DRAFT: Spatial economic modeling of disproportional impacts of heat stress through labor market

Problem and significance: Heat stress disproportionately impacts regional and socioeconomic groups through labor market disruption. This research takes a novel approach to quantify the socioeconomic and labor market consequences of heat stress. Traditional works often employ analysis at a global or national scale, but these can be improved to capture the nuanced effects at regional and local levels. While we have Brazil as a case study, our research fills this gap by inserting detailed spatial modeling into the global context to expand our analysis, capturing broader labor market implications, including labor reallocation, production damage, income effects, and international trade shifts. The results reveal an alarming trend of exacerbated regional and socioeconomic inequalities.

Drawing parallels to the US context, where labor heat stress has been linked to significant work-related deaths and projected GDP losses in warming scenarios, our research adds to the global narrative on climate impacts on labor markets by examining the intersection of climate impacts across labor heterogeneity—a dimension not fully explored in existing literature, particularly at the spatial and sectoral detail level adopted in this work (BLS, 2023; Saeed et al., 2022; De Lima et al., 2021). We delve into the labor market's pivotal role in connecting agricultural and non-agricultural sectors, emphasizing the patterns of the impacts through different categories of job stability, educational level, income deciles, and equity considerations at the sub-regional level, offering a nuanced understanding of workforce vulnerability to climate change. More specifically, the research questions are: What are the potential sectoral impacts of heat stress, especially on agricultural production and exports? What is the role of international trade relationships in these impacts? What are the socioeconomic characteristics of the workforce that suffer the most? What is the heat stress impacts on the current regional and social inequality status?

Methodology: We couple two existing models representing 1) the structural dynamics of the Brazilian regional economy and 2) international production chains through global trade relations. This approach ensures a comprehensive understanding of both local impacts and global feedback effects. Integrating the regional TERM (The Enormous Regional Model) with the global GTAP (Global Trade Analysis Project) version 7, we establish a connection primarily through international trade channels following the approach adopted in Horridge and Ferreira-Filho (2003) (Corong and Tsigas, 2017; Horridge, 2012).

Data: The model built enables a nuanced analysis of 27 global production sectors and 19 global regions, alongside 30 Brazilian sectors, 5570 top-down and 137 bottom-up Brazilian regions, and detailed demographic data, including household income deciles, and labor categories of educational levels and employment types. Following Saeed et al. (2022) approach, we employ the CMIP6 data containing 14 climate models and 3 warming scenarios to represent the loss of labor productivity due to climate change. The data has high spatial resolution and considers different labor occupations by its exposure to heat and heavy work intensity, allowing for heterogeneity of impacts in the regional dimension and the labor market.

Preliminary and expected results: Globally, the preliminary results show a decline in the international trade share of Brazilian products, with the agricultural sector — particularly sugarcane, orange, cotton, livestock, and soy — being most affected. The textile and, food and beverage industries also suffer substantial setbacks in exports. Domestically, these shifts increase Brazilian imports, especially in oranges and livestock products. Regionally, we uncover a troubling

intensification of economic disparities, with the North and Northeast of Brazil — areas already less developed and reliant on agriculture — being most affected (Figure 1).

Furthermore, the socioeconomic results reveal that the most vulnerable populations, characterized by lower income, education levels, and job stability, are disproportionately impacted. Increased living costs and a decrease in real consumption aggravate lower-income households' plight (Figure 2 (a)). Simultaneously, the labor market shifts from formal to underground employment, significantly impacting less skilled workers (Figure 2 (b)). These changes signal decreased consumption and a growing population segment being excluded from labor social security mechanisms.

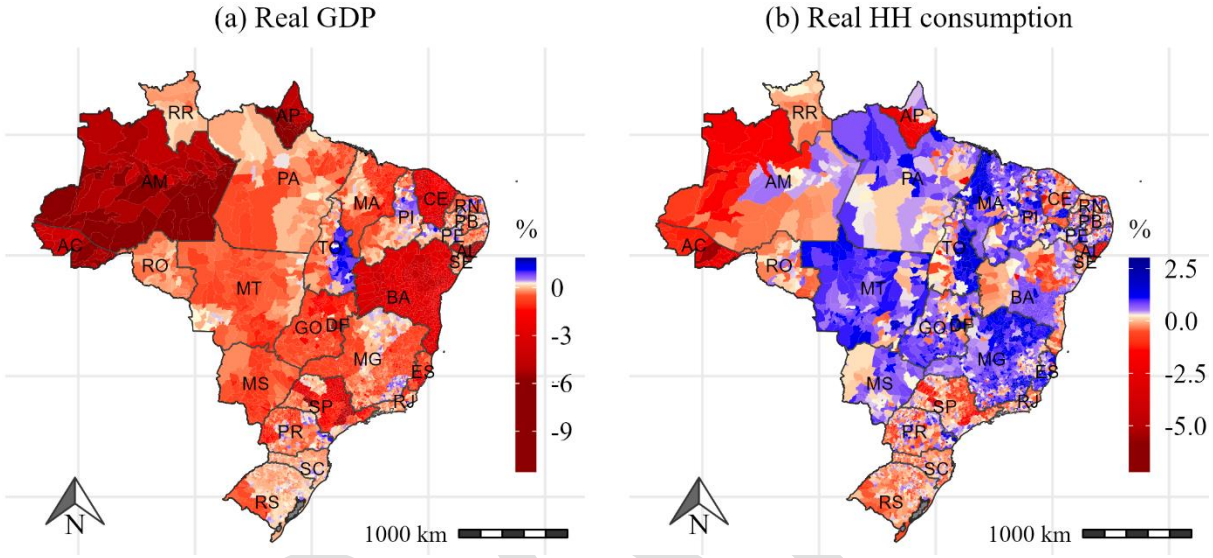

Figure 1: Regional impacts on real GDP (a) and real household consumption (b) by Brazilian municipality (percentage changes).

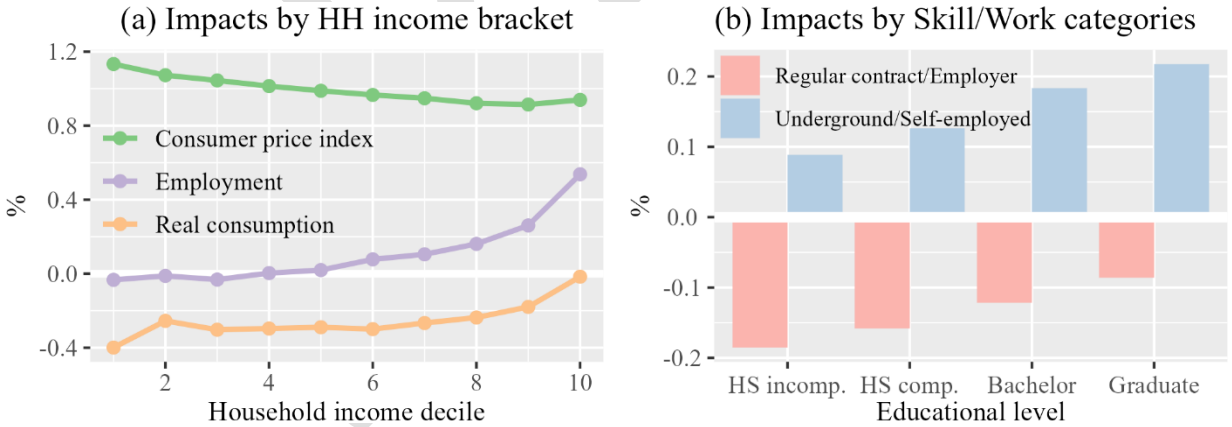

Figure 2: Impacts on price, employment and real consumption by household income decile (a) and impacts on employment by educational level (skill) and type of employment contract (b) (Percentage changes).

Implications and ability to generate discussion at the meeting: Our study brings a regional socio-economic perspective to the impacts of climate change on the labor market. It uniquely focuses on how workforce characteristics drive these effects, highlighting the vulnerability of specific workers and households to heat stress. By emphasizing income decile and equity, we contribute to a comprehensive understanding of economic inequality and its relation to climate adaptation. This approach fosters a discussion of strategies to balance environmental concerns with social equity.

This work has not been presented previously.

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