

Does Credit Affect Deforestation?

Evidence from a Rural Credit Policy in the Brazilian Amazon

EXECUTIVE SUMMARY*

JULIANO ASSUNÇÃO, CLARISSA C. E GANDOUR, AND ROMERO ROCHA

CLIMATE POLICY INITIATIVE RIO DE JANEIRO
NÚCLEO DE AVALIAÇÃO DE POLÍTICAS CLIMÁTICAS, PUC-RIO



CLIMATE POLICY INITIATIVE
NÚCLEO DE AVALIAÇÃO
DE POLÍTICAS CLIMÁTICAS
PUC-RIO



JANUARY 2013

The deforestation rate in the Brazilian Amazon decreased sharply in the second half of the 2000s, falling from a peak of 27,000 km² in 2004 to 5,000 km² in 2011. In a previous CPI/NAPC study [Assunção et al. (2011)], we estimate that conservation policies introduced in the mid to late 2000s prevented the loss of approximately 62,000 km² of forest in the 2005 through 2009 period. This study takes a closer look at one of these policies — the Brazilian Central Bank Resolution 3,545.

Introduced in mid-2008, Resolution 3,545 placed a condition on rural credit in the Brazilian Amazon Biome — to get credit, borrowers had to present proof of compliance with environmental regulation. Since rural credit is an important source of financing for rural producers in Brazil, this credit restriction may have had significant economic and environmental compliance impacts. In this study, we quantitatively evaluate Resolution 3,545's effect on credit concession and deforestation in the Amazon Biome. This analysis not only assesses the effectiveness of the conditional credit policy, but also enhances our understanding about the region's financial environment.

We estimate that approximately **BRL 2.9 billion (USD 1.4 billion) in rural credit was not contracted in the 2008 through 2011 period** due to restrictions imposed by Resolution 3,545. This reduction in credit **prevented over 2,700 km² of forest area from being cleared**, which represents a **15% decrease in deforestation** during the period.

These results suggest that there are binding credit constraints for potential deforesters. As a consequence, policies that increase the availability of financial resources for farmers in the Amazon should incorporate this potential adverse effect on deforestation.

The resolution's **impact on deforestation was only significant in municipalities where cattle ranching is the main economic activity**. In municipalities where crop production is predominant, deforestation was not affected by Resolution 3,545.

The policy also affected the composition of credit contracts in the Amazon Biome. In the case of cattle, there was a reduction in the number of medium and large contracts, with an increase of small contracts. In the case of crops, on the other hand, we only document a decrease in the number of medium contracts.

Box 1 – A bit of theory

The relationship between deforestation and credit is theoretically unclear. In economies with well functioning credit markets, farmland size (and thus deforestation) should not be affected by the availability of credit. However, credit-rationed farmers are expected to change their production decisions according to the amount of credit made available to them [Banerjee et al. (2003) and Banerjee & Duflo (2012)]. In this case, variation in subsidized credit leading to variation in deforestation (through changes in farmland area) is therefore evidence of binding credit constraints for deforestation activities. If farmers were not credit constrained they could simply substitute the subsidized credit for other sources of financing, without any change in the optimal size of land.

Yet, the way in which the availability of subsidized credit is related to deforestation is ambiguous even for credit-constrained farmers. The nature of this relationship depends on how credit is used, as well as on which agricultural technology is adopted. On the one hand, should credit be used to augment rural production by means of incorporating new land for production, increases in subsidized rural credit will likely lead to rising deforestation, as forest areas are cleared and converted into agricultural land. On the other hand, should it be used to fund the capital expenditures required to drive up productivity per unit of land used for production, increases in subsidized rural credit may actually reduce deforestation. After all, greater productivity allows for the expansion of agricultural production without the need of extending production into new land. Empirical evaluations of how credit affects deforestation shed light on this ambiguous relationship.

* This Executive Summary describes the main findings of a more detailed paper. For the full-length paper, please refer to Does Credit Affect Deforestation? Evidence from a Rural Credit Policy in the Brazilian Amazon by Assunção et al. (2012).

Resolution 3,545: A Rural Credit Policy Introduced in 2008

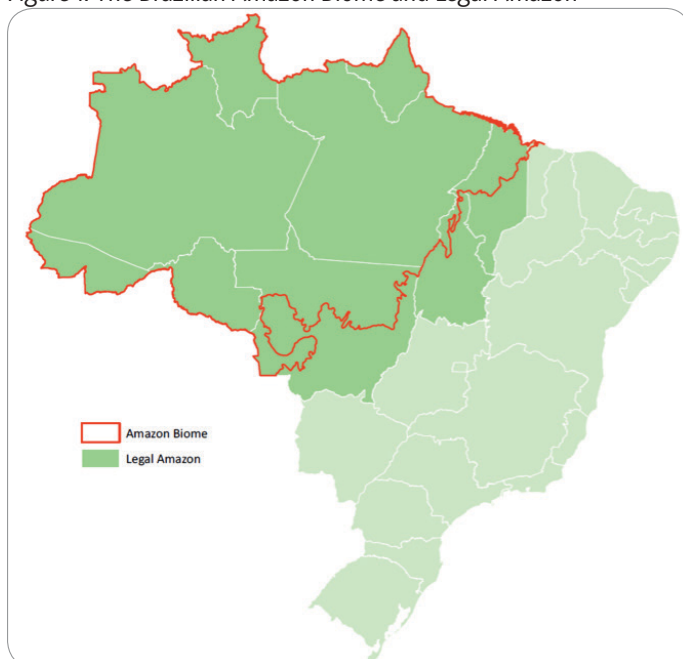
Resolution 3,545 led to a significant reduction in the concession of rural credit in the Amazon Biome.

Rural credit, used to finance short-term working capital, investment, and commercialization of rural production, is one of Brazil's most traditional mechanisms of supporting agriculture (MAPA (2003)). The Brazilian Ministry of Agriculture (*Ministério da Agricultura, Pecuária e Abastecimento*, MAPA) estimates that approximately 30% of the resources needed in a typical harvest year are funded through rural credit (MAPA (2003)). The remaining 70% come from producers' own resources, as well as from other agents of agribusiness and other market mechanisms. In light of this, any policy measure that affects rural credit also affects one of Brazil's main support mechanisms for agricultural production. Resolution 3,545 is one such policy.

Published February 29th, 2008, Resolution 3,545 placed a condition on rural credit in the Brazilian Amazon Biome — to get credit, borrowers had to present proof of compliance with environmental regulations, the legitimacy of their land claims, and the regularity of their rural establishments.

The measure, aimed at restricting credit for those who infringed environmental regulations, applied to all

Figure 1: The Brazilian Amazon Biome and Legal Amazon



establishments in municipalities located entirely or partially within the Amazon Biome. As the Amazon Biome is contained within the Legal Amazon, all biome municipalities are necessarily located in the Legal Amazon, but not all Legal Amazon municipalities are part of the biome (see Figure 1). The resolution's requirements applied not only to landowners, but also to associates, sharecroppers and tenants.

Implementation of Resolution 3,545 terms by all credit agents was optional as of May 1st, 2008, and obligatory as of July 1st, 2008.

To prove credit eligibility, Resolution 3,545 required borrowers to present a series of documents. Such documentation, however, varied according to borrower profiles. Small-scale producers — particularly beneficiaries of the National Program for Strengthening of Family Agriculture (*Programa Nacional de Fortalecimento da Agricultura Familiar*, Pronaf) — were subject to less stringent requirements, with some Pronaf categories being entirely exempt from abiding by the resolution's conditions.

Resolution 3,545 represented a restriction on official rural credit — and thereby on the fraction of rural credit that is largely subsidized via lower interest rates — while other sources of financing for agricultural activity suffered no such restriction.

Results

Policy Effectiveness for Credit Reduction

Our results suggest that farmers anticipated the credit restriction in 2008 and sought credit before Resolution 3,545 became mandatory. Aggregate trends reveal that the pattern of credit concession observed in previous years was broken in 2008. Instead of the typically higher volume of credit negotiated in the second half of the year, the credit series for 2008 peaks in April and again in June. Yet, the total volume of credit negotiated in 2008 is similar to that of previous years. Although the resolution was published in February 2008, its implementation was optional as of May 2008 and compulsory as of July 2008. As this timing coincides with the subsequent unseasonable peaks in 2008, these peaks likely capture borrowers' efforts to gain early access to resources that would soon be restricted. This behavior seems to be more relevant for cattle-specific credit loans than for crop-specific ones, perhaps due to the intrinsically seasonal component of crop production.

Despite the anticipation of the credit restriction in

Table 1: Observed and Estimated Credit Concessions in Full Sample, by Type of Contract, 2002-2011 (BRL million)

YEAR	TOTAL RURAL CREDIT			CATTLE-SPECIFIC CONTRACTS			CROP-SPECIFIC CONTRACTS		
	OBSERVED	ESTIMATED	DIFFERENCE	OBSERVED	ESTIMATED	DIFFERENCE	OBSERVED	ESTIMATED	DIFFERENCE
2002	1,595			1,092			503		
2003	2,306			1,312			994		
2004	3,002			1,679			1,324		
2005	2,982			1,945			1,037		
2006	2,623			1,856			767		
2007	2,630			1,818			812		
2008	2,506	3,174	668	1,740	2,253	512	765	944	179
2009	2,772	3,594	821	1,845	2,564	719	927	1,079	152
2010	3,203	3,852	649	2,271	2,873	601	932	1,008	76
2011	3,170	3,928	758	2,258	3,037	779	912	945	33
2008-2011 TOTAL	11,651	14,547	2,896	8,114	10,727	2,611	3,536	3,976	440

Note: Figures presented in columns labeled "Estimated" were calculated in counterfactual simulations and refer to estimates of what would have occurred in the absence of the policy.

2008, we show that Resolution 3,545 did, in fact, lead to a significant reduction in the concession of rural credit in the Amazon Biome. In counterfactual simulations, we estimate that approximately BRL 2.9 billion (USD 1.4 billion) less credit was loaned in the 2008 through 2011 period as a result of restrictions imposed by the resolution. Most of this total, BRL 2.6 billion (USD 1.3 billion), referred to cattle-specific contracts (see Table 1).

For a given municipality within the biome, Resolution 3,545 also caused a greater reduction in non-Pronaf credit, which affected larger-scale producers, as compared to Pronaf credit, which targeted smaller-scale producers. This result is to be expected in light of the legal exemptions that were introduced for small-scale producers.

To explore differences between sectors and ensure that our results are not driven by the comparison of structurally different municipalities, we separately evaluate the resolution's impact in two subsamples: municipalities where cattle ranching is the main economic activity (cattle-oriented municipalities), and those where crop production is the main economic activity (crop-oriented municipalities). We find that, although credit cuts were observed in both subsamples following the implementation of the resolution, the effect was higher in cattle-oriented municipalities (see Table 2).

We also investigate the impact of Resolution 3,545 on the size distribution of credit contracts. Results indicate that the resolution had a distributional effect for cattle-specific credit contracts, reducing the number of medium and large contracts, and slightly increasing the

number of small contracts. The resolution also appears to have led to a decrease in the number of medium crop-specific contracts, but had no significant impact on small ones. This is likely the consequence of banks and credit cooperatives striving to allocate resources to small-scale producers, which faced less stringent requirements.

Policy Effectiveness for Deforestation Reduction

The resolution-induced reduction in rural credit led to a decrease in deforestation in the Amazon Biome.

We explore the variation in credit concession caused by Resolution 3,545 to identify the effect of credit on deforestation. Results suggest that credit has a positive and strongly significant relationship with deforestation — the resolution-induced reduction in rural credit in the Amazon Biome led to a decrease in deforestation in the biome. In particular, those municipalities where credit decreased most as a result of Resolution 3,545 were also the ones that presented the sharper drops in deforestation.

Counterfactual simulations indicate that, in the absence of the credit constraint imposed by Resolution 3,545, over 2,700 km² of forest area would have been cleared from 2009 through 2011. Considering that the deforestation rate in the Legal Amazon in the late 2000s was about 5,000 km² per year, the effect that can be attributed to the resolution is quite impressive (see Table 3).

Table 2: Observed and Estimated Total Rural Credit Concessions in Full Sample and Subsamples, 2002-2011 (BRL million)

YEAR	FULL SAMPLE			CATTLE-ORIENTED MUNICIPALITIES			CROP-ORIENTED MUNICIPALITIES		
	OBSERVED	ESTIMATED	DIFFERENCE	OBSERVED	ESTIMATED	DIFFERENCE	OBSERVED	ESTIMATED	DIFFERENCE
2002	1,595			1,107			487		
2003	2,306			1,509			797		
2004	3,002			1,954			1,047		
2005	2,982			2,059			922		
2006	2,623			1,960			662		
2007	2,630			1,884			746		
2008	2,506	3,174	668	1,785	2,336	550	719	861	141
2009	2,772	3,594	821	1,968	2,658	690	798	965	166
2010	3,203	3,852	649	2,360	2,934	574	837	960	123
2011	3,170	3,928	758	2,259	2,989	731	905	996	91
2008-2011 TOTAL	11,651	14,547	2,896	8,372	10,918	2,545	3,260	3,781	521

Note: Figures presented in columns labeled "Estimated" were calculated in counterfactual simulations and refer to estimates of what would have occurred in the absence of the policy.

Finally, we find that the magnitude of the impact of credit on deforestation varies according to main regional economic activity. It appears to be higher in municipalities where cattle ranching, not crop production, predominates (see Table 3). In line with the discussion presented in Box 1, this suggests that cattle ranchers are credit constrained, as changes in the availability of subsidized credit for this category are related to changes in deforestation.

On the other hand, in municipalities where crop production is the leading economic activity, it appears that a reduction in credit does not translate into a reduction in deforestation. There are two possible explanations for this. First, crop farmers might be structurally less vulnerable than cattle ranchers to conditions such as the ones included in Resolution 3,545. This could be because a more solid organizational structure makes them better equipped to meet the resolution's legal requirements, or because they are able to compensate for the decrease in subsidized rural credit by accessing alternative sources of financing. These producers are essentially not credit constrained, and are thus able to sustain investment and deforestation at the same levels as before the credit policy intervention. Second, crop farmers might be investing a larger share of rural credit loans in the intensification of production. In this case, the decrease in rural credit would not lead to a decrease in forest clearings, as the now-restricted resources were not originally being used to push agricultural production into forest areas.

Overall, the evaluation of Resolution 3,545 helps us better understand the economic environment of the

Brazilian Amazon. It suggests that cattle ranchers are more heavily dependent on subsidized rural credit for production and for sustaining deforestation activities. In contrast, crop farmers appear to be less dependent on these same subsidies, or, at least, to make use of the subsidies to intensify productivity instead of expanding their production frontier.

Policy Implications

Our analysis shows that Resolution 3,545 effectively reduced deforestation in the Amazon. The results have two key policy implications.

First, the evidence shows that **conditional rural credit can be an effective policy instrument to combat deforestation**. Along these lines, the differential effects across sectors and regions suggest that it might complement rather than substitute other conservation efforts. **The pre-existent socio-economic circumstances matter** — credit reduction mostly came from the reduction of cattle credit rather than crop credit. **The implementation details also matter**. The lag between the announcement and enforcement of the resolution induced farmers to anticipate credit in 2008, mitigating part of the effect. Also, less stringent requirements and exemptions have determined that large producers were more affected than small producers.

Second, our analysis suggests that **the financial environment in the Amazon is characterized by significant credit constraints**. Especially in municipalities where cattle ranching is the predominant activity, fewer resources correspond with less deforestation. This is a

Table 3: Observed and Estimated Deforestation in Full Sample and Subsamples, 2002–2011 (km²)

YEAR	FULL SAMPLE			CATTLE-ORIENTED MUNICIPALITIES			CROP-ORIENTED MUNICIPALITIES		
	OBSERVED	ESTIMATED	DIFFERENCE	OBSERVED	ESTIMATED	DIFFERENCE	OBSERVED	ESTIMATED	DIFFERENCE
2002	21,549			18,820			2,728		
2003	25,686			21,635			4,051		
2004	23,087			19,708			3,378		
2005	20,087			17,656			2,431		
2006	9,946			8,823			1,123		
2007	10,565			9,372			1,193		
2008	11,295			9,757			1,539		
2009	5,220	5,688	468	4,566	5,149	584	654	818	165
2010	5,657	7,398	1,741	4,690	5,456	766	966	1,150	184
2011	5,119	5,693	574	4,473	4,316	-158	645	525	-120
2009-2011 TOTAL	15,995	18,778	2,783	13,730	14,922	1,192	2,265	2,493	229

Note: Figures presented in columns labeled “Estimated” were calculated in counterfactual simulations and refer to estimates of what would have occurred in the absence of the policy.

key finding with implications for policy design. In particular, **policies that increase the availability of financial resources (e.g. payments for environmental services) may lead to higher deforestation rates**, depending on the economic environment and existing resources in the area. Our results do not suggest that these policies will necessarily increase deforestation but that these policies should take into account the nature of financial constraints that are prevailing in the Amazon, avoiding potentially adverse rebound effects.

Acknowledgements

Arthur Bragança, Luiz Felipe Brandão, Pedro Pessoa, and Ricardo Dahis provided excellent research assistance.

We thank the Brazilian Ministry of the Environment, and particularly Roque Tumolo Neto, for their continuous support. We are also grateful to Pedro James Hemsley, Joana Chiavari, Dimitri Szerman, and Arthur Bragança for helpful comments.

Bibliography (executive summary only)

- Assunção, J., Rocha, R., and Gandour, C. (2011). Deforestation Slowdown in the Legal Amazon: Prices or Policies? Working Paper 1.
- Banerjee, A. V., and Duflo, E. (2012). Do firms want to borrow more? Testing credit constraints using a directed lending program. Mimeo, MIT.
- Banerjee, A. V., Munshi, K., and Duflo, E. (2003). The (mis)allocation of capital. *Journal of the European Economic Association*, 1(2-3):484–494.
- Brasil, Ministério da Agricultura, Pecuária e Abastecimento (2003). Plano Agrícola e Pecuário 2003–2004. Secretaria de Política Agrícola, Brasília.
- IPAM (2009). Evolução na Política para o Controle do Desmatamento na Amazônia Brasileira: O PPCDAm. *Clima e Floresta*, 15.
- Ipea, Cepal, and GIZ (2011). Avaliação do Plano de Ação para a Prevenção e Controle do Desmatamento da Amazônia Legal. Technical report.