POLICY BRIEF

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

The Environmental Impacts of the Ferrogrão Railroad

An Ex-Ante Evaluation of Deforestation Risks

To address the nation's poor infrastructure quality, the federal government established a goal of implementing a large portfolio of transportation infrastructure projects in the coming decade. This portfolio includes building railroads through the Amazon, which is not only the largest tropical forest in the world but also a provider of essential ecosystem services for Brazil's agricultural sector. Therefore, it is critical that these projects are built at the lowest possible social and environmental cost and that the nation adopts a sustainable development approach to infrastructure. Yet, assessing the environmental impact of large infrastructure projects is challenging.

This brief presents projections of the likely deforestation from the EF-170 railroad construction, one of the most important infrastructure projects currently in planning phase in the country. The projections were made using a novel market access approach developed by researchers from Climate Policy Initiative/ Pontifical Catholic University of Rio de Janeiro (CPI/ PUC-Rio). The analysis explicitly incorporates the effects of the construction of the railway beyond its immediate surroundings. The methodology also identifies those municipalities where the implementation of infrastructure investments will increase the pressure on deforestation, highlighting where mitigation efforts must be targeted beforehand.

The researchers find that the improvement in market access provided by the railroad will induce farmers and ranchers to expand their production. If no mitigation measures are implemented, this will increase the demand for land and increasing deforestation by 2,043 square kilometers in the state of Mato Grosso. This increased deforestation will raise carbon emissions by 75 million tons.

Considering a price of US$25 per ton of carbon[1] this implies that the deforestation resulting from the construction of Ferrogrão has a cost of approximately US$1,9 billion. This environmental cost corresponds to about 60% of the projected cost of the railroad's implementation. It is worth noting that this pricing exercise does not incorporate other deforestation costs related to the reduction of biodiversity or other ecosystem services. It only emphasizes the importance of considering the costs connected to changes in land use in the assessment of this project.

1 This price corresponds to the average of carbon prices of the 28 national carbon pricing programs in operation globally.

RECOMMENDATIONS

- Government bodies and investment agencies should incorporate the use of new analytical methods highlighted in this brief to help ensure deforestation risks are incorporated in the planning process and execution of transport infrastructure investments.
- Multilateral organizations and green bond issuers must take into account the full deforestation cost when evaluating the social cost of the Ferrogrão railroad.

ABOUT THE FERROGRÃO RAILROAD PROJECT

The EF-170 Ferrogrão railroad will extend around 1,000 kilometers, running parallel to the BR163 (Santarém–Cuiabá) road, and will connect Sinop (Mato Grosso) to Itaituba (Pará). It is a greenfield project, meaning it will be built from scratch, and its total investment is estimated at about US$3.1 billion.[2] Ferrogrão is one of the main projects located in the Amazon from the Investment Partnership Program (PPI), and its auction is expected to occur in the first quarter of 2020.

The expansion of the Brazilian agricultural frontier and the demand for an integrated cargo transport infrastructure that connects the grain producers from the state of Mato Grosso to ports located in the north of Brazil has motivated the construction of Ferrogrão. The railway will establish a new export corridor via the Miritituba (Itaituba district) fluvial port. This will produce socio-economic benefits for grain producers in municipalities located in the mid-north of the state of Mato Grosso and for the municipalities surrounding Itaituba.

Ferrogrão's construction will be especially beneficial for Mato Grosso producers. These producers export about 70% of their production using the ports of Santos (SP) and Paranaguá (PR), which are both located more than 2,000 kilometers from the state. Ferrogrão's construction will reduce this distance considerably, reducing export costs and, consequently, increasing the competitiveness of grain producers in the state. It is estimated that the railroad will carry over 40 million tons of grains by 2050.

PROJECTED DEFORESTATION DUE TO THE FERROGRÃO RAILROAD & MITIGATION OPPORTUNITIES

Combining a market access approach built from insights of the trade literature[3] with a comprehensive dataset on logistics investments, freight rates and land use in the Amazon, CPI/ PUC-Rio's researchers estimate the effects of the construction of projects similar to Ferrogrão on land use in the region. Using these estimates, they project the effects of Ferrogrão's construction on land use decisions and, as a consequence, deforestation. These projections reflect a "business-as-usual" scenario in which no mitigation measures are implemented.

The researchers find that the improvement in market access provided by the railroad will induce farmers and ranchers to expand their production, increasing the demand for land and increasing deforestation by 2,043 square kilometers. This is a conservative estimate for at least three reasons. First, the freight model used, possibly underestimates the actual costs of exporting via the Miritituba port, thus underestimating the reduction of freights resulting from the Ferrogrão construction. Secondly, the projection does not consider that the construction of Ferrogrão tends to reduce freights on the competing logistical corredors (ex: BR-163, Malha Norte etc.) which could potentialize its impact on deforestation. Third, the projection does not consider the construction of Ferrogrão to possibly increase the population of municipalities that experiment reductions in transportation costs, which could enhance even more its impact on deforestation.

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2 Number obtained using an exchange rate of R$4.14/US$1

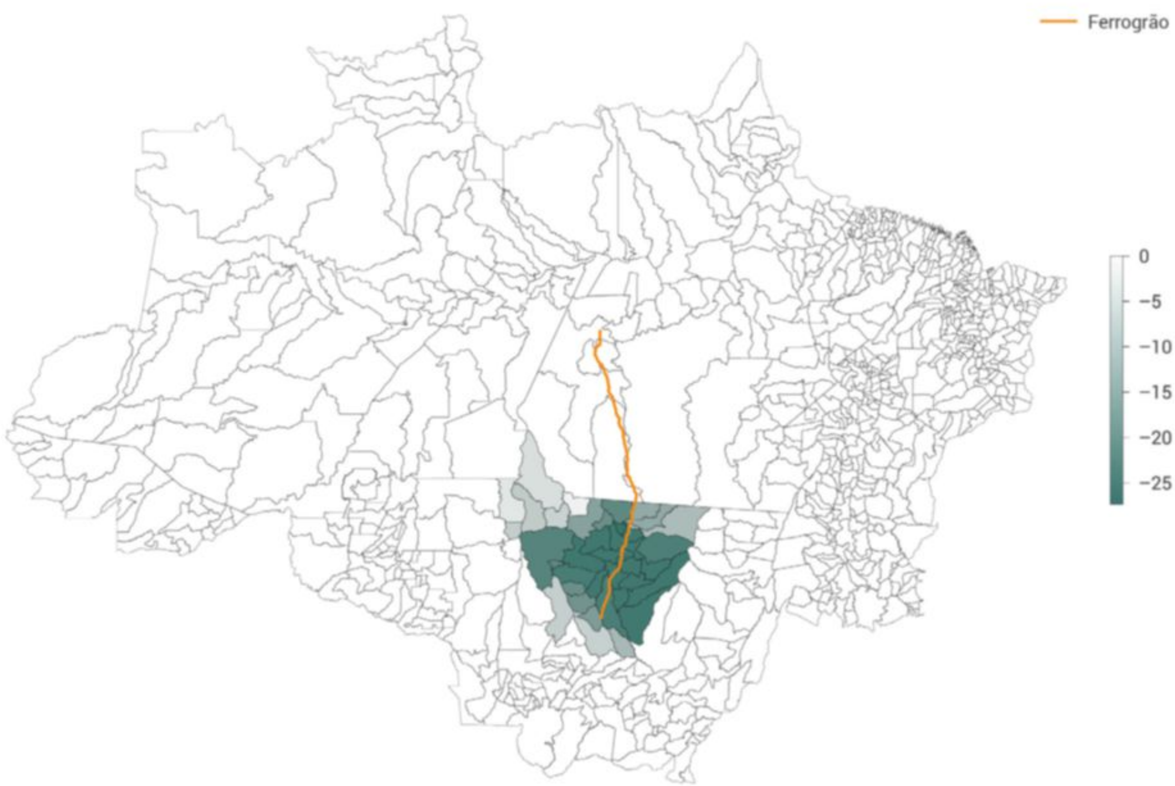
3 See Eaton, J., & Kortum, S. (2002). Technology, geography, and trade. Econometrica, 70(5), 1741-1779 and Donaldson, D., & Hornbeck, R. (2016). Railroads and American economic growth: A "market access" approach. The Quarterly Journal of Economics, 131(2), 799-858.

This increased deforestation is equivalent to a loss of more than 285,000 soccer fields of natural vegetation and 75 million tons of carbon and translates to a cost of US$3 billion, when the cost of carbon emissions is priced at US$25.13 per ton of carbon. This price corresponds to the average carbon prices of the 28 national carbon pricing programs in operations globally[4]. It is similar to the EU ETS price (european emissions trading scheme) and considerably lower than the US$40-80 carbon tons that the High-Level Commision on Carbon Pricing considered necessary in order to reach the objetives of the Paris Agreement.

The cost of the forest clearing associated with the project is around 60% of the implementation cost of Ferrogrão, suggesting that the impact on carbon emissions stemming from deforestation increases considerably the social costs. This cost would further increase if other deforestation costs were to be included like the decrease in biodiversity or the reduction of ecosystem services' provision. It is important to emphasize that these estimates do not reflect a comprehensive assessment of the environmental cost of the Ferrogrão. The construction of this railroad might have other environmental impacts (e.g., reduction in fuel consumption) not considered here. The estimates presented in this brief merely highlight the importance of considering the costs associated with deforestation in the assessment of this project.

The researchers arrive at these conclusions by rebuilding the transportation network in an exercise where the construction of Ferrogrão and its effect over transport costs between municipalities and the nearest port are simulated. Figure 1 reports the results of this exercise. A total of 38 municipalities benefit from the construction of this railroad. It is in these municipalities where the environmental risk of the project is concentrated and, therefore, this is where mitigation efforts should concentrate.

Figure 1: The Construction of *Ferrogrão* and Cost to Port



4 Data extracted from the World Bank's "Carbon Price Dashboard"https://carbonpricingdashboard.worldbank.org/

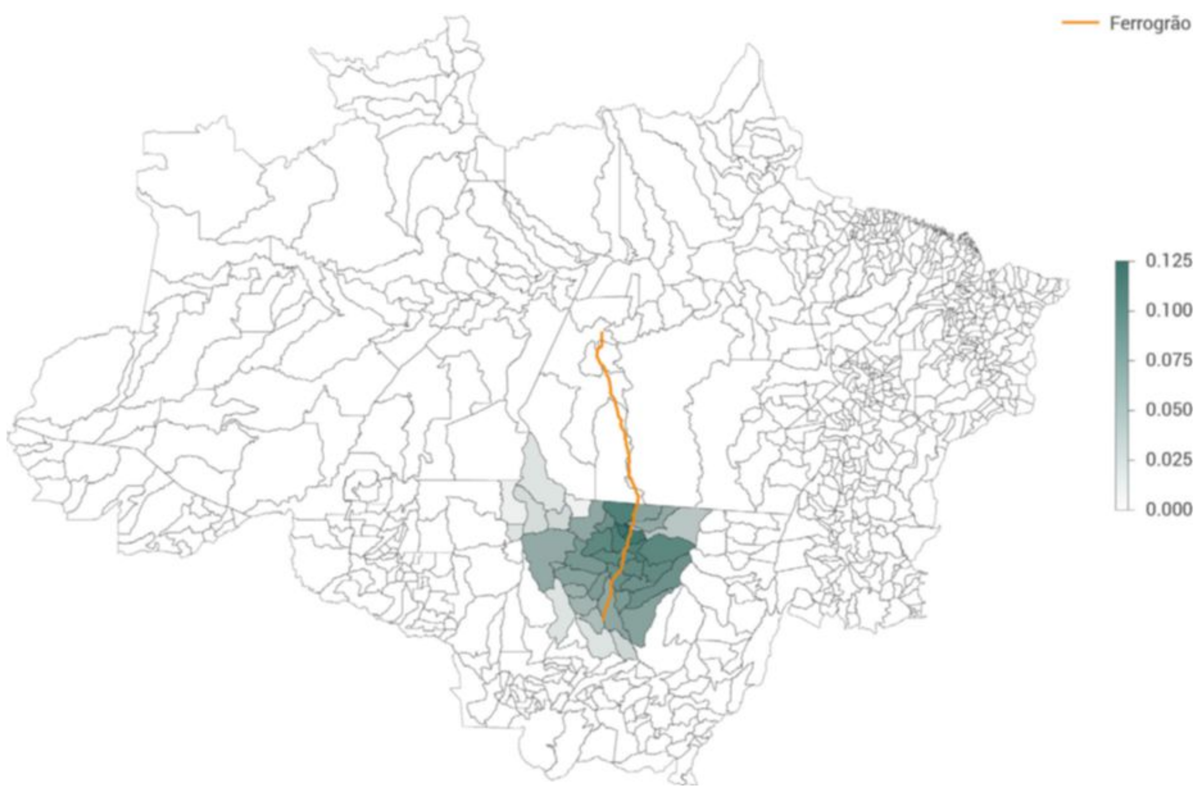
Notes: *The figure reports the change in the cost (in R$) of transporting one ton of agricultural goods to the nearest port caused by the construction of the Ferrogrão railroad. Darker municipalities denote a greater decrease in costs and lighter municipalities denote a lower decrease in costs.*

The benefited municipalities in this exercise can be divided in two groups. The first group is comprised of municipalities that already exported grains by the Miritituba (Pará) water port and simply stopped using the BR163 road in favor of using Ferrogrão instead for grain transportation. The second group is comprised of municipalities that exported grains by the Santos (São Paulo) port and that started to export by the Miritituba (Pará) water port after the Ferrogrão construction.

After construction, the reduction in transportation costs is converted to market access gains. This reduction in transportation costs will generate an average improvement of 8% in these municipalities' access to markets (domestic or international).

Figure 2 reports how these gains in market access are distributed geographically. Gains in market access are more scattered than the reduction of transportation costs due to the fact that initial levels of market access differ between benefited municipalities.

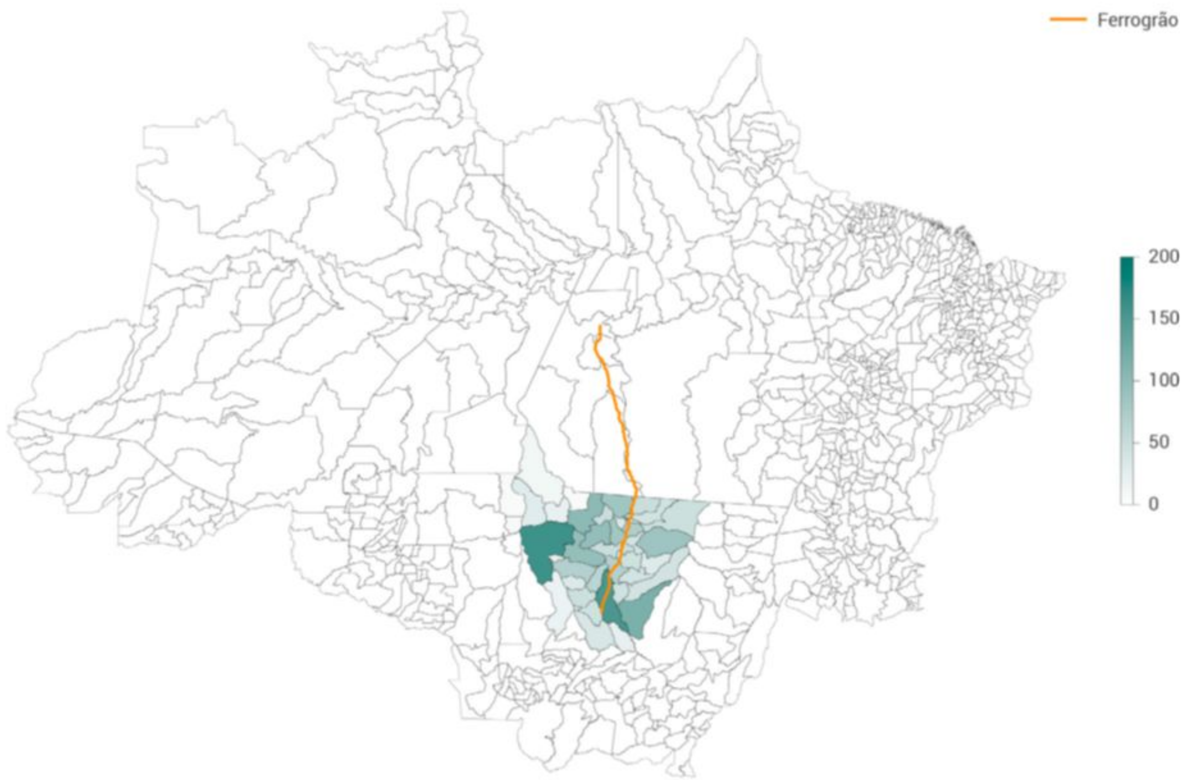
Figure 2: The Construction of *Ferrogrão* and Access to Market



Notes: *The figure reports the change in market access (in percent) caused by the construction of the Ferrogrão railroad. Darker municipalities denote a higher increase in market access and lighter municipalities denote a lower increase in market access.*

Lastly, the gain in market access due to the construction of the railroad is converted to an increase in land use and in farming activities. Hence, there is a reduction in forest cover. Figure 3 reports the effects of Ferrogrão construction over deforestation in different municipalities benefited by the venture. Projected deforestation is greater in large municipalities that obtain expressive access to market gains in consequence of Ferrogrão's construction.

Figure 3: The Construction of *Ferrogrão* and Deforestation



Notes: *The figure reports the change in deforestation (in square kilometers) caused by the construction of the Ferrogrão railroad. Darker municipalities denote a higher loss of forest and lighter municipalities denote a lower loss of forest.*

The model indicates that a total of 2,043 square kilometers will be deforested due to the construction of Ferrogrão. This deforestation projection, as with all projections derived from econometric models, has some degree of uncertainty. However, the analysis shows that the railroad will induce between 1,671 square kilometers (61 million tons of carbon or US$ 1.55 billion) and 2,416 square kilometers (88 million tons of carbon or US$ 2.24 billion), within a 95% confidence level. This underscores the robustness of the results.

CONCLUSION

This brief summarizes the deforestation risk associated with the construction of the Ferrogrão railroad. The results indicate that this railroad is likely to generate over 2,000 km^2 of deforestation in the state of Mato Grosso (Brazil) if no mitigation measures are implemented. Considering a price of US$25 per ton of carbon, this implies in a cost of about US$1.9 billion of the deforestation, roughly 60% of the cost of implementing this project. This figure is likely an underestimate of the deforestation cost as it does not consider other costs of deforestation other than emissions (e.g., loss of biodiversity, provisional reduction in ecosystem services, etc).

The analysis highlights the importance of implementing mitigation measures that reduce the project's environmental footprint. These measures might include command and control efforts, implementation of the forest code, and the implementation of payment for ecosystem services (PES) schemes. These measures will be fundamental to enable the improvement in logistics generated by *Ferrogrão* not to translate in more deforestation in this environmentally sensitive region.

DATA SOURCES

Land use: The analysis uses land use data from the Mapbiomas project. Using satellite image and ground truth observations, this data set classifies each pixel of 30 by 30 meters in a range of different possible land uses for the period 1985 to 2018. This data is aggregated at the municipality-level in five different categories: forests, pasture, agriculture, mosaic of pasture and agriculture, and others. The borders of the municipalities are hold fixed in the year of 2010 to keep border changes and municipalities splits from influence the results.

Transportation costs: The transportation costs matrices are built from several sources.

The **Ministry of Transportation** provides information on federal roads for the years of 1980, 1990, 2000, and 2010. Roads are divided in segments with each segment being classified as being paved or non-paved. The **Agroindustrial Logistics Research Group of the College of Agriculture Luiz de Queiroz** (ESALQ LOG) provides data on freight rates by road of several products between more than one thousand locations in the country. These products include soybeans, corn, rice, and sugar.

Using these two pieces of information, the costs of transporting one ton of the typical agricultural good in different types of roads is estimated using an optimization routine. The cost to transport goods for one kilometer using paved roads is estimated as R$ 0.10 per ton and the cost to transport goods for one kilometer using non-paved road is estimated as R$ 0.20 per ton. The optimization routine is also used to obtain the costs of traveling pixels without transportation infrastructure. The cost to travel one kilometer without roads outside protected areas is set to R$ 0.50 per ton and the cost traverse without roads inside protected areas is set to R$ 1.00 per ton.

The road network and its freights provide sufficient information to estimate the bilateral transportation costs between the municipalities used in the analysis. However, to obtain the transportation costs to the nearest port, it is important to incorporate the possibility of transporting goods using railways and waterways.

Information on railways and rail stations for the years of 1980, 1990, 2000, and 2010 comes from the **Ministry of Transportation** while information on freight rates come from official documents from the **National Land Transportation Agency** (ANTT). There is a fixed cost of R$ 16 per ton to enter cargo into a rail station and a cost per kilometer of R$ 0.09 per ton to transport goods using a railway.

Information on navigable rivers and river ports also comes from the **Ministry of Transportation**. This data is supplemented with official information of port authorizations and from information collected from statistical yearbooks were used to determine which were ports transported relevant volumes of cargo the years of 1980, 1990, 2000, and 2010. Data on the freight rates of waterways comes from the **Applied Economics Research Institute** (IPEA). There is a fixed cost of R$ 16 per ton to enter cargo into a port and a cost per kilometer of R$ 0.04 per ton using a waterway.

METHODOLOGY

In an innovative application of market access methodology first developed by Dave Donaldson and Richard Hornbeck, researchers from CPI/ PUC-Rio adapt Donaldson and Hornbeck's approach to quantify the effects of the construction of a road, railway, or waterway on deforestation. The methodology uses four steps, as outlined below.

1. **The analysis first identifies transport Infrastructure development over time to determine bilateral transportation costs.** Georeferenced information of the evolution of the transport infrastructure and freight data are used to measure the evolution of bilateral trade costs between all Brazilian municipalities and the closest port in the period of 1980 – 2010.

2. **The bilateral trade costs are combined with municipal population measures to create measures of market access for each municipality.** Usually, the construction of roads and railways tends to increase the access to market municipalities close to these investments. However, it is possible to observe countless other municipalities that gain market access that are not directly surrounding the main transportation corridors constructed during the period under analysis. *This reflects the capacity of the market access measure, to sum up the multiple dimensions in which changes in transportation costs might affect municipalities' market access.*

3. **Next, the response, or elasticity, of agricultural expansion to the changes in market access in the Legal Amazon municipalities is estimated.** This is done combining the market access data with georeferenced information on land use during the 1985-2015 period. The results of this model show that an increase of 1% in market access increases the amount of land used in farming activities by about 0.33%.

4. **Finally, changes in the quantity of land devoted to farming activities are used to infer how changes in market access influenced the forest cover in Amazon municipalities.** This exercise considers that areas not used in farming activities remain as native vegetation which – in the Amazon context – means that they remain covered as forests.

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