LONG TERM CONSEQUENCES OF CLIMATE SHOCKS ON CROP INSURANCE IN BRAZIL

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INTRODUCTION

Drought is a climatological hazard that has affected the most significant number of people worldwide. Several famines that occurred in the past decades have been associated with the long-term effects of droughts. Food production has been largely affected by this disaster. Cunha et al (2019) reported widespread extreme drought events in Brazil from 2011 and 2019. The mega-droughts that occurred in 2014/2015 affecting southeastern (Nobre et al, 2016) and northeastern Brazil (Marengo et al, 2017) caused important impacts on agriculture and urban water supply. More recently, in 2019/2020, in the Paraná River basin, widespread drought events were caused by a combination of precipitation deficit and above-average atmospheric temperatures. The drought negatively affected the region's biodiversity, agribusiness, and livestock (Marengo et al, 2021).

Climate-driven shocks are the primary driver of crop losses worldwide (Kim et al, 2019). This makes insurance for climate risks fundamental in safeguarding sustainable farmers' long-term income and improving food security in drought-prone areas, which is ca. three-fourths of the global harvested areas (Kim et al, 2019).

After an extreme climate event, insurers tend to reassess risk, increasing premium rates (Cremades et al, 2018). One example of this phenomenon was in Germany in 2002. After severe damages caused by floods, insurers had to reassess risk increasing premium rates by 50%, which led to a reduction of 10-20% in the insured area (Schwarze and Wagner, 2004). A similar pattern occurred for floods in the USA in 2004 and 2005. The severe impacts of Hurricane Katrina and others increased premium rates and reduced insurance availability (Herweijer et al, 2009).

The increase in frequency and magnitude of extreme climate events is a major concern for farmers and risk managers. The uncertainty related to droughts and floods might treat risk management by decreasing insurance affordability (Cremades et al, 2018) and pushing less adapted farmers into poverty traps and food security insecurity. In addition, there is a tendency to increase the risk of simultaneous failure of wheat, maize, and soybean crops worldwide, and such socks can pose a risk to the global food system, amplifying threats to food security (Gaupp et al., 2019).

As previously mentioned, the aftermath of extreme events often increases premium rates and reduces insured areas. However, the same pattern has been poorly investigated in the literature. The goal of this paper is to investigate the effects of mega-droughts on crop insurance availability and insured area, analyzing the impacts of the droughts of 2014/2015 and 2019/2021 on premium rates,

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governmental subsidy for crop insurance, liability, and insured area for soybean and maize first and second cycles in Brazil.

METHODOLOGY

For this paper, we selected insurance panel data from the major Brazilian cash crops to represent crop production at the municipal level for all Brazilian municipalities in the 26 states: soybean and maize first and second cycle. Crop insurance data were retrieved from the Brazilian Subvention to Agricultural Insurance Database (SISSER, 2022) from 2009 to 2021. The measures of crop insurance were considered: *total premiums per hectare*, *liability per hectare*, *subsidy level*, and *total insured area*. These were compared with the commodities prices obtained from Esalq/BM&Ibovespa (CEPEA, 2022).

In order to evaluate the variation of insurance availability, we performed the lag 1 difference of the main studied variables x using the equation 1, being x_i the value of the insurance variable in year i and x_{diff} representing the lag 1 difference and being i a time-step of 1 year.

$$x_{diff} = \frac{x_i}{x_{i-1}} \quad (1)$$

The drought claims were modelled using the claim arrival point process (N_t known as Homogenous Poison process (HPP) (Burnecki et al, 2004). This process was simulated using the times between successive claims ($W_i = T_i - T_{i-1}$ where T_i is the time when the ith year when claims occurred. The claim arrival is given by equation 2, where the total arrival in a given year n divided by the total number of policies underwritten in the same year (P).

$$N_t = \frac{\sum_{t=1}^{\infty} I(T_i - t)}{\sum_{t=1}^{\infty} P(T_i - t)} \quad (2)$$

RESULTS

The variation of premiums, government subsidy, liability, and total insured area are displayed in Figure 1. After the droughts of 2014/2015, premium rates increased by more than 30% for maize's first cycle and 25% for the second one. The price of commodities changed by less than 5% (Table 2). The soybean insured area was the most affected, reducing significantly in 2015 even though there was an increase in 25% of insurance subsidy. The insured maize area showed a much smaller variation and was more sensitive to the governmental subsidy.

The claim arrival process showed minor sensitivity in 2014/2015 with values of ca. 4 claims per 100 policies for soybean and 1 claim per 100 policies for maize first cycle. The mega-drought of 2019/2021 increased premium rates to 100% for soybean and more than 125% for maize first and second cycles. Increasing maize premium rates were supported by an increase in subsidies of 40 and 50% for the first and second cycles, respectively. These increases in premium rates are partially explained by commodities prices that increased ca. 30% for maize and 50% for soybean. However, the claim frequency suggests that in 2021 there was an average of 21 claims per 100 policies for soybean, 33, and 39 per 100 policies for maize. The claim arrival process indicates increasing drought risk and is an essential factor influencing premium rates.

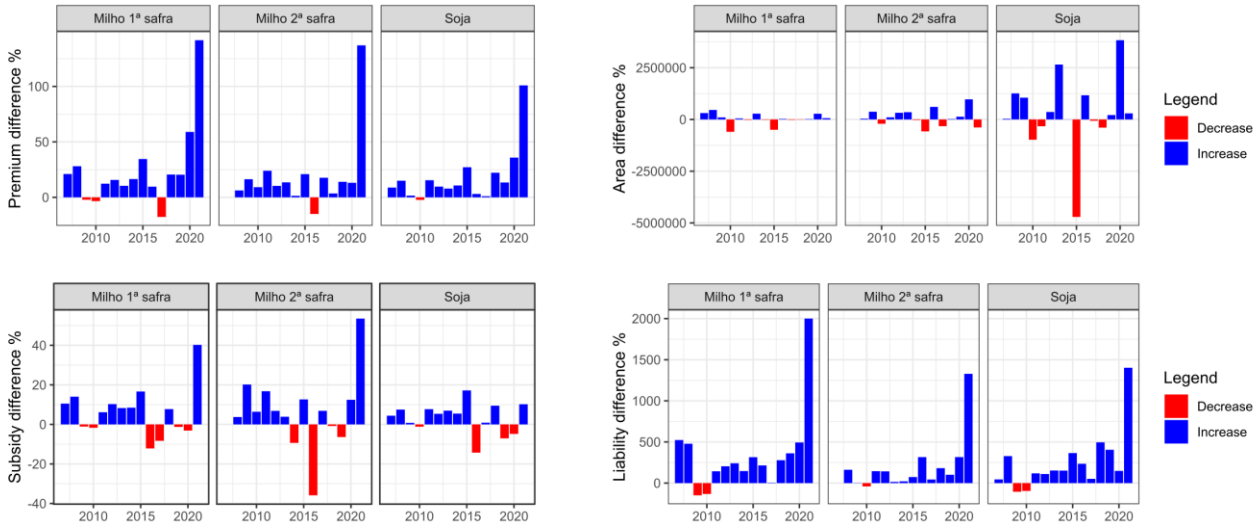

Figure 1. National average variation of premium per hectare, subsidy per hectare, liability per hectare and total insurance area.

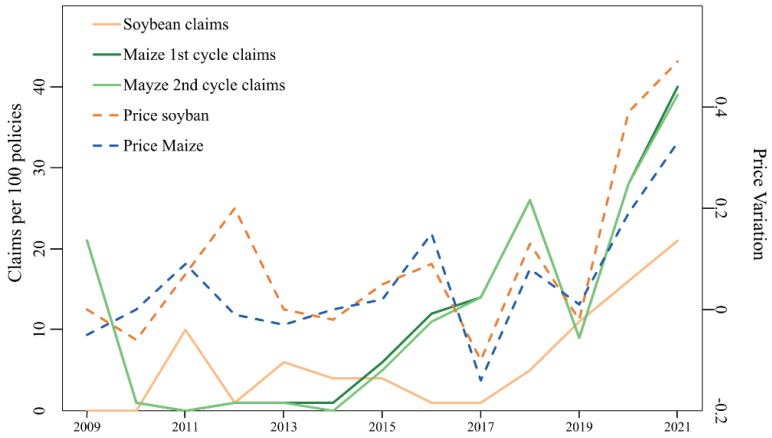

Figure 2. Drought claims frequency per 100 policies and price variation for soybean and maize over time

The aftermath of 2019/2021 is still being monitored since it is the most recent mega-drought event. However, we evaluated that the government subsidies were more significant for maize than soybean. Soybean cultivation is in a larger region than maize (Justino et al, 2013). A more considerable geographic extension favors risk pooling, which can be one explanation for why soybean required fewer subsidies. On the other hand, maize in the double-crop system is located mainly in the Paraná River basin. This explains why the subsidies were more required for maize.

CONCLUSIONS

In the last decades, severe droughts have affected large areas in Brazil. In particular, mega-droughts in 2014/2015 and 2019/2021 have posed significant challenges for water users, especially for risk management in agriculture. In this paper, we tested the hypothesis that after a climate shock, risk managers, i.e., insurers, need to reassess risk leading to an increase in premium rates and a decrease in insurance availability.

We used data from The Rural Insurance Premium Subvention Program (PSR) from 2009 to 2021 for Soybean, Maize 1st cycle, and Maize 2nd cycle. We found that risk premiums increased for all crops for 2015/2015 and 2019/2021. However, only the soybean insured area was reduced in 2015. For the other cases, the crop-insured area remained constant after mega-droughts. This was explained by geographical risk pooling and increased governmental subsidies.

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