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# THE POLITICAL ECONOMY BEHIND TRADE AND LAND USE: LEGAL AMAZON IN THE EU-MERCOSUR FREE TRADE AGREEMENT

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# INTRODUCTION

- Land use and trade are intertwined subjects.
- International trade, under a Ricardian interpretation, entails larger use of the abundant factor, which for a developing economy tends to be land and other primary factors.
- Moreover, in a recent movement, trade agreements tend to be celebrated considering environmental commitments by countries.
- This paper aims to analyze the effects and stability of a trade agreement on the Legal Amazon States. We study the European Union-Mercosur Free Trade Agreement, through a general equilibrium model, focusing on land use change and welfare.
- We build on the models developed by Caliendo et al. (2017) and Maggi (2018), by changing the closure of the model and the target variables.



# WELFARE AND FACTORS IN TRADE LITERATURE

- Quantitative trade models are usually employed to analyze the effect of a trade arrangement in economic variables when one is concerned with general equilibrium effects.
- Bekkers (2019) and Leal (2024) provide systematic revision on the adequacy of the CGE, structural gravity, and exact-hat algebra models, with this paper employing the last option due to its appropriateness to work with more granular data.
- Regarding previous works, literature is plentiful on the impact of trade agreements on the economic variables and the impact of productivity shocks on a country's states (Maggi, 2017, Caliendo e Parro, 2015, Pellegrina, 2022). We use the theoretical framework of the former papers to analyze the impact of the EMTA on the Legal Amazon states.
- Moreover, foreign demand is an important driver of land use change in the Legal Amazon states, specially considering the deforestation driver, with Pendril et al. (2022) and Haddad et al. (2024) indicating the 1/3 of the deforestation might be attributed to the the foreign component.



# MODEL

- The model consists of consumer, firm, trade, and market clearing conditions. The full model and derivation follows closely Caliendo and Parro (2017) and Maggi (2018), and we display the equations in their counterfactuals form, emphasizing the changes this paper implements.

$$\hat{P}_n^j = \left\{ \sum_{i=1}^N \pi_{ni}^j (\hat{\kappa}_{ni}^j \hat{x}_i^j)^{\theta^j} (\hat{T}_i^j)^{\gamma_i^j \theta^j} \right\}^{-1/\theta^j} \quad (1)$$

$$\hat{x}_n^j = \hat{\omega}_n^{\gamma_n^j} \prod_{k=1}^J (\hat{P}_n^k)^{\gamma_n^{jk}}, \forall j \in \{1, \dots, J\}, \forall n \in \{1, \dots, N\} \quad (2)$$

$$\pi_{ni}^{j'} = \pi_{ni}^j \left( \frac{\hat{P}_n^j}{\hat{\kappa}_{ni}^j \hat{x}_i^j} \right)^{\theta^j} (\hat{T}_i^j)^{\gamma_i^j \theta^j}, \forall j \in \{1, \dots, J\}, \forall n, i \in \{1, \dots, N\} \quad (3)$$



# MODEL

$$\hat{H}_n = \frac{\hat{L}_n \sum_{i=1} L_i \hat{H}_i \left( \frac{\hat{\omega}_i}{\phi_i \hat{P}_i \hat{U}^B + (1-\phi_i) \hat{S}_i / \hat{L}_i} \right)^{1/\beta_i}}{L^B \left( \frac{\hat{\omega}_n}{\phi_n \hat{P}_n \hat{U}^B + (1-\phi_n) \hat{S}_n / \hat{L}_n} \right)^{1/\beta_n}} \quad (4)$$

$$X_n^{j'} = \sum_{k=1}^J \gamma_n^{kj} + \alpha_j (\hat{\omega}_n (\hat{H}_n)^{\beta_n} (\hat{L}_n)^{1-\beta_n} (L_n I_n + \Upsilon_n + S_n) - S'_n - \Upsilon'_n) \quad (5)$$

$$\hat{\omega}_n (\hat{H}_n)^{\beta_n} (\hat{L}_n)^{1-\beta_n} (L_n I_n + \Upsilon_n + S_n) = \sum_j \gamma_n^j \sum_i \pi_{in}^{j'} X_j^{i'} \quad (6)$$



# MODEL

- The symbol hat above the variables indicates that we are working with the linear approximation of a variable, given by  $x'/x$ , in which  $x'$  indicates a new value of the variable, while  $x$  indicates the old value of this variable.
- We also emphasize the equation (4) in the previous slide. This equation allows to answer our research question, by endogeneizing the land use in the model, whereas labor is considered constant. This can be understood as a short-term closure if we were to analyze it considering the models in the CGE literature .



# SOLUTION ALGORITHM

- The solution algorithm uses data on

$$\{I_n, L_n, S_n, \pi_{ni}^j\}_{n=1, i=1, j=1}^{N, N, J}$$

with parameters  $\{\beta_n, \theta^j, \alpha_n^j, \gamma_n^j, \gamma_n^{jk}\}_{n=1, j=1, k=1}^{N, J, J}$

- Moreover, we consider relative changes on the

$$\text{following variables } \{\hat{S}_n, \hat{T}_n^j, \hat{K}_{ni}^j\}_{n=1, i=1, j=1}^{N, N, J}$$

- Next, we iterate through the following algorithm:

Given an  $\omega_0$  estimate and  $\epsilon > 0$ :

1. Solve simultaneously the system given by  $\hat{P}_n^j$  and  $\hat{x}_n^j$ , given the  $\omega_0$  estimate.
2. Compute  $\pi_{ni}^{j'}$  considering  $\hat{P}_n^j$  and  $\hat{x}_n^j$ .
3. Solve for  $\hat{H}_n$  consistent with  $\hat{P}_n^j$ .
4. Solve  $X_n^{j'}$ , using matrix inversion methods.
5. Obtain a new guess for  $\hat{\omega}_n$ .
6. Re-do all steps until  $|\hat{\omega}_n - \hat{\omega}_{n-1}| \leq \epsilon$ .

- This model was implemented in Julia.



# TAKING THE MODEL TO DATA

- Input-Output Data: WIOD and NEREUS, for the year of 2008
- Comex-Stat for inter state and nation flows
- Data on social accounts also comes from WIOD and NEREUS for the year of 2008.

## CHANGES IN WELFARE

$$\ln \hat{U}_n = \sum_{j=1}^J \alpha_n^j \left\{ \ln \hat{A}_n^j + \ln \left[ r_n \frac{\hat{\omega}_n}{\hat{x}_n^j} + (1 - r_n) \frac{\hat{S}_n}{\hat{x}_n^j \hat{L}_n} \right] \right\}$$



# SCENARIOS

Simulation	Description	Relevance
Scenario I	In this scenario, we reduce the transaction cost for any pair of Brazilian state-sector from/to any European country-sector, considering a homogeneous cost reduction in the tradeable sectors of the members of this trade agreement	This is the scenario of a "undiscriminated" free trade agreement, reducing the tariffs levied on the trade from Brazil and to Brazil with regard to the European Union
Scenario II	In this scenario, we reduce the transaction cost homogeneously for any pair of Brazilian state-sector from/to any European country-sector, except the primary sectors	This scenario can be understood as soft protectionism, given that these sectors, which tend to heavily export in the case of Brazil



# RESULTS-LAND AND STRUCTURE AND WELFARE CHANGE

Figure 1: Land and Structures, Welfare Change

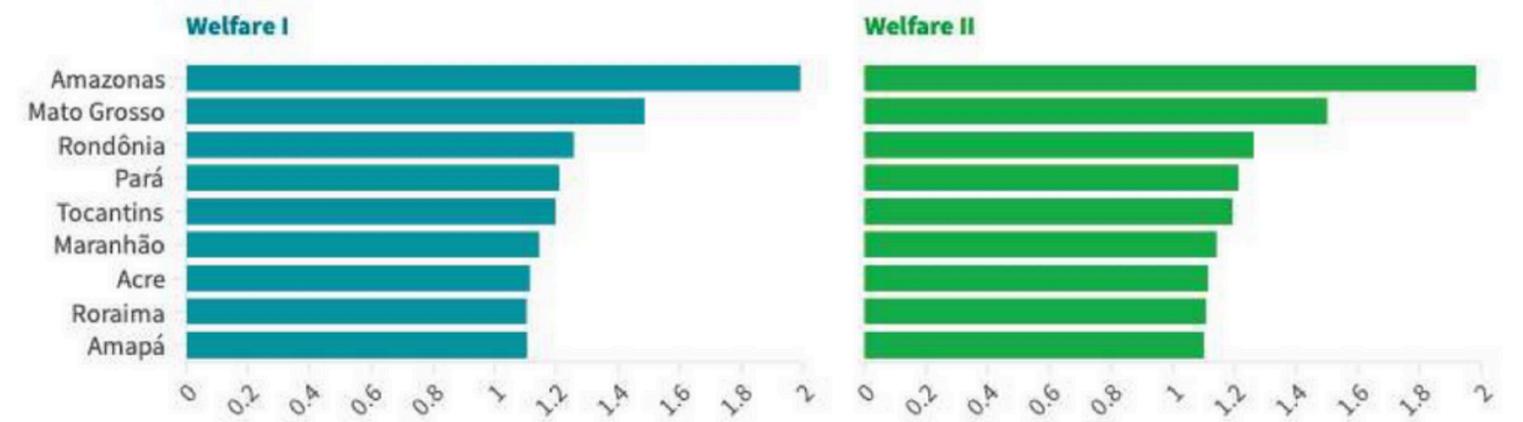
## Land and Structures Change



Source: Author's elaboration.

(a) Land and Structures Change

## Welfare Change



Source: Author's elaboration.

(b) Welfare Change

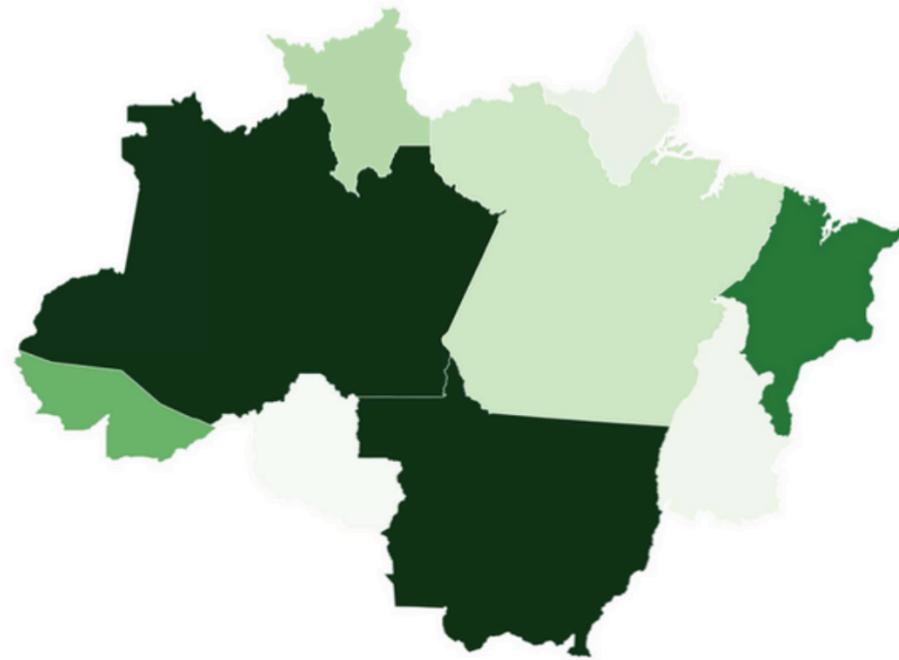
Source: Authors' elaboration



Figure 2: Land and Structures Change

Land and Structures Change I

0,52 1

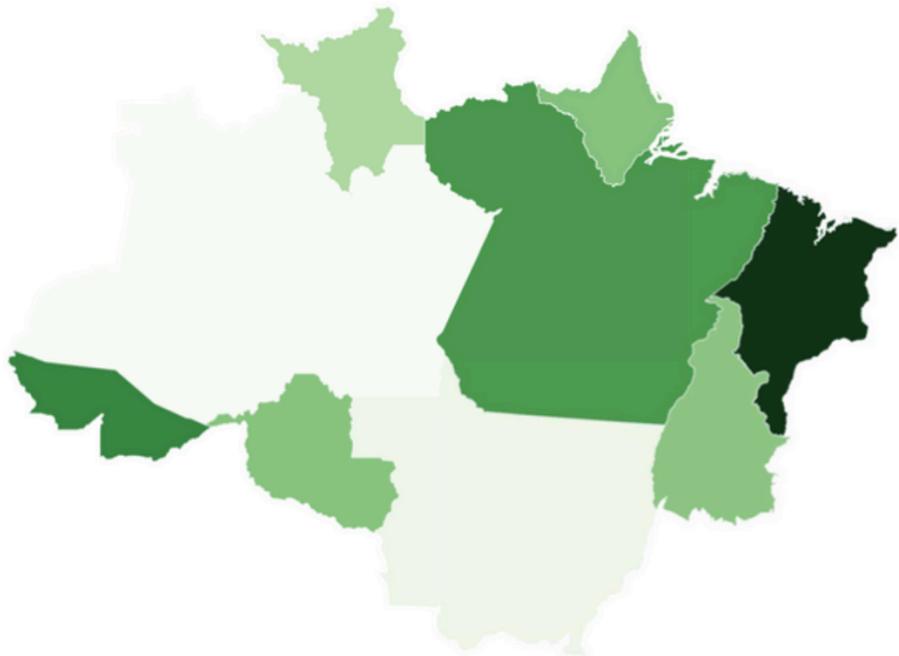


Source: Author's elaboration.

(a) Scenario I

Land and Structures Change II

0,51 1,55



Source: Author's elaboration.

(b) Scenario II

# RESULTS- LAND AND STRUCTURE CHANGE IN THE LEGAL AMAZON STATES

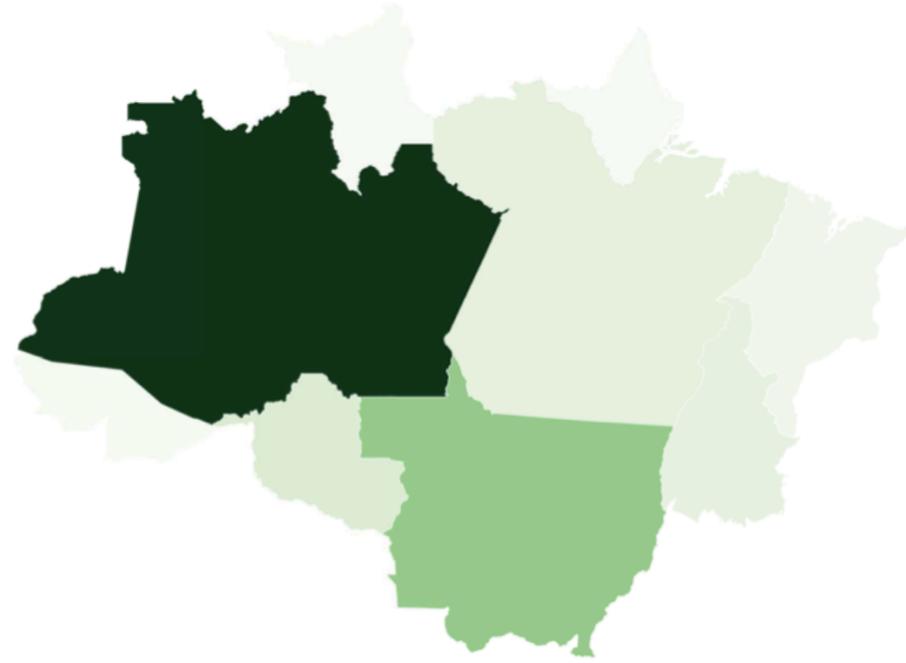
Source: Authors' elaboration



Figure 3: Welfare Change

Welfare Change I

1.1 1.99

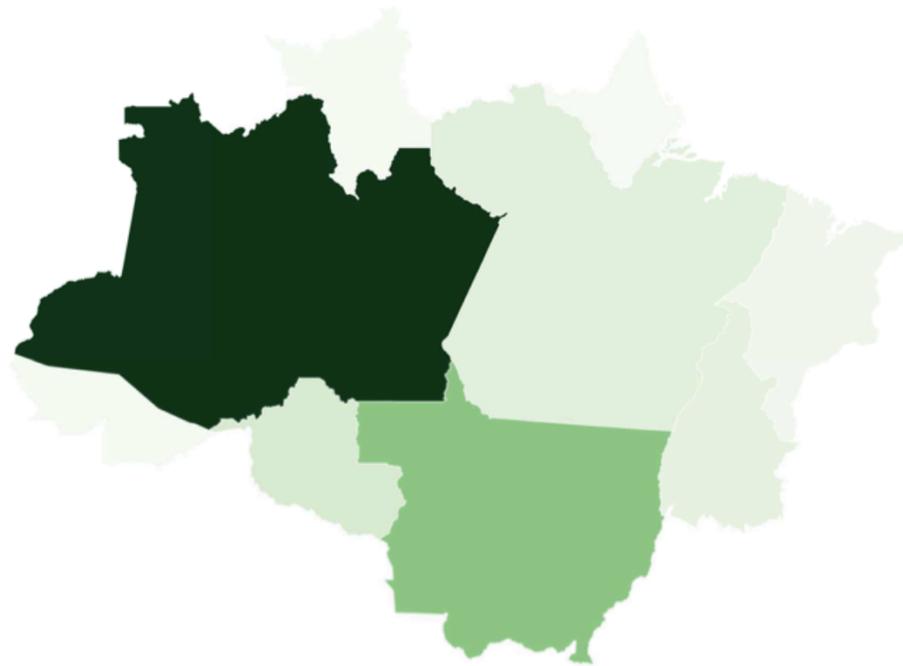


Source: Author's elaboration.

(a) Scenario I

Welfare Change II

1.1 1.99



Source: Author's elaboration.

(b) Scenario II

## RESULTS- WELFARE CHANGE IN THE LEGAL AMAZON STATES

Source: Authors' elaboration



## CONCLUDING REMARKS

- The effect of green protectionism on the land use in the Legal Amazon states is far from direct, as the previous figures indicate.
- Moreover, both scenarios simulated here indicate that the land use change pattern across the Legal Amazon states is not directly assessed by intuition. Scenario I indicates more land use in the inner Amazon states, while Scenario II indicates a growing land use pattern in the outer states of the Legal Amazon.
- The attempt of EU to diffuse their environmental preferences through economic means - Brussels effects and even EUDR- might cause more damage than benefit. Hence, within the EMTA, imposing higher tariffs on the Brazilian sectors usually associated with deforestation would not improve land use and welfare state wide.



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