The Ripple Effects of Drought: How Climate Change is Transforming Brazil's Wheat Production, Imports and Food Security

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Abstract

Climate change is intensifying extreme weather events globally, with Brazil experiencing its worst drought since 1950. Nearly 60% of its territory is affected, creating major challenges for agriculture and trade. This paper examines the impact of past droughts on Brazil's wheat production and global imports. While wheat is less dominant than soybeans or corn, it is essential for food security, hence it is largely imported and increasingly cultivated in Paraná, Rio Grande do Sul, and Santa Catarina. Yet, it remains understudied compared to the other two crops. The research employs the innovative endogenous network difference-in-differences (DID) method developed by the PIs, which captures both direct and indirect drought effects on trade networks. Unlike conventional DID approaches, this method accounts for spillover impacts on trade partners, providing deeper insights into global trade dynamics and adaptation. In line with the IPCC's call for research on climate-driven agricultural changes, the paper fosters international collaboration between Prof. Dall'erba and Prof. Chagas and supports interdisciplinary graduate training. Findings will inform adaptation policies, strengthen food security, and highlight the need for global cooperation in addressing climate impacts. All data and codes will be openly shared to ensure transparency and reproducibility, contributing to sustainable agricultural solutions worldwide.

Keywords: Climate Change, Drought, Wheat Trade, Food Security, Network Econometrics
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1 Introduction

Climate change intensifies the frequency and severity of extreme weather events worldwide. Brazil is currently experiencing a severe drought, considered the worst since records

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began in 1950, affecting nearly 60% of the country's territory. This drought spans from the northern Amazon region to the southeastern parts of the country. The situation poses significant challenges for various agricultural commodities, with ripple effects on Brazil's economy and global commodity markets. Among these commodities, wheat stands out due to its importance as a staple food crop and a widely traded agricultural product. Because wheat production in Brazil is relatively small compared to soybean and corn, wheat is largely imported and recent efforts aim to expand its cultivation, particularly in Paraná, Rio Grande do Sul, and Santa Catarina. The government recognizes wheat's critical role in food security, as it serves as a key ingredient in bread, pasta, pastries, and even animal feed. The other reason for choosing wheat is that it has been much less studied than corn and soybean (e.g., Branco et al., 2021; Da Silva et al., 2010).

This paper investigates two main aspects of Brazil's wheat trade. First, it explores the direct impact of drought events on wheat yield. Second, it examines the broader implications for Brazil's imports of wheat. Recent studies by Dall'Erba et al. (2021) and Vital et al. (2022) have emphasized that extreme weather events have global trade ramifications. A decrease in agricultural yield due to drought reduces exports, forcing trade partners to source imports from alternative suppliers in order to maintain their access to food. Conversely, Brazil's wheat imports, predominantly from Argentina, the United States, and Canada, may also be jeopardized by droughts taking place in those regions. This study aims to uncover the domestic and international linkages in Brazil's wheat trade, considering both imports and exports.

The paper employs a novel methodological framework known as the endogenous network difference-in-differences (DID) method, developed by the two principal investigators (PIs) and described in detail in Dall'erba et al. (2025). This approach advances traditional DID models (e.g Card, 1990; Roth et al., 2023) by incorporating the role of treatment effects on trade networks connecting treated and control countries. The model captures the impact of a shock on the network that connects treated and control groups, addressing the spillover effects overlooked by traditional DID estimators. For instance, while conventional DID models accurately measure the direct negative impact of drought

on local wheat yields, they fail to account for the cascading effects on countries reliant on trade with the affected region. Ignoring these network effects leads to biased and inconsistent estimates, which can hinder the development of effective adaptation policies.

By addressing these gaps, the study highlights the critical role of global trade in mitigating the threats posed by extreme weather events and promoting food security. It also challenges isolationist policies, such as those seen by the current Trump administration, which sought to undermine regional and global trade agreements. Instead, this paper underscores the importance of fostering international cooperation to address shared challenges in food security and climate change adaptation.

Although the endogenous network DID method has been thoroughly developed, it has not yet been applied to a specific case study. This paper fills that gap by focusing on Brazil and its trade partners. It seeks to quantify the extent to which droughts in Brazil's wheat-producing regions affect domestic production and international trade dynamics. Additionally, it will analyze how Brazil and its trade partners respond to such disruptions and propose optimal adaptation strategies. These strategies are particularly relevant as climate change is expected to increase the frequency and severity of extreme weather events in the future.

The paper's focus aligns with the calls from the Intergovernmental Panel on Climate Change (IPCC, 2023) and the broader scientific community for more research on climate-induced changes in agriculture, food supply, and societal impacts. The results are anticipated to contribute to more effective strategies for adapting to and mitigating climate change. Strong, research-based evidence is essential for shaping international agreements on climate action and food security, and this study aims to provide such evidence.

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