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Climate Risk and Access to Credit: Evidence from Colombian Potato Growers*

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Abstract

We study the effects of climate risk on credit access among small farmers in Colombia. Consistent with the use of credit as a smoothing mechanism, we show that credit access increases following adverse rainfall shocks. However, uncertainty about future rainfall—measured with past rainfall variability—reduces both credit access and loan maturities. This effect is driven by relatively wealthier households, suggesting a decline in credit demand as an ex-ante response to climate risk. We also show that rainfall variability dampens the increase in credit following negative rainfall shocks, potentially limiting the effectiveness of credit as an ex-post coping mechanism.

JEL Classification: G21, O13, O54, Q18, Q54
Keywords: Agriculture, credit, climate shocks, developing countries, Colombia

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1 Introduction

Agricultural households in developing countries are frequently exposed to high income volatility due to uninsured risks, such as unexpected productivity and price shocks. Previous literature has shown that financial constraints limit the ability of these households to smooth consumption (Jacoby and Skoufias, 1997; Rosenzweig and Wolpin, 1993). At the same time, risk exposure can further restrict access to credit (Boucher et al., 2008, 2009). As a result, credit constraints and risk exposure can reinforce one another, amplifying the adverse effects of risk on household welfare.

Climate change can intensify agricultural risks by increasing the frequency and severity of extreme weather events. Understanding how rural credit markets respond to heightened climate risk is therefore critical for designing policies that protect the most vulnerable population and the sustainability of farming. This paper examines how income risk—driven by rainfall shocks—affects access to formal credit among small farmers in Colombia. We begin by analyzing the ex post effects of adverse rainfall realizations, focusing on how droughts affect loan disbursements. We then study the ex ante effects of rainfall variability, which we interpret as a proxy for uncertainty about future farm income. Finally, we explore how these two dimensions of climate risk interact to shape credit access.

The ex post effects of climate risk on credit access can operate through both demand and supply mechanisms. On the demand side, temporary and unexpected climate shocks may lead farmers to seek more credit to smooth consumption (Morduch, 1995; Rosenzweig and Wolpin, 1993; Fafchamps and Lund, 2003; Udry, 1990). On the supply side, these shocks can reduce repayment capacity and damage credit histories, leading lenders to restrict credit (de Roux, 2021). The overall ex post impact on credit access is ambiguous and depends on the relative strength of these effects forces.

Uncertainty about future income, induced by climate risk, can also have ex ante effects on credit access. Risk-averse farmers may reduce their demand for credit when faced with greater income volatility. This is particularly relevant in settings with limited insurance and significant information asymmetries, where lenders shift much of the risk to borrowers through collateral requirements and repayment-based disbursements. Boucher et al. (2008) refer to this as risk rationing and show that it can be stronger for wealthier households, who have more to lose in the event of default. At the same time, if risk cannot be shifted to borrowers, lenders may reduce credit supply. In this case, both demand and supply respond in the same direction, leading to lower credit access in high-risk environments.

We examine these effects by focusing on potato farmers in Colombia. We argue that this is an ideal setting for studying the relationship between climate risk and credit access. Most potato cultivation in the country takes place on small, rain-fed plots. Due to the crop's high water requirements during the growing cycle, farmers are particularly vulnerable to drought-induced productivity shocks (Barrios-Perez et al., 2023). Also, the lack of formal insurance makes credit a critical coping tool. Moreover, potatoes are a non-perennial crop, requiring farmers to make production decisions each season. This facilitates the identification of short-term adjustments in credit demand and supply in response to changing climate conditions.

We combine administrative records on publicly funded loan disbursements to potato producers with high-resolution climate data, aggregated at the municipality level, to estimate the effects of climate risk on credit access. To distinguish between ex ante and ex post effects, we construct two separate measures of climate risk. For the ex ante component, we use the coefficient of variation in daily precipitation, calculated over five-year moving windows. This measure follows prior studies that rely on rainfall variability as a proxy for income and consumption uncertainty in rural settings (Colmer, 2021; Foster and Gehrke, 2017; Dercon and Christiaensen, 2011; Abay et al., 2022). The use of this measure assumes that farmers form expectations about future rainfall based on past rainfall patterns. Supporting this assumption, Kala (2017) provides evidence that farmers update their beliefs about future rainfall in response to its observed variability.

For the ex post effects of risk, we calculate the length of droughts during the crop cycle. We define this as the maximum number of consecutive days with less than 1mm of rainfall in a municipality during the harvest quarter and the one before it. The agronomy literature supports this measure, showing that prolonged droughts have strong negative effects on crop yields (Nasir and Toth, 2022).

We begin by motivating our two measures of climate risk through their relationship with potato output and its variability in producing municipalities. In particular, we show that output value declines with longer droughts but is not significantly associated with rainfall variability. This suggests that droughts lead to income losses for farmers, while rainfall variability does not capture realized output shocks. Moreover, we show that rainfall variability is positively correlated with output variability, supporting its use as a proxy for income uncertainty. The fact that rainfall variability does not directly affect total output, but is positively correlated with its variability motivates its interpretation as a mean-preserving spread of income.

We then explore the effects of these risk measures on credit access. Consistent with the use of credit as a smoothing mechanism, our results show that longer droughts increase the value of loan disbursements and the number borrowers in a municipality. In contrast, rainfall variability reduces credit access and decreases loan maturities. Also, the interaction between rainfall variability and drought length is negative suggesting that rainfall uncertainty dampens the response of credit after negative shocks.

We examine the mechanisms behind our findings by exploring heterogeneity across loan types and borrower characteristics. For drought length, we find that credit access increases across all loan types, including both subsidized loans, whose supply is determined by policy, and regular loans, with stronger effects for the latter. This is consistent with a demand-driven response to longer droughts. In contrast, rainfall variability reduces credit disbursements, particularly among wealthier farmers who, as shown by Boucher et al. (2008), are more likely to be risk rationed because have more to lose in case of default.

This paper contributes to three strands of the literature. First, it relates to the study of household strategies for coping with the ex post effects of climate risk in agricultural households. Previous research for developing countries has documented a range of responses to income shocks with lasting welfare consequences. These responses include the sale of land and other assets, reduced investments in human capital, increases in early marriage, migration, and changes in crop choices and input use (Arteaga et al., 2025; Jessoe et al., 2018; Jagnani et al., 2021; Aragón et al., 2021; Ibáñez et al., 2022; Rosenzweig and Wolpin, 1993; Jensen, 2000; Corno and Voena, 2023). These strategies are often driven by financial constraints that prevent households from using credit or savings to smooth consumption (Paxson, 1992; Foster, 1995; Morduch, 1995; Jacoby and Skoufias, 1997). We contribute to this literature by showing that small farmers in Colombia increase their use of credit following negative income shocks such as droughts. However, exposure to risk dampens this coping mechanism, potentially forcing households to rely on more costly strategies.

We also contribute to the analysis of the ex ante effects of risk exposure on agricultural households. Previous works show that households respond to uncertainty about future income by reducing investments in human capital (Foster and Gehrke, 2017; Kazianga, 2012; Fitzsimons, 2007), food expenditures (Gansonré, 2024), and input use (Dercon and Christiaensen, 2011), and by opting for less risky, low-return technologies (Yesuf and Bluffstone, 2009). We contribute to this literature by showing that climate risk has ex ante negative effects on credit accesses and on the use of credit to smooth consumption. Closely related to our paper, Colmer (2021) shows that income uncertainty, proxied by rainfall variability, affects household investment decisions by reducing child labor and increasing schooling in rural Ethiopia. Our paper complements this evidence by documenting that similar measures of climate-induced income uncertainty reduce credit uptake among small farmers in Colombia, highlighting how risk exposure shapes both human capital and financial decisions in agrarian contexts with limited insurance.

Our work is also related to a growing literature that explores the impact of climate risk on agricultural credit in developing countries. Prior research shows that income uncertainty can reduce credit demand, as farmers may be risk-rationed—choosing not to borrow due to concerns about their ability to repay under adverse conditions (Boucher et al., 2008, 2009; Abay et al., 2022). On the supply side, climate shocks can increase default rates, leading lenders to tighten credit conditions (de Roux, 2021; Aguilar-Gomez et al., 2024). This paper contributes to this literature by jointly analyzing the ex ante and ex post effects of climate risk on credit access. Our findings are consistent with the credit rationing framework proposed by Boucher et al. (2008) and further documented in Boucher et al. (2009) and Abay et al. (2022), and show that risk exposure can constrain farmers' ability to access credit after experiencing negative income shocks.

The remainder of this paper is organized as follows: Section 2 discusses the mechanisms through which climate risk can affect credit access. Section 3 describes the context and our main sources of data. In Section 4, we describe the empirical strategy used to conduct the econometric estimations, whose results are presented in Section 5. Finally, Section 6 concludes.

2 Conceptual Framework: Climate Risk and Credit Access

Agriculture in developing countries is highly exposed to climate risk due to the prevalence of rain-fed systems, limited access to risk management tools, and pervasive credit constraints (Komarek et al., 2020). Climate risk can affect both the demand and supply of formal credit through two conceptually distinct mechanisms: ex post effects, which arise from the realization of adverse weather shocks, and ex ante effects, which stem from uncertainty about future climatic conditions.

Ex post effects are caused by realized events—such as droughts, floods, or heat waves—that reduce agricultural output and income. These shocks may increase credit demand, as households seek to smooth consumption or finance the next production cycle (Morduch, 1995; Rosenzweig and Wolpin, 1993). However, they can simultaneously weaken borrowers' repayment capacity, increase default rates, and deteriorate credit histories (de Roux, 2021). Lenders may, therefore, respond by tightening lending conditions or reducing credit availability, particularly in areas or sectors perceived as high risk (Aguilar-Gomez et al., 2024; de Roux, 2021). As a result, the net effect of ex post risk on credit access is theoretically ambiguous, shaped by the interplay between increased credit demand and tightening supply.

Ex ante effects, by contrast, relate to the uncertainty surrounding future weather outcomes. This uncertainty may deter risk-averse farmers from borrowing, particularly in the absence of insurance or effective safety nets. In such cases, households may voluntarily refrain from taking loans to avoid the risk of default, even when credit could support productive investment. This is referred to as risk rationing (Boucher et al., 2008, 2009).

Unlike quantity rationing—where borrowers are denied credit by lenders—risk-rationed households are self-excluded from credit markets due to the perceived downside risk of borrowing. In the presence of income volatility, imperfect enforcement, and collateral requirements, farmers internalize the welfare loss associated with potential default and rationally choose not to borrow. Boucher et al. (2008) develop a theoretical model distinguishing risk from quantity rationing and show empirically that risk rationing can be more prevalent among relatively richer households who have more at stake in case of default. Subsequent studies, such as Abay et al. (2022), provide further evidence that greater rainfall variability is associated with lower credit uptake, consistent with a reduction in demand driven by income uncertainty.

Alternatively, on the supply side, lenders may also respond to ex ante risk by adjusting contract terms, requiring more collateral, or limiting exposure in high-risk areas, further restricting credit access (Kling et al., 2021; Do et al., 2021; Li and Wu, 2023).

3 Context and Data

3.1 Agricultural Credit in Colombia

In Colombia, the agricultural credit market operates under a hybrid model that combines private financial intermediation with strong state involvement. Commercial banks are legally required to allocate a share of their lending portfolio to the agricultural sector. This mandate can be fulfilled either through direct lending to agricultural producers or through compulsory investment in Finagro, the government's second-tier rural development bank. In both cases, these loans are subject to interest rate ceilings set by the regulator, with more stringent caps applied to loans directed toward small farmers.

Finagro provides rediscount resources to financial intermediaries. The state-owned Banco Agrario de Colombia (BAC), is the main provider of credit to small farmers and the main user of rediscounted Finagro loans. In contrast, private commercial banks tend to serve primarily medium and large-scale producers through direct loans. All agricultural loans, regardless of the lending institution or financing structure, can be covered by the Agricultural Guarantee Fund (FAG), a public guarantee scheme that reduces lenders' exposure to default risk. Under this arrangement, if a borrower defaults, the financial institution receives compensation from FAG, while the farmer retains the obligation to repay the fund.

In addition to standard Finagro loans, the government supports a set of Special Credit Lines (Líneas Especiales de Crédito, or LECs) aimed at advancing specific policy objectives. These credit lines offer subsidized interest rates and are typically used to support strategic crops, respond to natural disasters, or facilitate post-conflict reintegration. LECs are financed through rediscounted resources and are supplemented with central government funds to cover the cost of interest rate subsidies.

Despite extensive state involvement, recent estimates indicate that only about 40% of farmers in Colombia have access to formal loans, suggesting the persistence of significant constraints to credit access (Gáfaro et al., 2025). To complement our quantitative evidence, we use data from a focus group with leaders of 20 farmers' associations in Caqueta, a department located in the Andean- Amazonian foothills approximately 500 km south of Bogota, the country's capital.[1] Among the participants in the focus group, only 45% had applied for credit in the past five years, and of those, roughly half reported being denied. Among those who did not apply, 27% cited fear of being unable to repay as a reason. We interpret this as suggesting evidence of risk rationing consistent with the findings of Boucher et al. (2009). Participants also reported high exposure to climate risk, with an average rating of 4 on a 1-to-5 scale, and half identified climate change or weather shocks as the main source of risk to their agricultural activity.

The high rejection rates, coupled with the reported fear of repayment difficulties and strong perceived exposure to climate risk, suggest that climate risk may play a significant role in both the demand for and supply of credit among these farmers. While this is a small and selected sample of community leaders, we view these results as indicative of the potential role that risk plays in shaping credit access among farmers more broadly. This qualitative evidence motivates the quantitative analysis presented in the following section, which focuses on the population of potato farmers.

3.2 Potato Production in Colombia

Potato is the world's fourth most important food crop, after rice, maize, and wheat. In Colombia, is considered a key staple for most households. Its production is concentrated in two main areas: the plains of the departments of Boyacá and Cundinamarca, located in the center-east part of the country, and the department of Nariño, in the southwest area. These two regions account for more than 90% of total production (Ministerio de Agricultura y Desarrollo Rural, 2021). The vast majority of production is destined for domestic con-

[1] The region has a warm, humid climate, and agricultural production is dominated by rain-fed livestock systems and staple crops such as plantain and cassava, along with a variety of Amazonian fruits.The focus group was conducted during the Annual Meeting of Caqueta's Farmers' Markets, held on June 25–26 in Florencia, as part of a broader initiative to characterize risks in the region's agrifood systems. We are grateful to Claudia Marin, Santiago Saavedra, and María Jose Aranguren for their support in organizing the discussion and collecting the data.

sumption, with 92% sold as fresh produce and only 8% used by the food processing industry (Ministerio de Agricultura y Desarrollo Rural, 2022). Exports represent a negligible share of output—just 0.2% of total production on average between 2010 and 2019.

Potato farming in Colombia is predominantly carried out on small, rain-fed plots. Approximately 63% of farms cultivate fewer than three hectares, and most lack irrigation infrastructure, leaving production highly vulnerable to rainfall variability (Ministerio de Agricultura y Desarrollo Rural, 2022). Farmers typically align planting with the onset of the rainy season. There are two main sowing periods, starting in March and September, and the average production cycle lasts about five months (Barrios-Perez et al., 2023).

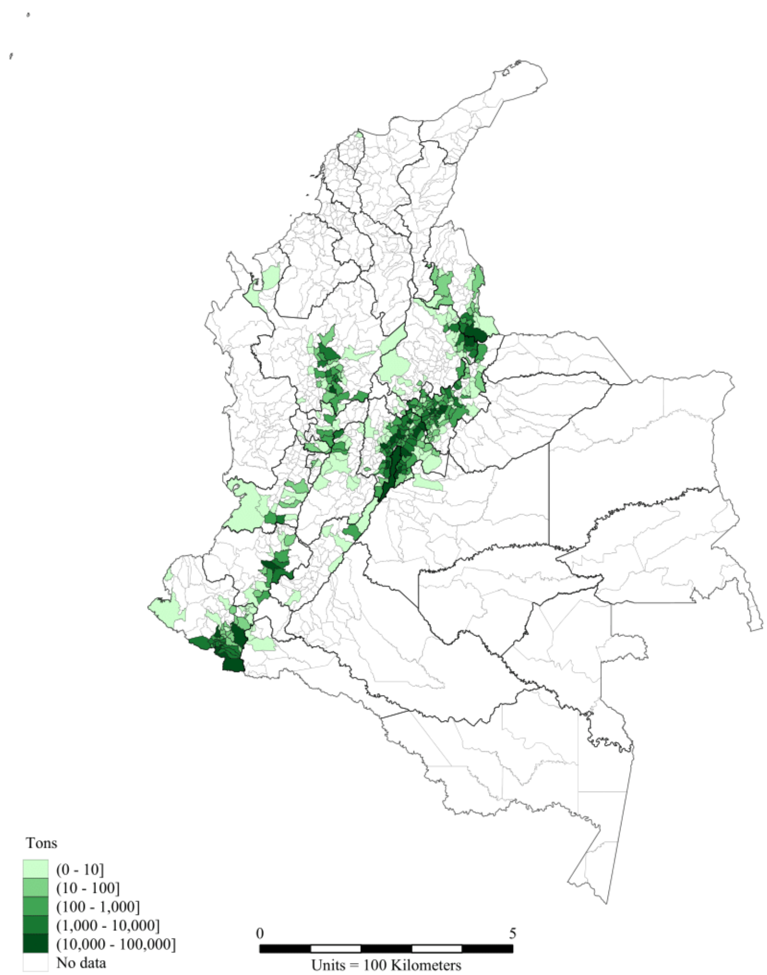
Due to the crop's high water requirements during the growing cycle, droughts have a negative impact on productivity (Ministerio de Agricultura y Desarrollo Rural, 2021; Pino and Chen, 2016; Contexto Ganadero, 2015). Prolonged dry spells and unpredictable water availability can delay planting, reduce yields, and lower farm income. As a result, the inability to accurately anticipate rainfall patterns constitutes a major source of production risk for farmers.

3.3 Data

Our analysis combines information on output, credit, and weather in potato producing municipalities to estimate the effects of climate risk on credit access. The final data set is a quarterly panel at the municipality level, covering the period from 2013Q1 to 2021Q4. In what follows, we describe the data sources and the construction of our main variables.

Production: We use data from the Information System for Prices and Supply of the Agricultural Sector (SIPSA, for its acronym in Spanish) to measure municipal-level output. SIPSA collects weekly wholesale prices and supplied quantities of food crops across major markets in the country and identifies the municipality of origin of supply. We calculate quarterly output volume and value for each producing municipality in each quarter by aggregating the information across destination markets.[2] Figure 1 shows the geographic distribution of output. As described in Section 3.2, most of the supply comes from the Andean regions in the east and southwest of the country.

Figure 1: Geographical Location of Potato Producing Municipalities According to SIPSA



Note: Map indicates average annual production (in tons) for the period 2013–2021. Source: SIPSA

Credit: We use official records of agricultural loan disbursements registered by Finagro. These include loans issued directly by banks to meet their compulsory agricultural lending quotas, as well as those financed through rediscounted resources. The dataset contains information at the producer level (e.g., location, asset ownership) and the loan level (e.g., amount, maturity, interest rate, guarantees, and intended crop). We focus on loans granted

[2]We exclude municipalities whose total potato output falls below the 1st percentile of the national distribution over the study period.

to small-scale potato producers, defined as those who have ever received credit for potato production and have assets below 284 legal monthly minimum wages.[3] With this data, we construct our main outcome variables: total loan disbursements, number of borrowers, average interest rate, and average loan maturity, aggregated at the municipality-quarter level.

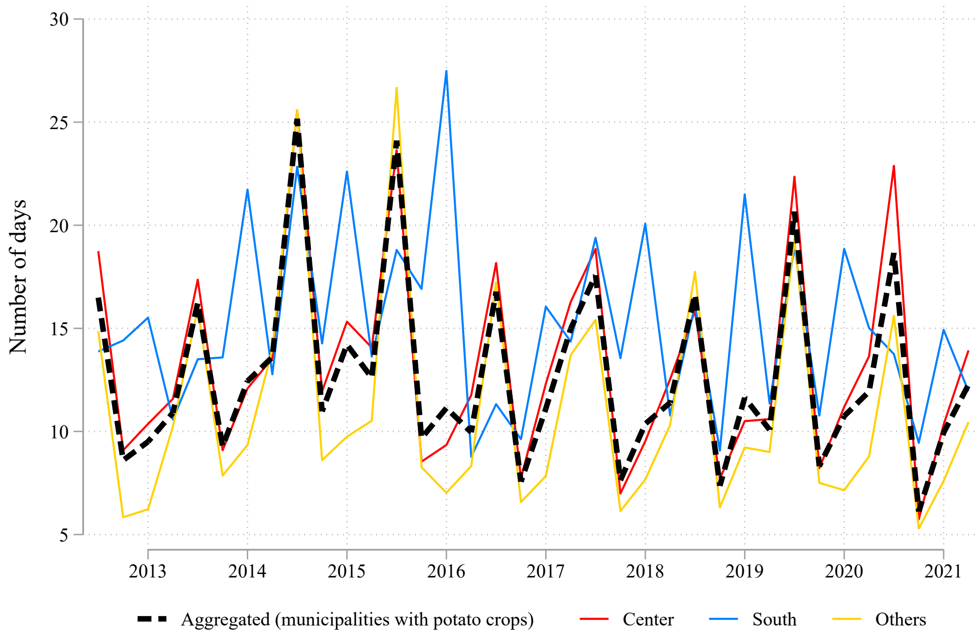
Climate: We use high-resolution rainfall data from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), provided by the University of California, Santa Barbara. CHIRPS includes daily precipitation data from 1981 onward, covering the entire Colombian territory at a spatial resolution of $0.005° \times 0.005°$ (5 $\mathbf{km^2}$). For each municipality, we calculate daily rainfall as the average across all polygons within its boundaries. We then construct two measures of climate risk at the municipality-quarter level: *(i)* maximum consecutive dry days, and *(ii)* daily rainfall variability.

Consecutive dry days, which capture crop's exposure to droughts, serves as a measure of realized production shocks. We calculate this metric as the maximum number of consecutive days with less than 1 mm of rainfall at a given municipality and quarter. To account for water availability throughout the crop cycle, our main specifications average this measure across two consecutive quarters. Figure 2 shows that potato-producing municipalities experienced an average of 12.8 consecutive dry days per quarter between 2013 and 2021, with clear seasonal drought patterns that differ across regions.

Following Colmer (2021), we measure rainfall variability at each quarter as the coefficient of variation of daily rainfall, calculated over a five-year moving window for each municipality. As we discuss further below, this measure captures farmers' uncertainty regarding future rainfall patterns and, consequently, future farm income. Figure 3 describes the trajectory of this variable, showing variation in rainfall variability both across regions and over time within regions. Our empirical strategy exploits this variation to identify its effects on credit access.

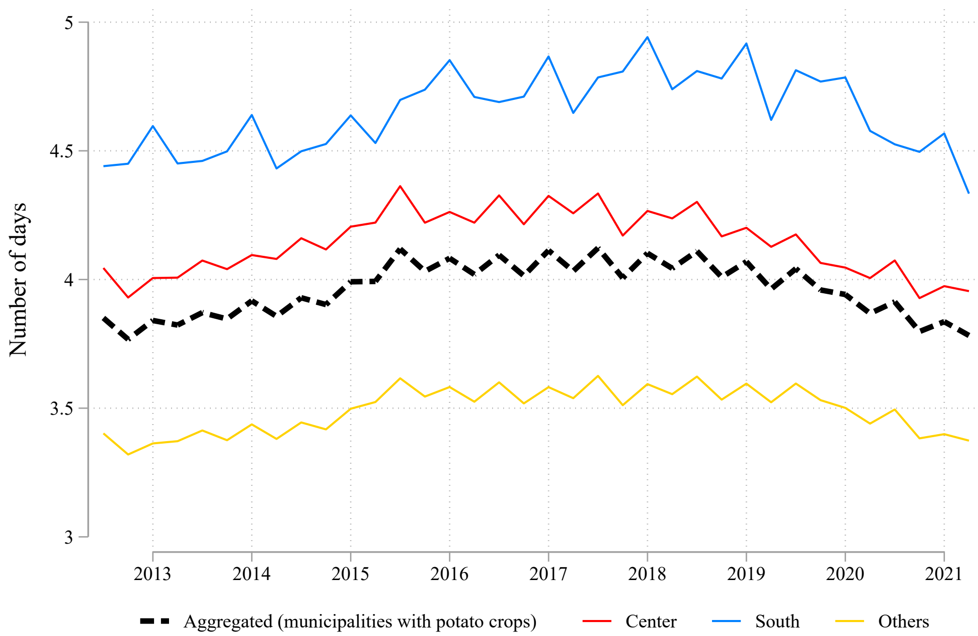
[3] This asset threshold is set by the regulator. In 2021, Colombia's monthly legal minimum wage was COP 908,526. Using an average exchange rate of around COP 3,500 = USD 1, this equated to approximately USD 259 per month.

Figure 2: Length of Longest Dry Periods by Quarter at Potato-producing Municipalities, 2013-2021



Source: CHIRPS

Figure 3: Coefficient of Variation of Daily Rainfall, 2013-2021



Source: CHIRPS

Our final dataset consists of municipality-quarter observations for the sample of 376 municipalities that received at least one potato loan between 2013Q1 and 2021Q4. Appendix Tables A1 and A2 report descriptive statistics for all variables used in our estimations.

4 Empirical Strategy

4.1 Baseline specification

We use aggregate data at the municipality and quarter level to estimate the following equation:

$$y_{it} = \alpha_1 P_{it} + \alpha_2 CV_{it} + X_{it}'\beta + a_i + b_t + u_{it}, \quad (1)$$

where y_{it} represents credit outcomes, including the value of loan disbursements, the number of borrowers, the average loan value, the average interest rate, and the maturity of loans issued in municipality i during quarter t. The variables P_{it} and CV_{it} measure climate risk as described earlier: P_{it} is the average of the maximum consecutive dry days at quarters t and $t-1$. We take this average over two quarters to reflect rainfall conditions during the entire crop cycle. CV_{it} is the coefficient of variation of daily rainfall over 5-year moving windows.

The estimation includes municipality and period (quarter-year) fixed effects (a_i and b_t) to account for differences in climate and production across municipalities, and aggregate shocks that affect all municipalities at a given time, respectively. Control variables X_{it} in our baseline specification include total rainfall in the municipality during quarters t and $t-1$ and their corresponding squares. These controls account for past and current climate conditions in the municipality. Finally, u_{it} represents a stochastic error term.

By including municipality fixed effects (a_i), the identifying variation in Equation (1) comes from deviations of the explanatory variables of interest (P_{it} and CV_{it}) from their averages in each municipality over time, net out of aggregate shocks and time trends, which are accounted for by the time fixed effects (b_i). The coefficient α_1 captures the effect of longer-than-usual dry periods on our credit outcomes. Similarly, α_2 measures the effect on credit access of greater rainfall variability than usual in the municipality.

Our empirical strategy uses the length of droughts a proxy for negative income shocks and the coefficient of variation of rainfall as a proxy for income uncertainty. Below we discuss the assumptions required for the validity of these proxies and provide some evidence motivating these assumptions.

4.2 Drought length as a negative income shock

Our underlying assumption is that rainfall realizations directly influence crop productivity and, consequently, farm income. We focus on rainfall motivated by agronomic evidence documenting the crop's stringent water requirements throughout the growing cycle (Nasir and Toth, 2022; Barrios-Perez et al., 2023).[4]

If longer dry periods represent a negative income shock for farmers, we should observe a decrease in the production value of potato in affected municipalities. To test this, we estimate Equation (1) using as dependent variable the output value. Columns 1 to 3 of Table 1 present the baseline estimations, excluding and including the coefficient of variation of daily rainfall, and using both variables at the same time, respectively. Columns 4 and 5 control for other weather shocks. Specifically, column 4 includes the maximum consecutive number of wet days ($\geq$ 1mm) during the crop cycle and the number of days with rainfall above the municipality's 90th percentile of its historic distribution (1981–2021). Column 5 adds measures of temperature shocks, including the average minimum and maximum temperatures and the number of days with maximum (minimum) temperatures above (below) the 90th (10th) percentile of the historical temperature distribution in the municipality. All columns include our baseline controls: total rainfall in the municipality during periods t and $t-1$ and their corresponding squares, and the average quarterly potato production over the past

[4] Interviews with staff from the Potato Producers Association confirm that droughts are the main production risk faced by these farmers in Colombia.

five years.

The results indicate that longer dry periods reduce output value. The stability of the point estimates across specifications suggests that this effect is not driven by the direct effect of other weather shocks. The fact that we find these negative effects on output value implies that lower output volume due to the lack of precipitation is not fully offset by price adjustments. As a result, this decline in aggregate production value likely leads to income losses for farmers.

Table 1: The effects of rainfall variability and weather shocks on potato production

	(1) Production Value	(2) Production Value	(3) Production Value	(4) Production Value	(5) Production Value
Longest drought length (days)	-7.10***		-7.40***	-6.77***	-6.31***
	(2.36)		(2.43)	(2.24)	(2.21)
Rainfall Variability (20 quarters)		-232.39	-242.55	-241.16	-233.71
		(199.19)	(199.51)	(199.70)	(203.59)
Adj. R^2	0.835	0.835	0.835	0.835	0.835
Observations	13,160	13,160	13,160	13,160	13,160
Municipalities	376	376	376	376	376
Baseline controls	Yes	Yes	Yes	Yes	Yes
Excessive rainfall	No	No	No	Yes	Yes
Temperature shocks	No	No	No	No	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as: precipitation (mm/quarter- year), precipitation squared, average precipitation in the last 20 quarters, and average potato production during the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

4.3 Rainfall variability as a measure of income uncertainty

We follow Colmer (2021) in using rainfall variability as a proxy for income uncertainty. For this measure to be valid, it must be positively correlated with income variability. As before, the rationale is that rainfall realizations directly influence farm productivity; thus, uncertainty about future rainfall translates into uncertainty about future productivity and, consequently, farm income. Kala (2017) provides evidence that farmers update their expectations about future rainfall based on past realizations. This suggest that farmers might use observed rainfall to form their expectations about future income.

Although we lack individual-level data to test this directly at the farmer level, we examine the relationship between rainfall variability and production value variability at the municipal level. In particular, Table 2 presents the results of estimating Equation 1, using the coefficient of variation of production value as the dependent variable. The results indicate that higher rainfall variability is associated with greater output variability, which may reflect increased income variability—and thus greater income uncertainty—within the municipality.

Table 2: The effects of rainfall variability and weather shocks on the variability of production value

	(1) Production Variability (20 quarters)	(2) Production Variability (20 quarters)	(3) Production Variability (20 quarters)	(4) Production Variability (20 quarters)	(5) Production Variability (20 quarters)
Longest drought length (days)	0.01		0.01^{*}	0.01^{*}	0.01^{*}
	(0.01)		(0.01)	(0.01)	(0.01)
Rainfall Variability (20 quarters)		0.54^{*}	0.57^{**}	0.57^{**}	0.55^{**}
		(0.27)	(0.28)	(0.28)	(0.28)
Adj. R^2	0.841	0.842	0.843	0.843	0.843
Observations	2,793	2,793	2,793	2,793	2,793
Municipalities	234	234	234	234	234
Baseline controls	Yes	Yes	Yes	Yes	Yes
Excessive rainfall	No	No	No	Yes	Yes
Temperature shocks	No	No	No	No	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as: precipitation (mm/quarter- year), precipitation squared, average precipitation in the last 20 quarters, and average potato production during the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

The coefficient α_2 in Equation (1) captures the effect of rainfall variability on credit access, conditional on realized droughts and other controls. Our interest lies in the effect of income variability on credit access, and we argue that rainfall variability can serve as a suitable proxy. Even if rainfall variability is a valid proxy for income variability, the identification assumption in this case requires that rainfall variability does not directly capture other income shocks.

In line with this assumption, Table 1 shows that conditional on the control variables, rainfall variability does not have a statistically significant effect on the contemporaneous value of production. Furthermore, the coefficient estimate of this variable remains largely unchanged after including alternative measures of weather shocks. Column 3 further confirms that even without any measures of shocks in the regression, rainfall variability has no statistically significant effect on production value. We interpret this as evidence that our measure of rainfall variability does not capture realized production shocks and can instead be interpreted as a mean-preserving spread of income.

5 Results

5.1 The Effects of Climate Risk on Credit Access

Table 3 presents the estimation results from Equation (1) with our measures of credit access. The estimated coefficients suggest that a 1 standard deviation increase in the duration of a drought (5.66 days) generates an average increase of 4.71 million COP in total credit value by municipality (column 1), and an increase of 0.42 borrowers receiving loans (column 2). Relative to mean credit value and borrowers, these effects represent 7.67% and 7.98% increases, respectively.

The increase in loan disbursements after longer droughts is consistent with the use of credit to smooth consumption after negative income shocks. Columns 3, 4 and 5 show that the average amount disbursed per borrower decreases, while average interest rate and average maturity do not change with drought length. This implies that those additional loans induced by the shock are slightly smaller but have otherwise similar characteristics that the average loans in the municipality during regular rainfall conditions.

Table 3 also shows that climate risk has a negative ex ante effect on credit access. In particular, rainfall variability decreases the value of credit in the municipality (column 1). This is driven by a reduction in the number of borrowers (column 2), without changes in the average value of loans per borrower (column 3) or in the average interest rate (column 4). Fewer borrowers obtaining loans in context of higher rainfall uncertainty can be driven by a decrease in credit demand or by a reduction in credit supply. Regulatory constraints on interest rates might explain that these shifts in either supply and demand are not accom-

Table 3: Effects of climate risk on credit access

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Longest drought length (days)	0.833***	0.075***	-0.038*	-0.002	0.065
	(0.270)	(0.023)	(0.021)	(0.007)	(0.065)
Rainfall Variability (20 quarters)	-58.652**	-4.792**	0.416	0.381	-4.823**
	(25.428)	(1.949)	(0.631)	(0.235)	(2.022)
Adj. R^2	0.760	0.779	0.228	0.604	0.480
Observations	13,160	13,160	5,433	5,433	5,433
Municipalities	376	376	302	302	302
Baseline controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

*** p<0.01, ** p<0.05, * p<0.1.

panied by price adjustments. Column 5 shows that higher rainfall variability is associated with shorter loan maturities. This can also be driven by either borrowers or lenders being less willing to take up or grant longer term loans in context of higher uncertainty.

So far, our results show that loan disbursements increase after negative rainfall shocks but decline in the presence of higher rainfall uncertainty. These findings are consistent with an increase in credit demand for consumption smoothing after adverse shocks, and a reduction in either credit demand or supply when future income is more uncertain. In the next section, we examine these mechanisms in greater detail.

5.2 Robustness

The first robustness check of our results consists of including the additional variables that account for other realized shocks used for the regression estimates of the value of production and its variability (Tables 1 and 2). Table A3 shows that the estimated coefficients of Equation 1 for the total value of credit and number of beneficiaries per municipality as outcomes remain stable across specifications with different sets of controls.

Second, we use alternative constructions of our measures of climate risk. In particular, we vary the time window used to compute rainfall variability (e.g., 8 or 12 quarters), and calculate the coefficient of variation for the period 1981–2012. Then, we consider two alternative definitions of droughts. One measure counts the number of dry days—whether consecutive or not—per municipality and quarter, while the other is an indicator variable equal to 1 whether total precipitation in year-quarter t is under 2 standard deviations of the historical distribution. Appendix Tables A4 to A7 confirm that our main results remain robust across these alternative specifications.

5.3 Potential Mechanisms

In this section, we discuss the potential mechanisms driving our results. We do this by exploring the heterogeneity in our coefficients of interest across several loan and borrower characteristics.

Credit demand as an ex-post coping mechanism.

The increase in the number of farmers obtaining loans after longer droughts, shown in Table 3, is consistent with a higher credit demand for consumption smoothing. However, it is also possible that the observed increase in credit reflects an expansion in credit supply as a policy response to support farmers facing income losses. As described in Section 3.2, Finagro's LEC program is the policy instrument that allows for such supply expansion.

To explore whether the increase in credit access after longer droughts results from a supply expansion, we estimate Equation (1) separately for LEC and non-LEC loans. Table 4 shows that longer droughts lead to an increase in both LEC (panel a) and non-LEC disbursements (panel b).[5] Also, interest rate for non-LEC loans increases, while there are no significant effects in LEC loans, whose interest rates are set by policy. The fact that we observe more non-LEC disbursements supports the interpretation that farmers increase

[5] Table A2 presents descriptive statistics for the variables used in these regressions and reports the drought elasticities of the dependent variables at their means.

their credit demand in response to longer droughts, while ruling out the possibility that the observed effects are fully attributable to supply-side policy responses. The interest rate increase in non-LEC loans might reflect both higher demand and also higher risk perceived by lenders from those farmers affected by the drought.

Table 5 shows that longer droughts lead to an increase in credit for both farmers with assets above and below the median. The fact that relatively poorer farmers are able to access credit for consumption smoothing suggests that the national guarantee scheme (FAG) might effectively mitigate collateral constraints for those unable to fully back their loans with assets. Consistent with this interpretation, Table 6 shows that the increase in credit access is concentrated among loans backed by the FAG. This pattern suggests that lenders are more willing to respond the higher demand granting credit when risk is partially absorbed by the public guarantee. As in our main specification, drought length has no statistically significant effects on the average interest rate in either sample. This is can be explained with the fact that interest rate caps apply to both types of loans.

Ex ante risk rationing.

The negative effect of rainfall variability on credit access is consistent with a risk rationing mechanism, as described by Boucher et al. (2008). In this framework, lenders transfer most of the risk to borrowers—through collateral requirements or reliance on credit histories for borrowers assessments —leading risk-averse farmers to reduce their credit demand under higher risk. Table 4 shows a strong negative effect of rainfall variability on LEC disbursements, while the effect on non-LEC loans is negative but not statistically significant. Because the supply of LEC loans—including their interest rates and maturities—is determined by policy and thus relatively exogenous to local weather conditions, the observed decline in LEC disbursements likely reflects a contraction in demand.[6] In contrast, for non-LEC loans—where interest rates can adjust up to a regulatory cap and maturities are flexible—we find that greater rainfall variability leads to higher average interest rates and shorter loan terms, con-

[6] The interpretation of LEC supply being relatively exogenous to local conditions is reinforced by the null effect of drought length on LEC disbursements.

Table 4: Effects of rainfall risk on credit access by type of loan

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Panel A. LEC					
Longest drought length (days)	0.322**	0.027**	-0.032	0.004	0.106*
	(0.149)	(0.013)	(0.026)	(0.006)	(0.063)
Rainfall Variability (20 quarters)	-48.668***	-3.945***	0.396	-0.113	-1.013
	(14.666)	(1.076)	(0.702)	(0.149)	(2.030)
Adj. R^2	0.545	0.572	0.227	0.366	0.567
Observations	13,160	13,160	3,751	3,751	3,751
Municipalities	376	376	244	244	244
Baseline controls	Yes	Yes	Yes	Yes	Yes
Panel B. Non-LEC					
Longest drought length (days)	0.512***	0.049***	0.002	0.008***	0.158**
	(0.181)	(0.015)	(0.026)	(0.002)	(0.080)
Rainfall Variability (20 quarters)	-9.984	-0.914	-0.026	0.201**	-8.900***
	(14.401)	(1.201)	(0.883)	(0.083)	(2.564)
Adj. R^2	0.521	0.525	0.154	0.254	0.483
Observations	13,160	13,160	4,075	4,075	4,075
Municipalities	376	376	275	275	275
Baseline controls	Yes	Yes	Yes	Yes	Yes

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.
*** p<0.01, ** p<0.05, * p<0.1.

sistent with increased credit risk and both borrowers and lenders responding to this increased risk.

As discussed in Section 2, the model in Boucher et al. (2008) predicts that wealthier farmers may be more susceptible to risk rationing, as they have more to lose in the event of default. Consistent with this prediction, Table 5 shows that the negative effect of rainfall variability on credit access is concentrated among farmers with assets above the median.[7]

Finally, Table 6 shows that both loan value and the number of borrowers decline for loans backed by the FAG and for those with private guarantees. Since the FAG protects

[7] We further explore this mechanism for medium and large potato producers in Table A8 (Appendix). While rainfall variability does not significantly affect the total loan amount or the number of borrowers in this group, it has a significant negative effect on interest rates, suggesting a contraction in demand in a setting with relatively elastic supply and less binding interest rate caps.

Table 5: Effects of rainfall risk on credit access by size of borrower's assets

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Panel A. Assets above median					
Longest drought length (days)	0.563***	0.044***	-0.035	-0.006	0.005
	(0.200)	(0.015)	(0.023)	(0.007)	(0.073)
Rainfall Variability (20 quarters)	-64.679***	-5.449***	0.423	0.409*	-4.019**
	(24.144)	(1.747)	(0.764)	(0.220)	(2.005)
Adj. R^2	0.633	0.629	0.232	0.592	0.471
Observations	13,160	13,160	4,849	4,849	4,849
Municipalities	376	376	277	277	277
Baseline controls	Yes	Yes	Yes	Yes	Yes
Panel B. Aseets below median					
Longest drought length (days)	0.270**	0.031**	-0.001	-0.005	0.081
	(0.119)	(0.013)	(0.014)	(0.008)	(0.067)
Rainfall Variability (20 quarters)	6.027	0.657	1.045*	0.459	-5.562**
	(5.624)	(0.667)	(0.589)	(0.321)	(2.521)
Adj. R^2	0.727	0.706	0.228	0.640	0.519
Observations	13,160	13,160	3,248	3,248	3,248
Municipalities	376	376	231	231	231
Baseline controls	Yes	Yes	Yes	Yes	Yes

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.
*** p<0.01, ** p<0.05, * p<0.1.

lenders but not borrowers, a supply-side contraction would likely be mitigated for FAG-backed loans. The fact that this is not observed supports the interpretation that the decline in credit access reflects a demand-side response. Overall, the results are consistent with a contraction in credit demand in response to greater rainfall variability, as predicted by the risk rationing mechanism. However, it is not possible to completely rule out a supply reduction in response to the increased risk.

5.4 The Interaction Between Realized Shocks and Uncertainty

We finally explore whether rainfall variability limits the credit response to longer droughts. To do so, we re-estimate Equation (1), including an interaction variable between rainfall

Table 6: Effects of rainfall risk on credit access by type of collateral

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Panel A. FAG					
Longest drought length (days)	0.865***	0.075***	-0.034*	-0.005	0.072
	(0.279)	(0.023)	(0.019)	(0.007)	(0.063)
Rainfall Variability (20 quarters)	-45.284**	-4.090**	0.610	0.324	-4.927***
	(19.796)	(1.681)	(0.584)	(0.237)	(1.861)
Adj. R^2	0.767	0.780	0.270	0.614	0.508
Observations	13,160	13,160	5,339	5,339	5,339
Municipalities	376	376	296	296	296
Baseline controls	Yes	Yes	Yes	Yes	Yes
Panel B. Non-FAG					
Longest drought length (days)	-0.031	-0.000	-0.214**	0.025	-0.045
	(0.042)	(0.002)	(0.107)	(0.017)	(0.165)
Rainfall Variability (20 quarters)	-13.368**	-0.719**	3.797	0.241	-1.129
	(6.586)	(0.339)	(4.144)	(0.671)	(6.252)
Adj. R^2	0.425	0.467	0.139	0.438	0.294
Observations	13,160	13,160	1,444	1,445	1,445
Municipalities	376	376	142	142	142
Baseline controls	Yes	Yes	Yes	Yes	Yes

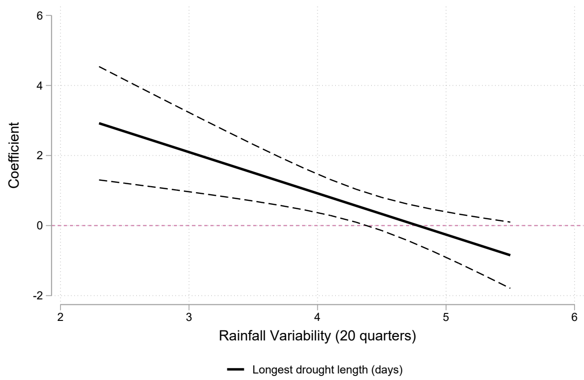
Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.
*** p<0.01, ** p<0.05, * p<0.1.

variability and drought length, $(P_{it} \times CV_{it})$. The coefficient of this interaction provides insights on the effect of an increase in the number of dry days on credit access, for different levels of rainfall variability.

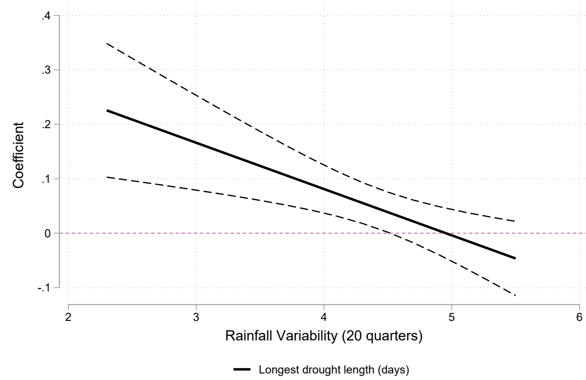
Figure 4 summarizes these results. The figure shows that the increase in the value of disbursements (Panel A) and borrowers (Panel B) after longer droughts occurs when the municipality has has low rainfall variability. As rainfall variability increases, the credit response to dry days is reduced to zero. Appendix Table A5 shows that this negative interaction between drought length and rainfall variability is robust to using the coefficient of variation of rainfall for a fixed period (1981–2012) before our period of analysis.

In sum, our results suggest that potato farmers use credit to smooth consumption following negative productivity shocks associated with droughts. However, climate uncertainty limits this use of credit as a coping mechanism.

Figure 4: Total marginal effects of weather shocks on credit disbursements and the number of borrowers



(a) Loans



(b) Borrowers

Note: Dashed lines correspond to the confidence internal at 95 percent of significance. Bold lines refer to the total marginal effect evaluated at each point of the distribution of rainfall variability. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

6 Final Remarks

This paper jointly assesses the ex ante and ex post effects of climate risk on credit access for small producers of potato in Colombia. First, we explore the ex post effects that come after droughts, a negative climate shock. Second, we investigate the ex ante effects through the uncertainty surrounding future climate realizations, using rainfall variability as a proxy of that uncertainty. Finally, we analyze how these two effects interact to influence farmers' use of credit as a coping mechanism for climate risk.

Our results suggest that climate risk plays a relevant role in credit access to potato producers: Longer droughts increase total loans disbursed and the number of borrowers. On the other hand, the results suggest that rainfall variability is associated with less credit access. This could reflect a lower interest of households to borrow under scenarios of greater uncertainty or a lower willingness of financial intermediaries to offer credit in these places. Additionally, we found that after a drought, credit might act as an ex post income smoothing mechanism in municipalities with low rainfall variability. These results are consistent regardless the total value of household assets, or the presence of a public-funded guarantee scheme that helps to mitigate the lack of collateral in producers who cannot back debts with their own assets. With respect to the interest rate, results show that climate risk does not impact it significantly, which could be explained by the interest rate caps and subsidized rates for smallholders in the Colombian context.

It is possible to draw some relevant policy implications from our analysis. On one hand, identifying the barriers that impede access to credit in municipalities farthest from the main markets is relevant to the design of policies that seek to provide consumption-smoothing mechanisms in the most vulnerable households. On the other hand, if climate change is expected to increase variability in rainfall patterns and generate more frequent, intense, and less predictable droughts, credit effectiveness as an income-smoothing mechanism or a way to overcome financial constraints that prevent technology adoption, could be limited. Recognizing the climate risk and considering actions to mitigate it should be part of the adaptation policies with respect to climate change.

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Appendix

Tables

Table A1: Descriptive Statistics of Variables from Tables 1 and 3

Variable	Units	Obs	Mean	Std. Dev.	Min	Max	Elasticity Longest drought length (days)
Panel A:							
Production value	Million COP	13,160	559.75	2,383.65	0	49,672.6	-0.167
Total credit	Million COP	13,160	61.35	196.11	0	3,728.91	0.171
Borrowers	Individuals	13,160	5.26	15.85	0	273	0.180
Precipitation	mm	13,160	386.34	209.11	0	1,860,963	
Longest drought length (days)	Days	13,160	12.63	5.66	1	124.5	
Panel B:							
Credit per borrower	Million COP	5,433	11.37	5.67	0.96	100.82	-0.043
Interest rate	%	5,433	3.9	2.49	-2	7	-0.006
Maturity	Months	5,433	22.35	19.15	6	132	0.038
Precipitation	mm	5,433	330.72	165.83	72.14	1,275.22	
Longest drought length (days)	Days	5,433	13.07	4.92	2	33	

Table A2: Descriptive Statistics of Variables from Tables 4 to 6

Variable	Units	Obs	Mean	Std. Dev.	Min	Max	Elasticity Longest drought length (days)
Panel A: LEC							
Total credit LEC	Million COP	13,160	30.26	121.14	0	3,241.32	0.134
Borrowers LEC	Individuals	13,160	2.55	9.46	0	214	0.128
Total credit non-LEC	Million COP	13,160	31.08	119.56	0	2,765.61	0.207
Borrowers non-LEC	Individuals	13,160	2.73	10.09	0	224	0.222
Panel B: FAG							
Total credit FAG	Million COP	13,160	56.46	181.18	0	3,565.21	0.193
Borrowers FAG	Individuals	13,160	5.01	15.15	0	268	0.189
Total credit non-FAG	Million COP	13,160	4.88	23.38	0	574.67	-0.080
Borrowers non-FAG	Individuals	13,160	0.25	1.15	0	33	-0.003
Panel C: Assets							
Total credit Assests above median	Million COP	13,160	45.84	153.35	0	3,692.85	0.155
Borrowers Assests above median	Individuals	13,160	3.49	11.01	0	263	0.159
Total credit Assests below median	Million COP	13,160	15.5	65.77	0	1,459.83	0.220
Borrowers Assests below median	Individuals	13,160	1.76	7.15	0	158	0.222
Panel D: Distance							
Total credit Closest to the market	Million COP	11,023	54.68	198.67	0	3,728.91	0.216
Borrowers Closest to the market	Individuals	11,023	4.72	16.2	0	273	0.219
Total credit Far away from the market	Million COP	9,788	20.89	92.27	0	2,304.97	0.081
Borrowers Far away from the market	Individuals	9,788	1.78	7.32	0	166	0.092

Table A3: Effects of climate risk on credit access, controlling for other realized shocks

	(1) Total Credit	(2) Total Credit	(3) Total Credit	(4) Borrowers	(5) Borrowers	(6) Borrowers
Longest drought length (days)	0.833***	0.723***	0.825***	0.075***	0.067***	0.077***
	(0.270)	(0.261)	(0.272)	(0.023)	(0.022)	(0.024)
Rainfall Variability (20 quarters)	-58.652**	-58.653**	-61.389**	-4.792**	-4.789**	-4.958**
	(25.428)	(25.316)	(25.936)	(1.949)	(1.939)	(1.987)
Adj. R^2	0.760	0.761	0.761	0.779	0.780	0.780
Observations	13,160	13,160	13,160	13,160	13,160	13,160
Municipalities	376	376	376	376	376	376
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Excessive rainfall	No	Yes	Yes	No	Yes	Yes
Temperature shocks	No	No	Yes	No	No	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

Table A4: Effects of climate risk on credit access, using different lengths for rainfall variability

	(1) Total Credit	(2) Total Credit	(3) Total Credit	(4) Borrowers	(5) Borrowers	(6) Borrowers	(7) Credit per Borrower	(8) Credit per Borrower	(9) Credit per Borrower
Longest drought length (days)	0.833***	0.894***	0.958***	0.075***	0.080***	0.085***	-0.038*	-0.038*	-0.039*
	(0.270)	(0.292)	(0.306)	(0.023)	(0.025)	(0.025)	(0.021)	(0.021)	(0.021)
Rainfall Variability (20 quarters)	-58.652**			-4.792**			0.416		
	(25.428)			(1.949)			(0.631)		
Rainfall Variability (12 quarters)		-50.010***			-3.888***			-0.364	
		(17.467)			(1.325)			(0.559)	
Rainfall Variability (8 quarters)			-45.714***			-3.388***			0.097
			(14.164)			(0.947)			(0.597)
Adj. R^2	0.760	0.760	0.760	0.779	0.779	0.779	0.228	0.228	0.228
Observations	13,160	13,160	13,160	13,160	13,160	13,160	5,433	5,433	5,433
Municipalities	376	376	376	376	376	376	302	302	302
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

Table A5: Effects of climate risk on credit access, using fixed value of rainfall variability

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Longest drought length (days)	8.177***	0.624***	0.009	-0.022	-0.271
	(2.017)	(0.151)	(0.184)	(0.050)	(0.482)
Rainfall Var. (Fixed) × Longest drought	-1.753***	-0.131***	-0.011	0.005	0.081
	(0.446)	(0.033)	(0.043)	(0.012)	(0.111)
Adj. R^2	0.760	0.779	0.228	0.604	0.479
Observations	13,160	13,160	5,433	5,433	5,433
Municipalities	376	376	302	302	302
Baseline controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

Table A6: Effects of climate risk on credit access, using non-consecutive number of dry days

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Drought days	0.796**	0.052**	-0.019	-0.021***	-0.015
	(0.345)	(0.023)	(0.021)	(0.007)	(0.062)
Rainfall Variability (20 quarters)	-59.015**	-4.844**	0.445	0.384	-4.868**
	(25.564)	(1.958)	(0.629)	(0.235)	(2.036)
Adj. R^2	0.760	0.779	0.228	0.605	0.480
Observations	13,160	13,160	5,433	5,433	5,433
Municipalities	376	376	302	302	302
Baseline controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

Table A7: Effects of climate risk on credit access, using total precipitation under 2SD

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Precipitation under 2 SD	-5.828*	-0.488*	-0.135	-0.004	0.209
	(3.265)	(0.252)	(0.168)	(0.060)	(0.533)
Rainfall Variability (20 quarters)	-59.378**	-4.860**	0.458	0.383	-4.891**
	(25.394)	(1.945)	(0.632)	(0.236)	(2.031)
Adj. R^2	0.760	0.779	0.228	0.604	0.480
Observations	13,160	13,160	5,433	5,433	5,433
Municipalities	376	376	302	302	302
Baseline controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

*** p<0.01, ** p<0.05, * p<0.1.

Table A8: Effects of climate risk on credit access, medium and big potato producers

	(1) Total Credit	(2) Borrowers	(3) Credit per Borrower	(4) Interest Rate	(5) Maturity
Longest drought length (days)	3.448*	0.020*	1.653**	0.027*	-0.145
	(2.058)	(0.011)	(0.723)	(0.015)	(0.111)
Rainfall Variability (20 quarters)	-4.153	0.363	14.008	-1.098**	2.106
	(31.157)	(0.271)	(34.289)	(0.447)	(3.537)
Adj. R^2	0.042	0.597	0.361	0.297	0.155
Observations	5,732	5,732	2,344	2,344	2,344
Municipalities	315	315	171	171	171
Baseline controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.

Table A9: Effects of climate risk on credit access: XXXX

	(1) Total Credit	(2) Borrowers
Rainfall Variability (20 quarters)	-28.281	-2.442
	(26.365)	(2.018)
Longest drought length (days)	5.629***	0.421***
	(1.677)	(0.125)
Rainfall Var. (20 q.) × Long. drought len. (days)	-1.177***	-0.085***
	(0.378)	(0.028)
Adj. R^2	0.761	0.780
Observations	13,160	13,160
Municipalities		
Baseline controls		

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: We include additional control variables such as total precipitation (mm/quarter-year), precipitation squared, and average precipitation in the last 20 quarters. Sources: SIPSA, Finagro, Chirps and Copernicus. Own Estimations.
*** p<0.01, ** p<0.05, * p<0.1.