionally, land owners, or those seeking to own land, will implicitly or explicitly weigh the potential returns to the use of land against the cost of land clearing (Walker and Homma, 1996; Lubowski et al., 2008; Garrett et al., 2013a; Richards et al., 2014). Over the past decade, both sides of this equation have been dynamic.

Environmental policies put into place since 2000 through the Government of Brazil's Action Plans for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAM, 2018) have generally sought to increase the costs of clearing. Restrictions on clearings on private lands, coupled with punitive fines or property seizures, for example, increased the risk and potential cost of land clearing on many properties (Assunção and Rocha, 2014; Soares-Filho et al., 2014; Brandão et al., 2020). Jurisdictional or farm level restrictions on finance in high deforestation regions, from the loss of access to subsidized public finance to property seizures, similarly conveyed new costs in land clearing (Sills et al., 2020). Supply chain interventions also implicitly reduced returns to land clearing, by reducing market options for produce derived from newly cleared properties (Walker et al., 2009b; Soares-Filho et al., 2010; Pfaff et al., 2014; Gibbs et al., 2015; Klingler et al., 2018).

If environmental policies sought to increase the cost of land clearing, several other factors acted to increase the opportunity costs of keeping land forested. Improvements in roadways and transportation, for example, decreased transaction costs and increased farm gate prices (Walker et al., 2009a). Supply chains for many major export commodities also expanded and adapted technologies to the Amazon, leading to higher farm or ranch level returns. Bumps in commodity prices also occasionally bestowed new investment capital on farmers, first, in the early 2000's, and then more recently, from 2016 to today (Richards and Arima, 2018). Forest loss trends in the Amazon, perhaps not surprisingly, closely followed the periodic price bumps for exports such as beef (since the late 2000's), soybeans and gold (DeFries et al., 2013; Verburg et al., 2014).

Despite recognition of the importance of prices for key exports commodities as drivers of deforestation, relatively little attention has been afforded to understanding their influences. Clearly, changes in the global supply or demand for beef or soybeans are critical determinants (Garrett et al., 2013b; Fuchs et al., 2019; Richards et al., 2020). Poor corn or soybean harvests

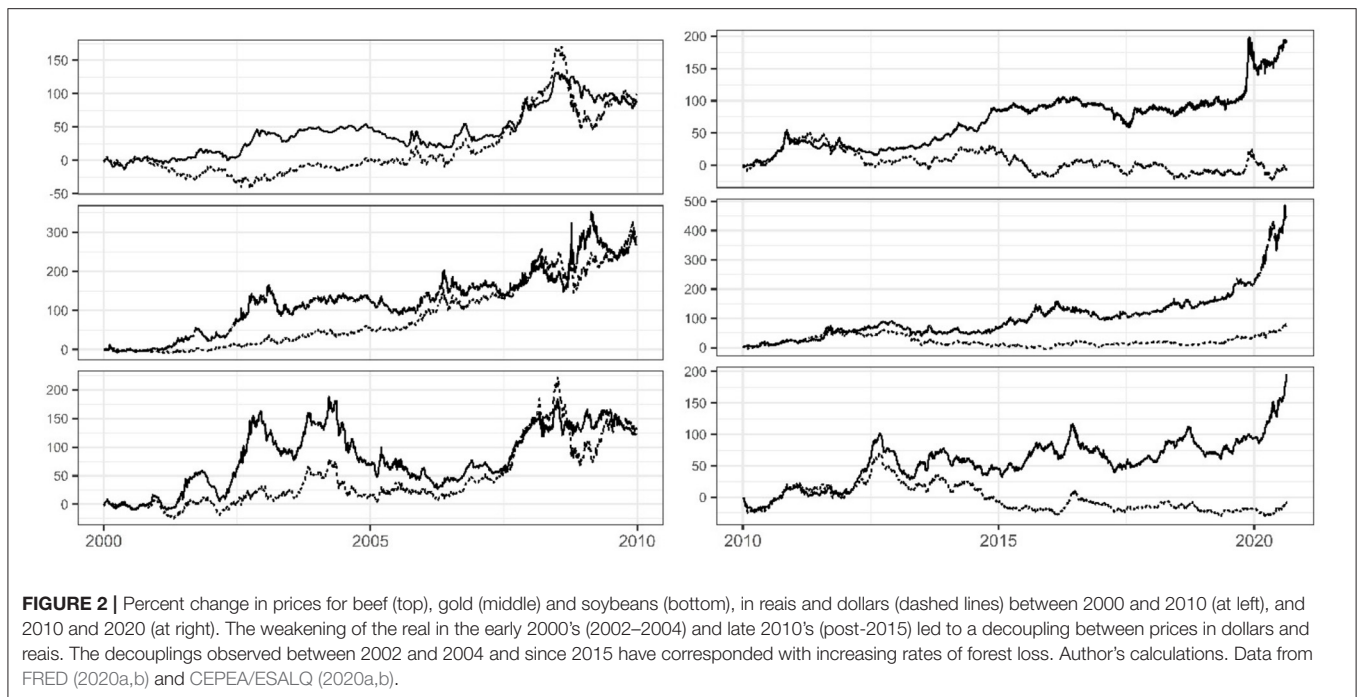


**FIGURE 1** | Relationship between economic growth and the strength of the real. The strength of the real has closely followed changes in Brazil's Gross Domestic Product. Large increases in GDP have correlated with the strengthening of the real against the dollar. Since 1999, each 1% increase in Brazil's GDP corresponded with an approximate 7% decline in the value of the real against the U.S. dollar. Author's calculations. Data drawn from (FRED, 2020a).

in the US, as happened in 2004 and 2012, for example, can lead to bumps in farm prices, globally. Similarly, the decade long, positive arc in demand for soybeans that began in the mid-2000's sustained food prices despite a rapid increase in global production (much of which was driven by growth in Brazil). The effect of national-level policies and economic conditions on farm level prices for export products, however, also warrant discussion.

## THE MACROECONOMICS OF FOREST CHANGE IN THE BRAZILIAN AMAZON

Researchers have long recognized the role of national-scale economic policies and trends as important drivers of forest loss in the Amazon. For much of the 1980's and 1990's public financial support and tax credits were seen as critical sources of investment capital to the region. Moreover, publicly funded infrastructure and colonization programs were widely cited as important drivers of forest loss in Brazil (Mahar, 1989; Binswanger, 1991; Browder, Godfrey and Godfrey, 1997; Hecht and Cockburn, 2010). When public coffers were full, capital spilled out into the frontier in the form of public subsidies and infrastructure projects. When they were bare, public investment and forest loss in the Amazon came to a relative halt (Fearnside, 2005). Amazon deforestation during the late twentieth century, not coincidentally, positively correlated with the strength of Brazil's economy (López and Galinato, 2005).



Over the past two decades, the Amazon economy has pivoted from a reliance on public investment funds to a reliance on international markets. This pivot flipped the relationship between national-level economic growth and deforestation incentives. If, historically, deforestation once rose with public investment, and by extension, the strength of the country's economy, today, deforestation is more likely to decline when the economy is gaining strength.

Currency values reflect a nation's economic activity and growth prospects. When the economy grows faster, the real strengthens against the US dollar. Conversely, when economic growth slows or retracts, the real loses value. From 2004 to 2013, for example, when Brazil's GDP grew, on average, by 4% per year, the real strengthened from 3:1\$US to more than 2:1\$US. More recently, or since 2015, Brazil's economy struggled and the real shed value against the US dollar. By 2020, the real had fallen to nearly 5:1\$US dollars (FRED, 2020a). Statistically, each 1% change in Brazil's GDP has corresponded with 7% decline in the value of the real against the U.S. dollar (see **Figure 1**).

The exchange rate is a key driver, and perhaps the key driver, in price determination for the export commodities that form the basis of Brazil's extractive and agricultural economy<sup>1</sup>. When the real is weak, exporters, including soybean farmers, reap higher prices for their harvests (Richards et al., 2012; Nepstad et al., 2014). Consequently, a weak real can drive a boom in soybean prices, even when food prices are low, globally (in dollars). Conversely, a strong real can suppress prices for exporters; create a scarcity in investment capital; and disincentive land clearings.

<sup>1</sup>In general, Brazil's currency has been more volatile than market prices (in US\$ for many key exports. Since the late 1990's, prices in Brazilian currency have scaled from 13 to 126 Rs per 60 kg *saco*. Over the same period, prices in dollars for the equivalent quantity ranged from roughly 8\$US to 42\$US.

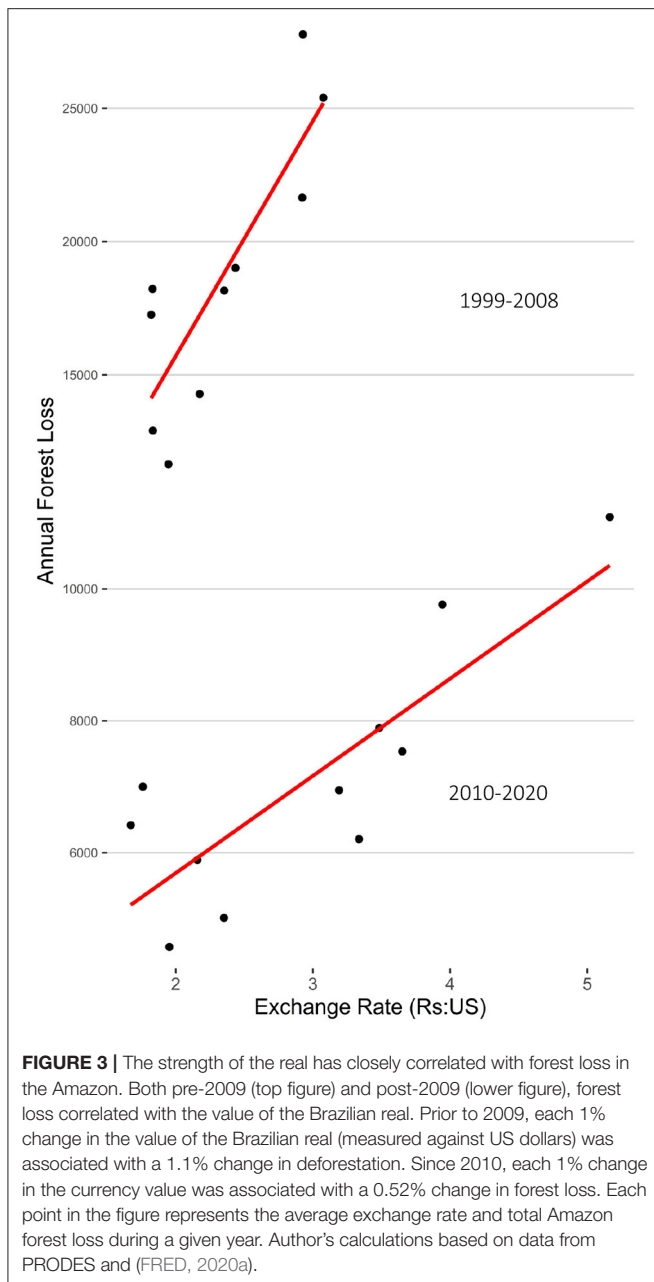
When North American farmers were reaping an agricultural windfall from 2008 to 2010, for example, the strong real meant Brazilian farmers struggling with lower prices (see **Figure 2**).

Given the relationship between economic growth and the value of Brazil's currency, and between currency values and farm prices for exports, it follows that annual forest loss in the Amazon, all else being equal, is likely to increase during periods of economic recession and fall during periods of growth. Recent trends certainly reflect this relationship. From 2004 to 2013, a period of economic growth, deforestation declined rapidly, ultimately plateauing at 5,000 km<sup>2</sup> per year from 2012 to 2014 (PRODES, 2020); however, amidst more recent economic troubles, deforestation rates have risen to more than 9,600 km<sup>2</sup> per year.

While policies have reduced rates of forest loss in the Amazon (e.g., see the top and bottom of **Figure 3**), the relationship between trends in forest loss and the exchange rate has remained remarkably steady over the past two decades. Before the enactment and implementation of the second phase of the Government's PPCDAm, each 1% change in the Brazilian real was associated with a 1.1% change in deforestation in the Amazon. Since 2009, partially in reflection of the more recent spike in forest loss and ongoing economic crisis, each 1% loss in the currency value was associated with a 0.52% change in forest loss (**Figure 3**).

## IMPLICATIONS FOR POLICY

For nearly a decade, amidst robust economic growth, Brazil was widely acclaimed as a leader in environmental policy (Nepstad et al., 2009, 2014; Arima et al., 2014). Unfortunately, concerns over the state of the Amazon forest are rising once again. In this article we have argued that the recent surge



in forest loss is a partial reflection of the state of Brazil's national economy. Ultimately, if Brazil hopes to avoid future surges in forest loss, policies should be crafted to insulate land use change incentives from cyclical changes or swings in Brazil's economy.

We offer several suggests for environmental policymaking in the Amazon.

First, environmental interests should recognize the importance of the strength of the Brazilian economy as a force for augmenting or suppressing farm, ranch or mine-level returns in the Amazon. All else being equal, economic growth in Brazil will act as a suppressant for deforestation in the Amazon. So long as Brazil's real floats freely, economic growth

in Brazil will relate inversely to incentives for forest loss in the Amazon.

Second, policies should recognize that while economic growth, nationally, will align with environmental priorities, this might not be true at the local scale. Price increases imply greater opportunity costs for leaving forests standing (VanWey et al., 2013; Weinhold et al., 2013; Richards et al., 2015). When prices are high, local governments, landowners and land managers will face incentives for land clearing. In this sense, economic and environmental tradeoffs will shift with scale and proximity to deforestation decisions. It is important to recognize that local scale incentives are likely to diverge from those at the national level.

Third, policy makers should recognize the dynamic and cyclical nature of the currency markets that influence incentives for land use change. Policies put into place during periods of economic growth, or during periods when the real is strong, are likely to have been designed and implemented when incentives for land clearing are already low. Policymakers should recognize that these conditions are unlikely to persist. To the extent possible, policies to slow deforestation should seek to insulate potentially clearable forest areas from future price or currency swings. Policy evaluations, meanwhile, must account for the confounding influences of periodic currency swings on forest loss.

## CONCLUSION

Amazon deforestation remains an important source of anthropogenic greenhouse gas emissions and poses a significant obstacle to global emissions reductions targets (Shukla et al., 1990). Recent increases in annual forest loss in Brazil are once again raising the concern of much of the world's environmental community.

To reduce forest loss, academics and environmental interests have promoted a range of technical or governance solutions. Often, these solutions have focused on reducing the development potential of land (e.g., through protected areas, or through the enforcement of mandated reserves on private property), or through technical assistance or production intensification for farmers (Cohn et al., 2014; Stabile et al., 2020). Others have called attention to the importance of environmental governance, and the need to improve local accountability for forest loss (Reydon et al., 2020).

In this article we have argued that land clearing incentives are inversely weighted against the value of the real and, by extension, the strength of Brazil's economy. Consequently, economic incentives for forest loss, and deforestation levels, are likely to rise during periods of economic recessions or low growth. During an economic crisis, higher micro-level incentives for forest clearing may also be coupled with political imperatives to generate foreign exchange, a well-funded agricultural lobby, and reduced domestic support for publicly-supported environmental protections (Fearnside, 2018).

Recognizing the influence of economic growth on land use change in the Amazon by no means discounts the importance

of environmental policies in reducing land use change. The drivers of deforestation in the Amazon remain complex, and vary with the heterogeneous social, economic and environmental factors that define the region (Busch and Ferretti-Gallon, 2017). The state of Brazil's economy by no means supersedes these influences; rather, it imparts its effects through its direct influence on the prices and returns that inform farm level clearing decisions.

Continuous, broad-based economic growth is an obvious policy goal for nearly every government. Here, we have sought to show that this goal, for Brazil, is also well-aligned with international and national-level

environmental goals and emissions targets. Recognition of this alignment could lead to new alliances between environmental interests and other economic sectors, and force policy makers to take a broader view toward the role of macro-level economic changes and their macro-level impacts on the distribution of global environmental change.

## AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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