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Abstract

This paper examines the effect of conflict on agricultural production of small farmers. First, an inter-temporal model of agricultural production is developed, in which the impact of conflict is transmitted through two channels: violent shocks and uncertainty brought about by conflict. The model shows how conflict induces sub-optimal agricultural decisions in terms of land use and investment. We test the model using a unique household survey applied to 4,800 households in four micro-regions of Colombia. The survey collects detailed information on household economic conditions, incidence of violent shocks, and the presence of non-state armed actors. The results show that conflict affects agricultural production through different channels. In regions with intense conflict, households reduce the amount of land allocated to perennial crops, increase production of seasonal crops, and cut back investments. Households seem to learn to live amid conflict. Recent presence of non-state armed actors induces farmers strongly to cut back land use for perennial crops, pasture, and investments. As presence is more prolonged, farmers increase land use for pasture and investments rebound. However, total agricultural production may be lower because shocks and presence result in more land being idle. Households habituate to conflict, yet at a lower equilibrium.

Keywords: conflict, uncertainty, agricultural production, small-farmers, developing economies

JEL Codes: D13, D74, Q1

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Producción Agrícola en Medio del Conflicto: Los Efectos de los Choques, la Incertidumbre y la Gobernabilidad de los Actores Armados al Margen de la Ley [*]

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Resumen

Este trabajo analiza el efecto del conflicto en la producción agrícola de los pequeños agricultores. Primero desarrollamos un modelo intertemporal de producción agrícola, en donde el impacto del conflicto se transmite a través de dos canales: choques violentos e incertidumbre generada por el conflicto. El modelo muestra cómo el conflicto induce decisiones agrícolas sub-óptimas en términos de uso de la tierra y la inversión. Las predicciones del modelo son evaluadas usando una encuesta de hogares aplicada a 4.800 hogares en cuatro micro-regiones de Colombia. La encuesta recoge información detallada sobre las condiciones económicas de los hogares, la incidencia de los choques violentos y la presencia de actores armados al margen de la ley. En las regiones con un intenso conflicto, los hogares reducen la cantidad de tierra asignada a los cultivos permanentes, aumentan la producción de cultivos transitorios, y disminuyen las inversiones. Los hogares parecen aprender a vivir en medio del conflicto. La presencia reciente de los actores armados al margen de la ley induce a los agricultores a reducir fuertemente el uso del suelo para los cultivos permanentes y pastos, y a disminuir las inversiones. Cuando la presencia es más prolongada, los agricultores incrementan el uso del suelo para pastos y las inversiones se recuperan. Sin embargo, la producción agrícola total puede ser menor debido a que los choques y una mayor presencia llevan a tener más tierra inactiva. Los hogares se habitúan al conflicto, sin embargo, en un equilibrio más bajo.

Palabras clave: conflicto, incertidumbre, producción agrícola, pequeños agricultores, economías en desarrollo

Códigos JEL: D13, D74, Q1

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1. Introduction

Conflict imposes costs on economic production through two broad channels. First, assaults and attacks during conflicts cause devastation and limit market transactions. Second, the presence of non-state armed actors prompts households to modify behavior regardless of whether they are exposed to violent shocks. Studies in the economic literature focus mostly on the impact of violent shocks during conflict (Blattman and Miguel 2010). However, these two channels are far from being perfectly correlated. Kalyvas (2006) forcefully shows that violence and conflict are not interchangeable concepts. In regions in which a contesting group exerts hegemonic control, violence against the population is presumably low. Because the hegemonic group already controls the population, there is little need to resort to violent tactics. Thus, papers focusing on the first channel underestimate the total effect of conflict and ignore an important dimension of armed conflict. The purpose of this paper is to identify and distinguish the effect of violent shocks on household behavior from the uncertainty and fear brought about by conflict (hereinafter, uncertainty).

There is ample evidence of the first channel. Armed combat, terrorist attacks, looting, and overall devastation generate the destruction of public and private capital and assets, thereby decreasing the productive capacity of firms and households (Blattman and Miguel 2010; Ibáñez and Moya 2010; Justino 2011). Aggression against the civilian population destroys or deteriorates human capital through abductions, killings, and maiming (De Walque 2006; Camacho 2008; Walque and Verwimp 2009; Verwimp, Bundervoet et al. 2010). These violent shocks also reduce market efficiency. Contraction in the supply of goods and higher transactions costs cause price increases and reductions in the size of networks (Deininger 2003; Justino 2011). All of these effects produce a drop in household income and consumption, and countries experience a decline in aggregate production (Abadie and Gardeazabal 2003; Brück 2004; Justino and Verwimp 2006). The findings also show that conflict adversely affects economic performance, but countries and households may quickly recover from devastation if a threshold of destruction is not surpassed (Murdoch and Sandler 2002; Abadie and Gardeazabal 2003; Justino and Verwimp 2006; Nillesen and Verwimp 2010; Akresh, Verwimp et al. 2011).

Nevertheless, conflict imposes additional costs besides destruction. Violence also increases uncertainty and risk (Rockmore 2011). In addition, non-state actors may impose governance structures in the regions they control by enforcing rules of conduct, taxing households and production, obliging households to grow certain crops (i.e., illegal crops), and favoring some groups over others (Kalyvas 2006; Justino 2011). Regardless of whether they face violent shocks, households adjust their behavior in anticipation of a conflict induced-shock to avoid being targeted, to minimize potential losses after an attack, or to abide by rules imposed by non-state armed actors. These adjustments seek to minimize conflict risk, not to maximize profits (Verpoorten 2009).

Identifying the strategies that households adopt to confront conflict despite not facing direct violent shocks is important for three reasons. First, the bulk of the population is not directly affected by violent shocks, but a large proportion modifies their behavior in response to the violent context in which they live. This is particularly relevant for countries facing long-lasting low- or medium-intensity conflict. Second, households learn to live amid conflict and change their behavior in subtle ways. These costs are largely unaccounted for in current studies and may be high. Third, once the conflict ends, households may remain entrenched in the low-risk strategies adopted during the conflict, preventing them from reaping the benefits of peace. Thus, incomes may not necessarily return to previous levels in a post-conflict period for many households.

To understand how conflict distorts agricultural decisions, we first propose a theoretical model where a farmer living in autarky decides whether to invest in perennial or seasonal crops and how much to invest. It is assumed that perennial crops need higher investment to be more productive than seasonal ones. Each period, the farmer is hit by a violent shock that decreases production. The violent shock could arise from a permanent or a transitory distribution, where the former implies that shocks tend to be worse. However, the farmer is uncertain about the nature of the shock and assigns a belief to each distribution. The belief represents the uncertainty faced by the farmer, which is updated once a shock is observed.

The model predicts that farmers prefer to invest in seasonal crops when facing more negative violent shocks and when beliefs are biased toward permanent shocks. But since seasonal crops are less profitable, farmers are driven to a low-income equilibrium. On the

other hand, if farmers are sufficiently risk averse, a violent shock has a non-linear effect on investment. If uncertainty is low, the effect is negative since productivity is lower; but when uncertainty increases, the effect could be positive, since the farmer will update his belief toward the permanent distribution, where more investment is used for self-insurance.

We then test the hypothesis derived from the model using a unique dataset for Colombia, a country that has experienced ongoing conflict for over 50 years. We designed a household survey to collect detailed information on the dynamics of conflict, such as the occurrence of violent shocks, the historic presence of armed groups, and the governance structures they impose on the population. This unique dataset allows us to examine and separate the impact of conflict through violent shocks from uncertainty, measured in terms of years of presence of non-state armed actors. Our paper attempts to discover whether conflict has an effect on household behavior beyond the impact of conflict-induced shocks. We concentrate the analysis on household decisions related to agricultural production, such as land use and investment.

Estimating a causal relationship between violent shocks and the presence of armed groups, on the one hand, and agricultural decisions, on the other, is difficult. Armed groups do not randomly locate themselves across the territory. Non-state actors establish their presence in regions with particular geographical and institutional characteristics that favor their war objectives. Incidence of covariate shocks is not random either. Non-state actors attack certain groups of the population to illegally seize assets, strengthen territorial control, or prevent future civilian resistance (Azam and Hoeffler 2002; Engel and Ibáñez 2007). In order to correct for this endogeneity, we use a spatial discontinuity strategy similar to Acemoglu et al. (2012), Naidu (2012), and Dube et al. (2010). We create a pair of contiguous districts, one with presence of non-state armed groups and the other without. Unobservables that jointly determine armed group presence and agricultural decisions vary smoothly across districts and are potential sources of bias. Our identification strategy controls for these unobservable by including fixed effects for each contiguous pair. We also include a rich set of geographic, household, land plot, rural district, and municipality controls that may also determine the presence of non-state armed actors or incidence of violent shocks.

The results of this study show that conflict affects land use and investment beyond violent shocks. Conflict shocks induce households to reduce the amount of land allocated to perennial crops and increase land use for seasonal crops. Total production may decrease as the percentage of idle land rises and overall investment falls. Nonetheless, households appear to habituate somehow to the presence of non-state armed actors. During the initial years of armed group presence, farmers cut back production of perennial crops and pasture. As presence is more prolonged, households gradually adjust their behavior and increase pasture, and overall investment. Households adjust decisions in order to re-optimize investment.

The policy implications from our paper complement those of current studies that underestimate the economic consequences of conflict. We argue that policies in post-conflict periods should focus on more than just reconstruction efforts. In order to ensure a long-term recovery and a sustainable post-conflict economy, policies should incentivize households to alter their sub-optimal decision making adopted during conflict.

Recent research provides examples of how households modify production decisions to reduce conflict risk. First, small agricultural producers change their cattle portfolio by selling it to provide for financial resource and smooth household consumption (Verpoorten 2009). Second, households shift income sources to protect consumption. Farmers may rely more on subsistence activities to protect food consumption and their income, or resort to income activities that are less sensitive to conflict (Deininger 2003; Bozzoli and Brück 2009). Third, conflict induces adjustments in investment decisions. Households may save more as future income becomes increasingly uncertain, or invest more in mobile assets to minimize the risk forced migration entails (Grun 2008; Verpoorten 2009). Because assets signal household wealth and some are difficult to conceal, assets may become liabilities (Engel and Ibáñez 2007; Rockmore 2011).

Since these adjustments in behavior seek to minimize conflict risk, households adopt sub-optimal production decisions. Households living in conflict regions may produce less, earn lower profits, and face higher costs, despite not being direct victims of conflict induced-shocks. These sub-optimal strategies may persist after the conflict ends. In Mozambique, three years after the ceasefire, households were still practicing many of their wartime coping strategies (Bozzoli and Brück 2009).

The lack of detailed data on conflict dynamics limits the contributions of the papers discussed above. These papers explore potential adjustments in behavior in response to conflict, yet conflict is measured as the incidence of violent shocks. These papers assume that the coefficient for the incidence of idiosyncratic or covariate shocks captures losses from violent shocks and uncertainty, if these are correlated. However, conflict dynamics are complex. Kalyvas (2006) shows that, in regions in which non-state armed actors exercise strong regional control, violence against civilians is lower or practically non-existent. Thus, the coefficient for conflict-induced shocks only captures a fraction of the economic losses from conflict. These costs, such as the destruction and devastation of private assets and public infrastructure, are more easily recovered once the conflict ends (Blattman and Miguel 2010).

A notable exception is Rockmore (2011), who separates risk of violence from exposure to violence when analyzing the impact of conflict. The paper separates risk into objective and subjective risk. The author measures objective risk as attacks against the community in the previous year, and subjective risk as the perceptions of survey respondents about the difficulty of cultivating land due to insecurity. Both risks are predicted using the distance of the community to attacks of armed groups in previous years and household controls. His estimates show that subjective risk has a greater impact than objective risk on household consumption. In fact, half of the welfare losses caused by conflict are related to risk rather than direct exposure to violence.

We depart from Rockmore's (2011) approach in several ways. First, both measures of risks in his paper only use attacks to capture conflict dynamics, yet uncertainty may arise even when no attack or assault has occurred. Instead, we use objective data on the presence of armed groups and relate it to subjective beliefs through our model. Second, the impact of the risk of violence might be highly non-linear. In initial periods, households may react abruptly to the presence of non-state actors and the incidence of shocks. Once non-state actors remain for a long period, households may habituate to their presence, and reactions are less abrupt or may converge to a low-income equilibrium, but with low risk of being victimized. Third, we focus on production decisions rather than consumption.

The structure of the paper is as follows. Section 2 provides a brief summary of the Colombian conflict. Section 3 develops a theoretical model that includes the effect of both

violent shocks and uncertainty on decisions taken by a small farmer. In Section 4, we describe the data and the empirical strategy and discuss the results. Section 5 concludes.

2. Conflict in Colombia

During the 20th century, Colombia faced two conflicts. The first one began in 1948, following the assassination of Jorge Eliécer Gaitán, the presidential candidate from the Liberal Party. During this period, known as *La Violencia*, violent disputes between the two traditional political parties (*Liberal* and *Conservador*) fueled the conflict. Nearly 200,000 people were killed between 1948 and 1953 (Guzmán, Fals-Borda et al. 1963; Sánchez and Meertens 2001). In 1953, a military dictatorship, headed by General Rojas Pinilla, overthrew the democratically elected government and provided amnesty to the liberal guerrillas. The dictatorship lasted five years. Democracy was restored after the two traditional parties brokered a power-sharing agreement that lasted from 1958 until 1974.

The power-sharing agreement significantly reduced violence, yet the structural causes of *La Violencia* remained unresolved. Income inequality, a weak state unable to establish a presence in many regions of the country, uncertain property rights over land, and a unequal land distribution predominated in many regions of the country. In addition, this agreement excluded participation in the electoral process for other political groups. New left-wing guerrilla groups, namely the National Liberation Army (*Ejercito de Liberacion Nacional*—ELN) and the Revolutionary Armed Forces of Colombia (*Fuerzas Armadas Revolucionarias de Colombia*—FARC), emerged in the 1960s. These groups aimed to overthrow the government and called for an aggressive agrarian reform. During the first two decades, these guerrilla groups were in small, controlled, isolated regions of the country, from which they launched sporadic attacks. By the end of the 1970s, the guerrilla groups modified their strategy in order to collect monetary resources to fund their war strategies. Kidnappings, cattle thefts, and extortion against landowners and drug dealers intensified in many regions of the country.

Right-wing paramilitary groups were formed in the 1980s. Several factors contributed to the emergence of these groups. First, illegal drugs provided financial resources that

strengthened left-wing guerrilla groups but also fostered the formation of vigilante groups, created by drug dealers and local landlords in response to kidnappings, cattle thefts, and extortion (*Verdad Abierta*, 2011).[1] Second, failed peace negotiations with guerrilla groups in 1982 and 1986 led to the appearance of these groups to protect the civilian population against assaults from guerrilla groups (Romero 2002). Third, landowners in several regions of the country created vigilante groups of fewer than 1,000 men to protect their property and agricultural production (Duncan 2005; Duncan 2006). Initially, these groups were organized to defend land barons and drug dealers, but in 1997, vigilante groups merged under the name Colombian Self-Defense Units (*Autodefensas Unidas de Colombia*—AUC) to contest the territories dominated by the guerrillas and to launch attacks in strategic regions to further their war objectives.

The rise of paramilitary groups and the monetary resources amassed from the illegal drug trade contributed significantly to fuel the conflict and expand the conflict geographically. Attacks against the civilian population by guerrillas and paramilitaries increased, leading to massacres, selective homicides, death threats, and massive forced displacement. According to the Official Group of Historical Memory (2013), for the period between 1985 and 2013, more than 166,000 people died due to conflict, 1,982 massacres were perpetrated by non-state armed actors, and 8.3 million hectares were illegally seized. Some 3.9 million people, equivalent to 8.4 percent of the population, were forced to emigrate.[2]

Non-state armed actors consolidated significantly during this period. While in 1978, the FARC had seven fronts and 850 combatants, by 2000 it had grown to 66 fronts and 16,000 combatants. The ELN increased to 4,500 combatants in 2000 from 350 in 1984 (Sánchez, Díaz et al. 2003). In 1993, the AUC had 1,200 combatants; by 2002, it had grown to 10,000 (Echandía 2006). From 2002 onward, the conflict eased. Massive financial resources provided to the Armed Forces and a peace process with paramilitary groups between 2003 and 2006 helped reduce the level of violence. This led to 38 collective demobilizations of a total of 31,767 combatants (Valencia 2007). Still, the scope of the demobilization was limited, as some groups did not demobilize and others preserved their wartime structures. The groups mutated

[1] www.verdadabierta.com retrieved on July 7, 2012
[2] www.accionsocial.gov.co retrieved on July 15, 2012.

into smaller drug-dealing bands, known as BACRIM (criminal bands), which were scattered around the country. In 2009, 82 criminal groups with an estimated 5,000 former combatants had a presence in 273 municipalities (Fundación Nuevo Arco Iris, 2009),[3] To this day, guerrilla groups still operate in several regions of the country.

3. The Model

As explained in the literature review, we propose a model that divides the impact of conflict into the impact of violent shocks and the impact of uncertainty. The model features a small farmer who lives in autarky and has to decide every season whether to invest in perennial or seasonal crops and how much to invest. Perennial crops are characterized by large investments, which make them more productive than seasonal ones. The violent shock is included as a multiplicative shock to the production function. It represents the amount of production that is left to the farmer after the shock. We assume farmers are uncertain as to whether the shocks are permanent or transitory. Shocks are assumed to be permanent when the non-state armed actor is hegemonic in the region, whereas they are assumed to be transitory if the government is the hegemonic actor. The uncertainty caused by conflict is included through the farmers' beliefs about the distribution of the shocks. [4]

The model predicts that farmers prefer to invest in seasonal crops when facing more negative violent shocks and when beliefs are biased toward permanent shocks. Although seasonal crops are less risky when farmers are facing high-intensity violent shocks, they are also less profitable; thus, farmers are driven to a low-income equilibrium. Moreover, if farmers are sufficiently risk averse, they prefer to invest more when facing permanent shocks as a self-insurance strategy. Thus, a more violent shock has two opposite effects: it decreases

[3] http://www.verdadabierta.com/component/content/article/50-rearmados/1520-narcotrafico-extorsion-sicariato-y-robo-de-tierras-tendrian-afectados-a-25-departamentos-el-tiempo retrieved on July 7, 2012.

[4] The model does not consider any strategic interaction with non-state armed actors; the unique interaction is through the shocks. Although farmers may make decisions to decrease their vulnerability to non-state armed actors, we abstract from modeling the decisions taken by the non-state armed groups. Our aim is to generate testable predictions of farmers' decisions, and empirically we deal with the endogeneity that arises from the strategic interaction. Similarly, we do not model market interactions that can generate general equilibrium effects, but we control for them in the empirical strategy.

investment, since the shock lowers its productivity, but it also increases investment, since a more negative shock leads to belief updating toward the permanent distribution. The second effect vanishes as uncertainty over the distribution diminishes, that is, when the farmer is almost certain of the type of shock distribution she is facing and there is little room for updating.

Consider an infinitely lived farmer who maximizes his discounted inter-temporal utility $\sum_{t=0}^{\infty} \beta^t u(c_t)$, where c_t is the consumption at time t, $\beta \in (0,1)$ is the discount factor, and $u(\cdot)$ is an increasing and concave function. Each period *t*, the farmer decides whether to invest in seasonal or perennial crops, $i \in \{s, p\}$ and how much to invest k, before observing the violent shock z. After the shock occurs, the amount $z_t f_i(k_t)$ is produced.[5] We assume that both production functions are increasing and concave, and that the marginal productivity is always higher for the perennial crops $f_p'(\cdot) > f_s'(\cdot)$, although for lower investments $f_p(\cdot) < f_s(\cdot)$. In other words, we assume the single crossing property holds. For simplicity of notation, we assume that there is full depreciation of capital in each period; however, all of the results presented here will hold without this assumption. In each period, production is distributed between consumption c_t and investment in capital for next period's production k_{t+1}.

Violent shocks can arise from two possible distributions. When the non-state armed actor is hegemonic in the region, we will say that shocks are permanent and are distributed according to the c.d.f. $G(z)$ with p.d.f. $g(z)$. When this is not the case, we will say that shocks are transitory and are distributed with c.d.f. $H(z)$ and p.d.f. $h(z)$.

We assume that $H(z)$ dominates $G(z)$ in the monotone likelihood ratio (MLR) order. This implies that the more negative the shock, the more likely it was drawn from the permanent distribution rather than the transitory one. In this context, it implies that larger violent shocks are more likely to arise in regions where the non-state armed actor is hegemonic. The MLR dominance also generates first-order stochastic dominance (Athey 2002). Hence, the expectation of monotone functions with respect to the shock is greater

[5] The shock can also capture losses in human capital, labor, or other production factors. Just assume that these factors enter multiplicatively with respect to the capital; thus, reductions in these factors can be represented as a multiplicative shock.

when shocks are transitory. This implies that farmers in regions where non-state armed actors are hegemonic are worse off.

As the evidence suggests, we will let the farmer be uncertain about the nature of the shocks. The farmer believes with probability q_t that shocks are permanent and with probability $1 - q_t$ that shocks are transitory. When the farmer faces a shock z_t, she updates this belief using Bayes' rule. Given our dominance assumption on the distributions, a larger negative shock induces a larger subsequent q_{t+1}. Note that the model includes both risk, through z, and ambiguity, through q. However, although there is risk aversion, we assume for the sake of simplicity that the individual is ambiguity neutral.[6]

The problem can be expressed recursively as:

$$v(i,k,q,z) = \max_{c,k',i'} u(c) + \beta\left[q' \int v(i',k',q',z')dG(z') + (1-q') \int v(i',k',q',z')dH(z')\right]$$

$$\text{subject to } c + k' = zf_i(k) \text{ and } q' = \frac{g(z)q}{g(z)q + h(z)(1-q)}$$

Note that the choice of which crop to use depends on its expected value. In order to have an interesting problem we will assume that $E\left[v\left(p,k_p,0,z\right)\middle|0\right] > E[v(p,k_s,0,z)|0]$ and $E\left[v\left(p,k_p,1,z\right)\middle|1\right] < E[v(s,k_s,1,z)|1]$, where k_i is the optimal capital choice when crop i has been chosen. That is, perennial crops yield a higher expected utility whenever farmers face transitory shocks, whereas seasonal crops are a better choice when facing permanent shocks.

Because of the single crossing property described earlier and the supermodularity of the production function,[7] the choice of crops is monotone on the beliefs. In particular there will be a threshold belief $\hat{q}$ such that if beliefs are lower than $\hat{q}$ it is optimal to choose perennial crops. Analogously, if beliefs are higher than $\hat{q}$ then it is optimal to choose seasonal crops. Moreover, since beliefs are updated according to the violent shock, a more negative shock can

[6] The results will hold if we assume ambiguity aversion. As we note below, the key predictions are obtained for sufficiently risk averse agents. In this sense, ambiguity aversion will make our predictions stronger.
[7] When functions are differentiable, supermodularity is equivalent to having a positive cross derivative.

change the optimal decision of the farmer from perennial crops to seasonal shocks if the updated shock crosses the threshold $\hat{q}$.

Our study also seeks to understand how farmers change investment in the presence of violent shocks and uncertainty. Therefore, we are interested in computing the derivative of k' with respect to shock z and belief q. First note that the problem is concave in k' and its first order condition is given by:

$$u'(c) = \beta \left[q' \int \frac{\partial v(i', k', q', z')}{\partial k} dG(z') + (1 - q') \int \frac{\partial v(i', k', q', z')}{\partial k'} dH(z') \right]$$

$$\text{where } \frac{\partial v(i', k', q', z')}{\partial k'} = u'(c') z' f_{i'}'(k')$$

The left-hand side of the equation is the opportunity cost of investing more in terms of current consumption. The right-hand side of the equation represents the discounted future marginal benefits of investment, an increase in future consumption via an increase in expected future production, weighted by the subsequent belief. Note that investment will be higher when the farmer chooses perennial crops, since their marginal return is higher.

The comparative static with respect beliefs is given by:

$$\frac{\partial k'}{\partial q} = - \frac{\beta \frac{\partial q'}{\partial q} \Delta dv}{u''(c) + \beta E \left[\frac{\partial^2 v(i', k', q', z')}{\partial k'^2} \middle| q' \right]}$$

The term $\Delta dv = \int \frac{\partial v(i', k', q', z')}{\partial k'} dG(z') - \int \frac{\partial v(i', k', p', z')}{\partial k'} dH(z')$ denotes the difference in the expected marginal benefit of investment given the type of shock. Its sign will depend on how such marginal benefit depends on z. To find this, we compute the cross partial derivative of the value function, which is given by:

$$\frac{\partial^2 v(i', k', q', z')}{d \partial k' \partial z} = u'(c') f_{i'}'(k') \left[\frac{u''(c')}{u'(c')} z' f_{i'}(k') + 1 \right]$$

If the farmer has a relative risk aversion greater than or equal to 1, a more negative shock implies a higher marginal benefit of investment.[8] This in turn implies that the expected marginal benefit is higher when facing a more permanent shock, since $H(z')$ first order stochastically dominates $G(z')$, therefore Δdv is positive. Since the numerator of $\frac{\partial k'}{\partial q}$ is negative given the concavity of the problem, the result suggests that farmers invest more when they believe they are facing permanent shocks. The intuition for this result is that when the farmer expects negative shocks to be permanent and she is sufficiently risk averse, she values insurance more, and the only instrument available is investment. However, such a strategy lowers current consumption and thus the overall utility of the farmer.

We can also obtain the comparative static with respect to the violent shock:

$$\frac{\partial k'}{\partial z} = -\frac{-u''(c)f(k) + \beta \frac{\partial q'}{\partial z}\Delta dv}{u''(c) + \beta E\left[\frac{\partial^2 v(i', k', q', z')}{\partial k'^2}\middle| q'\right]}$$

The partial derivative $\frac{\partial q'}{\partial z} = \frac{q(1-q)\left(g'(z)h(z) - g(z)h'(z)\right)}{[g(z)q + h(z)(1-q)]^2} < 0$ denotes the change in beliefs after a shock. It is negative by the log supermodularity of the distributions, which is implied by the likelihood ratio ordering. Note also that this change in beliefs is close to zero when there is little uncertainty, that is, when the farmer is almost sure that shocks are permanent (q is close to 1), or transitory (q is close to 0).

The numerator of $\frac{\partial k'}{\partial z}$ is negative and is also increasing in q' since the second derivative of the value function is decreasing in z. On the other hand, the denominator is positive whenever there is little uncertainty. This implies that a more negative shock reduces investment and that this reduction is larger under permanent shocks than under transitory ones.

[8] Having a constant relative risk aversion implies a positive third derivative, which is a necessary condition to have precautionary savings (Leland, 1968).

However, when there is uncertainty, the reaction of farmers after a shock is mitigated or it can even change its sign. The intuition behind this result is that a more negative shock suggests that it is permanent, which leads the farmer to increase investment as a self-insurance strategy, as shown in $\frac{\partial k'}{\partial q}$. This effect vanishes when there is no uncertainty, since the effect on the updated beliefs also vanishes.

In sum, the model has several predictions that we test empirically. First, it predicts that more pessimistic beliefs (biased towards the permanent distribution) lead farmers to choose seasonal crops despite their being less profitable. Since beliefs are associated with the history of shocks that the farmer has experienced, regions with more intense conflict should switch from perennial crops to seasonal crops. However, beliefs could also be associated with the presence of non-state armed actors in the region. Therefore, the greater the number of years the non-state armed actor has been in the region, beliefs should be more pessimistic and we should expect a higher proportion of people choosing seasonal crops.

Second, if farmers are sufficiently risk averse, more pessimistic beliefs induce them to invest more (although in a less profitable activity) as a self-insurance strategy. Thus, we should observe greater investment the more years the non-state armed actor is present. On the other hand, a violent shock has two opposite impacts: it decreases investment since it decreases available production, but it also tends to increase investment at the same time, since beliefs are now more pessimistic.

4. Empirical Strategy

The purpose of the empirical analysis is to test the hypotheses put forth in the theoretical model. We measure shocks using violent shocks, while we use the number of years non-state armed actors have been present in the community as a proxy for beliefs about whether violent shocks are transitory or permanent. As non-state armed actors stay longer in the community, households believe with higher probability that non-state armed actors will become hegemonic in their region; thus, they expect shocks to be permanent. First, we test whether households that face a violent shock invest more in seasonal crops as opposed to

permanent crops. We also test whether investments in seasonal crops are higher as the number of years that non-state armed actors are present increases. Second, we gauge whether violent shocks reduce investment and whether households invest more in less profitable activities to increase their self-insurance as the number of years that non-state armed actors are present is greater. Both predictions imply that violent shocks and a prolonged presence of non-state armed actors would push farmers toward less risky, yet less profitable activities. Thus, conflict may push households onto a low-income trajectory.

4.1. The Data

We use four different sources of data. The first is the Colombian Longitudinal Survey of the Universidad de los Andes (ELCA). We designed ELCA to understand the impact of internal conflict on household welfare, labor markets, and agricultural production, among others. The first wave of the survey was administered during the first semester of 2010 to 10,800 households, 6,000 households in urban areas and 4,800 in rural areas. The survey is representative of urban households from income strata one to four, and four rural micro-regions (Middle Atlantic, Central East, Cundi-Boyacense, and Coffee region). We selected the rural micro-regions and municipalities within them to maximize variation in conflict intensity. Two regions had a high intensity of conflict (Middle-Atlantic and Central East) and two a low intensity (Cundi-Boyacense and Coffee region). Within each municipality, rural districts were chosen randomly. In this paper, we use the rural sample, as conflict in Colombia occurs mainly in rural areas. The sample contains 17 municipalities and 222 rural districts. We only use households that report complete information on land use and investment, which are 3,760 households.

The survey collects standard information about employment, income, consumption, education, health, family formation, and social capital. For rural households, we collected detailed information on land tenure and property rights, agricultural production, and asset ownership. In addition, we designed a special module on shock incidence, which elicits information on conflict shocks. The questions were carefully designed to protect households and reduce apprehension about answering the questions truthfully. All households were geo-coded.

We also designed a rural district questionnaire for community leaders. The purpose of this questionnaire is to gather information on social and public infrastructure, incidences of shocks, including conflict, and access to markets. The questionnaire elicits detailed information on the history of conflict in the community in the previous 10 years, such as presence of non-state armed actors, imposition of rules and governance structures, and victimization of the civilian population.

Despite carefully designing the rural questionnaire to reduce underreporting of the presence of non-state actors and violent shocks, some underreporting may persist and it may be systematic. Some rural districts have a strong presence of non-state armed actors, and underreporting may be more prevalent in these areas. Respondents may be fearful or apprehensive about providing detailed information related to conflict. To correct for potential underreporting, we complemented the rural questionnaire with information from the national government. Specifically, we use information on the presence of non-state armed actors at the rural district level in the preceding 10 years.

To complement the above-described information, and using the coordinates where each household is located, we construct a set of geographic variables that includes altitude above sea level of the household and distance to the state capital, the nearest main road, the nearest marine coast, other roads, and coca crops. All distances are Euclidean and were calculated using data from IGAC,[9] the Integrated System of Illicit Crop Monitoring (SIMCI), and the National Roads Institute (INVIAS). Weather conditions affecting the households were obtained from data collected by the Institute of Hydrology, Meteorology, and Environmental Studies (IDEAM) between 1980 and 2009. The IDEAM collects information on daily rainfall at 1,365 monitoring stations in the country. As the stations are geo-referenced, we first calculated monthly rainfall for each station and then, using the Kriging[10] method values, we assigned rainfall values to each household. Municipal characteristics come from the Economic

[9] Government institution responsible for collecting geographic information.

[10] Kriging is a spatial interpolation method that estimates surfaces from sampled point values. The estimated values are weighted averages of the observed values within a neighborhood of sampled points. We can be confident about the accuracy of our estimations because we have a large sample of points uniformly distributed over the surface of the country. Given the characteristics of our data, we choose ordinary Kriging for our rainfall interpolation.

Development Research Center (CEDE) at the Universidad de los Andes and cover the period between 1990 and 2010.

4.2. Estimation Strategy

In order to understand the effect of conflict on agricultural decisions, we estimate the impact of violent shocks and years of presence of non-state armed actors on agricultural outcomes. We use two sets of agricultural outcomes: (i) the percentage of land devoted to perennial crops, seasonal crops, pasture, or idle land; and (ii) whether the household made any investments in the land plot in the previous three years or invested in permanent structures, fruit trees, or commercial trees in the previous three years.

First, we estimate a naïve approach by assuming that conflict is exogenous. We use the following reduced form for household *i* located in rural district *j* and state *k*:

$$y_{ijk} = \propto_0 + \alpha_k + X_{ijk}\beta + W_{jk}\gamma + \sum_{m=1}^{3} \theta_m P_{mjk} + \sum_{n=1}^{5} \lambda_n S_{njk} + \varepsilon_{ijk}$$

where y_{ijk} are outcomes related to agricultural decisions, X_{ijk} is a vector of household controls, W_{jk} is a vector of rural district controls, α_k are fixed effects at the state level, and ε_{ijkl} is a random term.

We capture conflict dynamics with the term $\sum_{m=1}^{3} \theta_m P_{mjkl} + \sum_{n=1}^{5} \lambda_n S_{njkl}$. The variable P_{mjkl} is a dummy equal to one if non-state actors have been present in rural district *jk*: (i) between one and three years; (ii) between four and six years; or (iii) between seven and nine years. These sets of dummies capture how households adjust decisions to account for the presence of non-state armed actors after controlling for violent shocks, and θ_m are the parameters of interest. S_{njkl} is a dummy variable equal to one if rural district *jk* face *n* types of violent shocks (*n*=1,2,…,5). These set of dummies capture the direct impact of conflict through destruction, devastation, and market impacts. The parameters λ_n are traditionally estimated in other studies.

Although the household questionnaire collects information on covariate and idiosyncratic violent shocks, we believe that underreporting is high and we prefer to use the information collected on the rural district questionnaire for covariate shocks. Violent shocks reported in the rural district questionnaire are murder, cattle theft, land seizure, threats by non-state armed actors, and kidnappings.

By using dummy variables for years of presence and type of shocks, we are capturing the non-linear effects of both variables. Initially, households may react abruptly to the presence of non-state actors. Once non-state actors stay for longer periods, households may habituate to their presence, and reactions are less abrupt or may converge to a low-income equilibrium, but with a low risk of being victimized. We expect that the effect of the presence of non-state armed actors is greater during the first years of presence and declines once households learn to live amid conflict. On the other hand, an increasing number of types of shocks signals an intensification of the conflict. Thus, we expect the effect to be larger as the number of types of shocks increases.

The presence of non-state armed actors and violent shocks is not random. Non-state armed actors attempt to control regions that serve their war aims, such as extracting economic rents or illegally seizing valuable assets, or where the costs of establishing a presence are lower, such as difficult geographic conditions or alienation of the civilian population from the state. In addition, aggression against the civilian population is deliberate and not a by-product of conflict. Non-state actors attack households with better economic conditions to seize assets, or community leaders to weaken support of the opponent (Azam and Hoeffler 2002; Engel and Ibáñez 2007). If we do not account correctly for endogeneity, our parameter estimates of θ_m and λ_n are biased.

To overcome this problem, we create pairs of contiguous rural districts with and without the presence of non-state armed actors. By comparing contiguous districts, we control for unobservables that vary smoothly across districts and are potential sources of bias. Geographic conditions, land productivity, and market shocks affect agricultural decisions and are also correlated with the presence of non-state armed actors. These conditions are similar across rural district borders. Thus, pair fixed-effects control for these unobservables. Acemoglu et al. (2012), Naidu (2012) and Dube et al. (2010) use a similar spatial discontinuity strategy. In

addition, we include a rich set of geographic, household, land plot, rural district, and municipality controls that may also determine the presence of non-state armed actors or incidence of violent shocks.

We estimate the following model for household *i* located in rural district *j* in pair *p* and

$$y_{ijp} = \propto_0 + \gamma_p + X_{ijp}\beta + W_{jp}\gamma + \sum_{m=1}^{3} \theta_m P_{mjp} + \sum_{n=1}^{5} \lambda_n S_{njp} + \varepsilon_{ijp}$$

where γ_p denotes a rural district pair fixed effect. We include household controls to account for preferences, and life cycle controls such as gender and age of the household head. To control for wealth and potential targeting from non-state armed actors, we use years of education and a wealth index constructed using principal components of household assets. We include variables for family composition (household size, number of members under 14 years of age, between 14-60 years old, and over 60 years of age). Finally, we have a dummy variable equal to one if the household is a beneficiary of *Familias en Acción*, a conditional cash transfer program.

We have a vector of land plot characteristic to control for variables that influence agricultural productivity. These variables also account for the value of land, thereby signaling the likelihood of being a victim of non-state armed actors. The controls include a dummy variable equal to one if the land plot has access to water sources, a dummy variable indicating whether the household has a formal legal title to the land plot, the rental value of the land,[11] and the size of the land plot. Since the data is geo-coded, we control for a rich set of geographic characteristics at the plot level: altitude above sea level, distance in kilometers from the land plot to the state capital, primary roads, other roads, nearest seashore, and nearest illicit crop cultivation. In order to capture other economic shocks that might be correlated with violent shocks, we include three variables that account for climate shocks: number of months during the previous years in which rainfall was one standard deviation below the historic mean,

[11] Based on the Colombian tax code and the appraisal values by municipality from IGAC, we calculate the rent for each household. The Colombian tax code states that the commercial value of a property must be maximum of two times its appraised value, and that the rent should be maximum of 1% of the commercial value. We calculate the rent for each household according to farm size.

number of months during the previous years in which rainfall was one standard deviation above the historic mean, and the rainfall historic mean (Miguel, Satyanath et al. 2004).

We construct two additional geographical controls at the rural district level that influence agricultural productivity and the attractiveness of the rural district for non-state armed actors. The controls are distance in kilometers to the nearest river and distance to the nearest water routes (sea or river).

In order to control for potential general equilibrium effects caused by conflict, we control for a price index of agricultural goods produced in the rural district and a dummy variable indicating whether the rural districts faces problems selling the agricultural goods.[12] We estimate the regressions with and without these variables to check for robustness, as these variables are endogenous.

Given that conflict in Colombia has a long history and it intensified in the last two decades, we include the average municipal homicide rates for the period ranging from 1993 to 2000 and the average municipal homicide rates for the period ranging from 2000 to 2008. These variables control for the historic effect of conflict.

4.3. Descriptive Statistics

The presence of non-state armed actors, years of presence, and incidence of violent shocks vary considerably across and within regions. Table 1 presents the distribution of years of presence for rural districts. A little more than 50 percent did not have a presence of non-state armed actors between 2001 and 2010. The average years of presence of non-state armed actors are 1.29, but the variance is large across rural districts, as the standard deviation is 2.01. Rural districts with presence are concentrated between one and four years (37.9%). However, 7 percent report a presence of five or more years.

[12] We use the price per kilogram for each product by state for the period ranging from 2006 to 2010 and calculate the average price for each community. Based on ELCA, we calculate the average production in kilograms by rural district. These data are used to compute the Paasche Index.

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Table 1. Years of Presence of Non-state Armed Actors (% rural districts)

Years of presence	Rural districts	Percentage
0	171	76.3%
1	23	10.3%
2	3	1.3%
3	2	0.9%
4	19	8.5%
5	3	1.3%
6	3	1.3%
Mean (Standard deviation)	0,64 (1,4)	

Source: Authors' calculations based on ELCA (Wave I) and National Government

The presence of non-state armed actors and the incidence of violent shocks do not necessarily overlap. Table 2 reports the incidence of covariate shocks by region and by type of shocks. We divide incidence for rural districts with and without at least one year of presence of non-state armed actors. The overall incidence of shocks at the rural district and at the household level is 37.3 and 38.03 percent, respectively. For the whole sample, the percentage of rural districts affected by at least one shock does not differ for those with and without armed group presence. Nonetheless, when we compare these figures by the percentage of households affected, this percentage is much lower for districts with armed group presence (15.5%) than without (22.6%). This difference is particularly great in the Middle-Atlantic and the Coffee regions, while in the Central Eastern region the overall incidence of shocks is higher for districts with armed group presence.

Map 1 depicts the overlapping of incidence of conflict shocks and presence of non-state armed actors for one of the four regions. The map clearly shows that violent shocks and presence of non-state armed actors do not necessarily coincide. Violent shocks occur frequently in rural district in which no non-state armed actors are present, and in many rural districts with presence of non-state armed actors the incidence of violent shocks is non-existent. Nearly 19.4 percent of rural districts with no presence of armed groups face a violent shock, while this figure is 16.5 percent for rural districts with presence.

There are two possible reasons for this lower incidence. As discussed by Kalyvas (2006), violence against the civilian population might be lower in regions with strong control of hegemonic non-state armed actors. Another potential explanation is that the likelihood of underreporting the incidence of violence is greater in regions with a stronger presence of non-state armed actors. Although we are able to correct for measurement error in years of presence, we do not have alternative sources of information for correcting incidence of covariate shocks. However, in the estimation we control for past history of homicide rates in the municipality, which is potentially correlated with incidence today.

When we divide incidence by type of shock, we find some interesting patterns. First, frequency of homicides is lower in rural districts with a presence of non-state armed actors in the Middle-Atlantic and the Coffee regions. Second, cattle theft and homicides drive the higher incidence of shocks in districts with presence of armed groups in the Central Eastern region. Cattle theft and homicides may be the result of generalized crime, which is high in Colombia, and not necessarily the presence of armed groups. Third, threats from armed groups are higher in three of the four regions in rural districts with presence of armed groups. In these regions, non-state armed actors may exert strong control, leading to more threats but lower incidence of other violent shocks. These pattern lend additional support to Kalyvas' (2006) hypothesis.

Table 2. Incidence of Conflict-induced Shocks by Region, with and without Presence of Non-state Armed Actors (% Rural Districts)

Micro-Region	Rural district	
	No presence	Presence
Middle-Atlantic	21%	5%
Cattle Theft	6%	0%
Homicides	6%	0%
Land seizure	0%	0%
Kidnaps	0%	0%
Threats from armed groups	8%	14%
Cundi-Boyacense	34%	52%
Cattle Theft	59%	69%
Homicides	13%	19%
Land seizure	0%	0%
Kidnaps	0%	0%
Threats from armed groups	0%	0%
Coffee region	29%	14%
Cattle Theft	17%	17%
Homicides	13%	8%
Land seizure	4%	0%
Kidnaps	0%	0%
Threats from armed groups	4%	0%
Central East	16%	29%
Cattle Theft	5%	33%
Homicides	15%	0%
Land seizure	0%	0%
Kidnaps	7%	0%
Threats from armed groups	5%	0%

Source: Authors' calculations based on ELCA (Wave I) and National Government

Table 3 presents descriptive statistics for all of the outcome variables. We divide the results for rural districts without and with at least one year of presence of non-state armed actors, and with and without the incidence of covariate conflict-induced shocks. Land is mostly dedicated to perennial (19.4%) and seasonal crops (15.4%), yet 6.2 percent of the land is idle. In regions with a least one year of presence, households dedicate a higher percentage of land to perennial crops, pasture, and idle land. By requiring less attention from farmers, both productive activities might be better suited for regions with armed conflict. In addition, cattle

provide daily cash and can be easily sold if households are forced to migrate. Overall investment during the three years before the survey is low: only 14.1 percent of households invested. Overall investment is similar for regions with and without armed group presence. Households living in regions with the presence of non-state armed actors invest more in fruit trees, and those living in regions without presence invest more in other commercial trees.

Agricultural outcomes for households living in rural districts with covariate violent shocks are also different. These households dedicate less land to perennial crops and more land to pasture and idle use. In addition, these households invest more overall and in permanent structures and other commercial threes. Higher investment by these households may signal targeting of non-state armed actors to wealthier households in the community.

Table 3. Descriptive Statistics: Outcome Variables

	=1 at least one year of presence			=1 at least one conflict-induced shock		
	No	**Yes**		**No**	**Yes**	
Annual agricultural income/hectares	2.44	0.08	-	3.17	0.11	-
	(87.2)	(0.50)		(100.0)	(0.47)	
Costs/hectares	1.58	0.09	-	2.05	0.09	-
	(56.99)	(0.82)		(65.42)	(0.70)	
% of land used in perennial crops	23.4%	27.4%	**	27.4%	19.2%	***
	(0.34)	(0.37)		(0.36)	(0.31)	
% of land used in seasonal crops	16.7%	15.3%	-	15.3%	18.2%	***
	(0.29)	(0.27)		(0.29)	(0.29)	
% of land used in pasture	6.6%	10.0%	***	6.1%	9.2%	***
	(0.18)	(0.21)		(0.17)	(0.20)	
=1 if invested in land plot since 2007	19.1%	23.2%	**	19.3%	20.8%	-
	(0.39)	(0.42)		(0.40)	(0.41)	
Observations	1,439	362		1,092	709	
=1 if hh had a credit with banks on survey day	62.6%	68.7%	**	58.9%	70.8%	***
	(0.48)	(0.46)		(0.49)	(0.45)	
=1 if hh had credit with family and friends on survey day	29.2%	30.0%	-	29.7%	29.0%	-
	(0.45)	(0.46)		(0.46)	(0.45)	
Observations	933	300		698	535	

Source: Authors' calculations based on ELCA (Wave I) and National Government * p<0.10, ** p<0.05, ***p<0.01

Tables 4 and 5 report descriptive statistics for control variables for the overall sample, divided by presence of non-state armed actors and incidence of conflict shocks. Rural districts with at least one year of presence of non-state armed actors are systematically different from those without presence. Nonetheless, the difference is driven mostly by geographic characteristics and not by household characteristics. The former have a younger population with smaller households, are less wealthy, and have less access to water sources for agricultural production. For other household characteristics, the differences are not statistically significant. In rural districts where non-state armed actors are present, weather variability is higher (more months of dry and rainy season), but with drier weather historically. These rural districts are located at higher altitudes and are more isolated, which facilitates the actions of non-state armed actors, and the prices of agricultural goods are higher. Lastly, these municipalities have a longer history of violence, as average municipal rates are higher for both periods.

Again, differences in household characteristics between rural districts with and without conflict shocks are small. Compared to rural district without shocks, districts with shocks have more educated household heads, a younger population, and less access to the conditional cash transfer program. Some interesting differences emerge in the characteristics of land plots that may signal targeting of households with more valuable land, yet with a weaker regime of property rights over land. In rural districts with conflict shocks, informality with respect to property rights over land is higher, land is more valuable (measured by its rental value), and farmers have more access to sources of water for agricultural production. These districts are located at higher altitudes, are more isolated and farther away from the state capital and seashores, and the prices of agricultural goods are lower, but these households are closer to regions with illicit crop production. In addition, these districts faced more climatic shocks in the year prior to the survey. Homicide rates in the municipalities in which these districts are located are lower in both periods for those that faced at least one shock compared to those without shocks.

Table 4a. Descriptive Statistics: Control Variables (Household Characteristics)

	=1 at least one year of presence			=1 at least one conflict-induced shock		
	No	**Yes**		**No**	**Yes**	
Number of members	4.71	4.62	-	4.64	4.75	-
	(2.02)	(1.94)		(1.99)	(2.00)	
=1 if household head is man	85.4%	85.3%	-	84.7%	86.4%	-
	(0.35)	(0.35)		(0.36)	(0.34)	
Household head's age	46.6	45.1	**	46.2	46.3	-
	(12.6)	(11.8)		(12.5)	(12.4)	
Household's head years of education	4.88	4.51	**	4.87	4.68	-
	(3.58)	(3.38)		(3.47)	(3.62)	
Members between 14-60 years old	2.93	2.87	-	2.94	2.89	-
	(1.41)	(1.37)		(1.40)	(1.40)	
Members less than 14 years	1.36	1.35	-	1.29	1.43	**
	(1.34)	(1.30)		(1.31)	(1.36)	
Members more than 60 years	0.42	0.40	-	0.41	0.42	-
	(0.68)	(0.66)		(0.67)	(0.70)	
=1 if is beneficiary of Familias en Acción	37.2%	40.0%	-	38.0%	37.8%	-
	(0.48)	(0.49)		(0.49)	(0.49)	
Wealth index	0.05	-0.10	-	0.09	-0.09	*
	(2.27)	(2.03)		(2.36)	(1.99)	
Observations	933	300		698	535	

Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel.

* p<0.10, ** p<0.05, ***p<0.01

Table 4b. Descriptive Statistics: Control Variables (Land Plot and Geographic Characteristics)

	=1 at least one year of presence			=1 at least one conflict-induced shock		
	No	Yes		No	Yes	
Land plot size (hectares)	1.56	2.82	-	3.5	3.2	-
	(4.78)	(4.88)		(5.03)	(4.48)	
=1 if land tenure is formal	25.9%	26.0%	-	28.7%	22.4%	***
	(0.44)	(0.44)		(0.45)	(0.42)	
Rental value of land	564,870	536,983	-	526,645	599,104	-
	(1'179,092)	(741,126)		(1'113,876)	(1'054,468)	
=1 if has access to water sources	65.1%	54.7%	***	61.2%	64.3%	-
	(0.48)	(0.50)		(0.49)	(0.48)	
=1 if fertility is high	1.5%	1.7%	-	1.6%	1.5%	-
	(0.12)	(0.13)		(0.12)	(0.12)	
=1 if fertility is from high to moderate	2.1%	0.0%	***	1.7%	1.5%	-
	(0.14)	(0.00)		(0.13)	(0.12)	
=1 if fertility is moderate	9.1%	6.3%	**	11.0%	5.0%	***
	(0.29)	(0.24)		(0.31)	(0.22)	
=1 if fertility is from moderate to high	20.6%	7.7%	***	24.6%	8.0%	***
	(0.40)	(0.27)		(0.43)	(0.27)	
=1 if fertility is from moderate to low	0.9%	1.3%	-	0.9%	1.1%	-
	(0.09)	(0.11)		(0.09)	(0.11)	
=1 if fertility is low	10.6%	18.7%	***	6.3%	20.7%	***
	(0.31)	(0.39)		(0.24)	(0.41)	
=1 if fertility is from low to moderate	22.0%	39.0%	***	23.4%	29.7%	***
	(0.41)	(0.49)		(0.42)	(0.46)	
=1 if fertility is very low	7.8%	6.7%	-	7.4%	7.7%	-
	(0.27)	(0.25)		(0.26)	(0.27)	
=1 if fertility is from very low to low	24.7%	18.0%	***	21.9%	24.5%	-
	(0.43)	(0.38)		(0.41)	(0.43)	
Months of drought	1.6	1.5	**	1.3	1.9	***
	(1.11)	(0.96)		(1.10)	(0.93)	
Months of wetness	0.69	0.80	**	0.97	0.39	***
	(0.88)	(0.93)		(0.95)	(0.69)	
Average historic rainfall	147.8	130.5	***	148.3	137.4	***
	(28.6)	(36.3)		(29.1)	(33.4)	
Height above sea level	1,466	1,705	***	1,197	1,951	***
	(1,020)	(1,050)		(958)	(970)	
Distance to the state's capital (km)	66.2	73.9	***	61.6	76.6	***
	(44.7)	(42.3)		(36.5)	(51.4)	
Distance to primary roads (km)	7.4	7.8	-	7.8	7.0	**
	(9.15)	(7.28)		(9.00)	(8.37)	
Distance to other roads (km)	3.8	3.2	***	3.5	3.9	**
	(2.37)	(2.29)		(2.4)	(2.3)	
Distance to the sea (km)	188.5	214.2	***	162.3	237.1	***
	(125.2)	(104.3)		(113.1)	(117.8)	
Distance to coca crops (km)	81.0	81.6	-	88.3	71.8	***
	(33.6)	(36.6)		(33.7)	(32.8)	
Observations	933	300		698	535	

Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel.
* p<0.10, ** p<0.05, ***p<0.01

Table 5. Descriptive Statistics: Control Variables(Rural District and Municipality Characteristics)

	=1 at least one year of presence			=1 at least one conflict-induced shock		
	No	**Yes**		**No**	**Yes**	
Distance to nearest river (km)	13.1	11.2	***	14.5	10.1	***
	(11.8)	(10.5)		(12.4)	(9.7)	
Distance to sea and river routes (km)	84.1	79.2	***	75.6	92.5	***
	(20.0)	(35.9)		(23.4)	(23.5)	
Price index of the community	1.14	1.22	***	1.17	1.15	-
	(0.33)	(0.33)		(0.27)	(0.40)	
=1 if community has problems to get credit	41.8%	44.0%	-	41.8%	43.0%	-
	(0.49)	(0.50)		(0.49)	(0.50)	
Number of banks on municipality	1.8	1.5	***	1.96	1.44	***
	(0.03)	(0.06)		(0.88)	(0.95)	
Daily agricultural wage	11,788	12,760	***	11,725	12,414	***
	(2,974)	(1,871)		(3,157)	(2,126)	
Municipal homicide rate 1993-2000	61.1	62.3	-	65.8	55.7	***
	(45.4)	(44.4)		(51.6)	(34.2)	
Observations	933	300		698	535	

Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel.

* p<0.10, ** p<0.05, ***p<0.01

The descriptive statistics show small differences in household characteristics in districts with and without armed group presence. Nonetheless, geographic characteristics are systematically different according to presence of non-state armed actors and conflict shocks. Our estimation strategy solves this endogeneity by creating contiguous pairs of communities. Table 6 shows whether our estimation strategy is effective in reducing household and geographical differences for rural districts with and without the presence of non-state armed actors. We first regress each control on state fixed effect and a dummy variable equal to one if the household lives in a rural district with armed group presence. Then, we estimate the same regression but, instead of the state fixed effect, we include the fixed effects for the contiguous pairs. The coefficient estimate for the dummy variable on armed group shows that the differences between household characteristics are even lower after we control for the fixed effect on the contiguous pairs. Nonetheless, differences in characteristics related to the value of the land plot are stronger, showing that non-state armed actors target households with more valuable land. Testing this may pose a threat to our identification strategy, so we estimate the regressions with and without these controls (whether the land plot has a legal title and whether the land plot has access to water sources) and find similar results. The differences in geographic characteristics are also smaller. Two of the coefficient estimates are no longer statistically significant, and the magnitude for almost all the others decreases considerably. We control for these geographic characteristics on all of the estimations.

Table 6a. Differences in household characteristics with and without armed group presence before and after controlling for fixed effects on contiguous pairs

	Before	After
Number of members	-0.104*	0.0806
	[0.0666]	[0.121]
=1 if household head is male	-0.0171	0.00190
	[0.0134]	[0.0247]
Household head's age	-0.930**	-0.649
	[0.444]	[0.793]
Household head's years of education	-0.156**	0.158
	[0.114]	[0.207]
Members between 14-60 years	-0.132***	0.0150
	[0.0475]	[0.0872]
Members less than 14 years	0.0246	-0.0185
	[0.0454]	[0.0816]
Members more than 60 years	0.00346	0.0841*
	[0.0244]	[0.0448]
=1 if beneficiary of Familias en Acción	-0.0172	-0.0184
	[0.0166]	[0.0290]
Wealth Index	-0.349***	0.0274
	[0.0847]	[0.148]
Land plot size (hectares)	-2.03	2.90
	(2.74)	(5.08)
=1 if land tenure is formal	-0.00130	-0.0945***
	[0.0159]	[0.0278]
Rental value of land	-59,413*	26,832
	[36,452]	[64,694]
=1 if access to water sources	-0.0662***	-0.0902***
	[0.0168]	[0.0282]
Observations	3,375	3,375

Robust standard errors in brackets. * p<0,10, **p<0,05, ***p<0,01. Author's calculations based on ELCA (Wave I), IGAC, IDEAM, INVIAS and National Government

Table 6b. Differences in geographical characteristics with and without armed group presence before and after controlling for fixed effects on contiguous pairs

	Before	After
Months of drought	0.348***	0.130***
	[0.0373]	[0.0218]
Months of wetness	0.123***	-0.131***
	[0.0308]	[0.0189]
Average historic rainfall	-5.076***	-5.490***
	[1.021]	[0.517]
Height above sea level	126.9***	212.2***
	[35.09]	[14.96]
Distance to the state's capital (km)	4.949***	2.726***
	[1.396]	[0.809]
Distance to primary roads (km)	4.283***	0.817***
	[0.297]	[0.0760]
Distance to other roads (km)	-0.773***	-0.663***
	[0.0817]	[0.0447]
Distance to the sea (km)	10.93***	-3.749**
	[3.946]	[1.832]
Distance to coca crops (km)	8.762***	-2.765***
	[1.151]	[0.391]
Observations	3,375	3,375

Robust standard errors in brackets. * p<0,10, **p<0,05, ***p<0,01. Author's calculations based on ELCA (Wave I), IGAC, IDEAM, INVIAS and National Government

4.4. Estimation Results

This paper examines the impact of conflict on agricultural production of small farmers. We explore two channels through which conflict affects agricultural production: presence of non-state armed actors and incidence of violent shocks. We concentrate on land use and investments. For each outcome, we report three columns. The first column reports the results for the naïve approach with state fixed effects, the second column rep the results when we control for the fixed effects of the contiguous pairs, and the third column controls for potential general equilibrium effects (daily agricultural wage and a price index for agricultural goods produced in the rural district). The coefficient estimates for the controls are robust, including the general equilibrium effects.

Table 7 reports the estimation results for the percentage of land dedicated to perennial crops, seasonal crops, pasture, and idle land. Similarly to findings in other papers (Bozzoli and Brück 2009; Verpoorten 2009), we find that households react to conflict shocks by changing production decisions. As a result of the shocks, households dedicate less land to perennial crops and pasture and more land to seasonal crops, and a lower percentage of the land is left idle. Adjustments in land use are particularly strong in rural districts with a high intensity of violent shocks, measured as those with two or three types of shocks. These changes are highly non-linear such that the impact of two types of shocks is much lower than the impact of three types of shocks. For example, the impact of two types of shocks on idle land is -0.06, while this figure for three types of shocks is -0.368. After controlling for general equilibrium effects, the impact of shocks on land dedicated to perennial crops weakens, while for seasonal crops and pastures the coefficient estimates are indeed similar. Interestingly, the impact for idle land becomes stronger, in particular for one type of shock that was not statistically significant. Changes in relative prices, such as the price of agricultural produce, seem to signal a structural adjustment, pushing households to reduce agricultural production.

The presence of non-state armed actors exerts a different effect than conflict shocks. The results show that households presumably habituate to living amid conflict once the presence of non-state armed actors is more prolonged. During the initial period of presence—from one to three years—households sharply adjust their productive decisions. The percentage of land allocated to perennial crops, or pasture, and production in seasonal crops is similar.

Once households perceive the presence of non-state armed actors as permanent, from the seventh year onward the percentage of land allocated to pastures and idle land increases. Thus, as predicted by the model, once the presence of non-state armed actors is deemed permanent, production is concentrated on less profitable activities. Pasture, which is used to feed livestock, is also an alternative. Livestock provide daily cash and can be easily sold if households need to leave when the conflict intensifies. However, a prolonged presence of non-state armed actors pushes households to exploit a lower percentage of their land. When we control for general equilibrium effects, the presence of non-state armed actors for a period of four to six years increases the percentage of land allocated to perennial crops. In addition, the impact of presence is greater for pastures and idle land.

Table 7. Use of Land (Percentage of total land plot): State Fixed Effects, Pseudo Region Fixed Effects, and General Equilibrium Controls

	Perennial Crops			Seasonal Crops			Pastures			Idle Land		
	SFE	PRFE	GEC	SFE	PRFE	GEC	SFE	PRFE	GEC	SFE	PRFE	GEC
Shock Intensity 1	-0.0175	-0.0893	-0.163**	0.0203*	0.0775	0.0916	-0.0136	-0.136*	-0.172**	0.00226	-0.0209	-0.0404*
	[0.0158]	[0.0964]	[0.0655]	[0.00958]	[0.0583]	[0.0672]	[0.00982]	[0.0644]	[0.0803]	[0.00873]	[0.0206]	[0.0225]
Shock Intensity 2	0.0146	-0.133	-0.0574	-0.00394	-0.0144	-0.00797	-0.0526*	-0.157**	-0.154*	0.00711	-0.0634*	-0.0889**
	[0.0332]	[0.0777]	[0.102]	[0.0279]	[0.0696]	[0.0761]	[0.0270]	[0.0728]	[0.0857]	[0.0120]	[0.0304]	[0.0345]
Shock Intensity 3	-0.271***	-0.211***	-0.117	0.250***	0.278***	0.289***	0.105***	-0.00652	-0.00925	-0.0991***	-0.368***	-0.408***
	[0.0334]	[0.0693]	[0.105]	[0.0222]	[0.0823]	[0.0990]	[0.0247]	[0.0654]	[0.0668]	[0.0322]	[0.0286]	[0.0320]
Years of Presence 1-3	0.00168	-0.249**	-0.227**	0.0101	-0.0308	-0.0324	0.00402	-0.123**	-0.117*	-0.00262	-0.0752*	-0.0752*
	[0.0226]	[0.0907]	[0.0868]	[0.0151]	[0.0604]	[0.0597]	[0.0105]	[0.0548]	[0.0617]	[0.00806]	[0.0367]	[0.0376]
Years of Presence 4-6	-0.00252	0.209	0.336**	-0.00675	0.0191	0.00939	0.0427	0.289**	0.327**	0.00936	0.0290	0.0307
	[0.0317]	[0.170]	[0.124]	[0.0401]	[0.121]	[0.119]	[0.0247]	[0.110]	[0.117]	[0.0224]	[0.0575]	[0.0655]
Years of Presence 7-9	0.111***	-0.0713	-0.0623	-0.0909***	-0.229	-0.250	0.0270	0.372*	0.408**	0.0315	0.323**	0.368***
	[0.0234]	[0.308]	[0.315]	[0.0132]	[0.240]	[0.256]	[0.0199]	[0.182]	[0.187]	[0.0267]	[0.125]	[0.117]
Observations	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760
R-Squared	0.149	0.219	0.220	0.120	0.196	0.196	0.108	0.165	0.166	0.045	0.118	0.118
Household and landplot characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conflict history controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Pseudo Region Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
General Equilibrium controls	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Clusters by municipality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in brackets. * p<0.10, ** p<0.05, *** p<0.01
Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel

Table 8 reports the results for investment. The incidence of conflict shocks has a strong impact on investment decisions. Overall investment decreases as a consequence of the conflict shock: the probability of investment for two and three types of shocks is 23.3 and 36.6 percentage points lower, respectively. Decreases in overall investment are mostly related to a lower investment in commercial trees. These results hold after controlling for general equilibrium effects. We find a counterintuitive result for permanent structures: two and three types of shocks increase investment in permanent structures. Although we control for several variables that capture wealth and regional characteristics to account for potential targeting, we might not be able to fully control for this.

The number of years of presence of non-state armed actors has a non-linear effect. Households seem to adjust their behavior gradually. Initial beliefs may perceive the presence of non-state armed actors as transitory, which prompts households to sharply reduce investments. As their presence is more prolonged, it may be perceived as permanent, and households learn to live amid conflict and invest more. We find these results for overall investment and for investments in permanent structures, fruit trees, and other commercial trees. During the initial one to three years of presence, overall investment decreases by 26.9 percent. In subsequent periods, overall investment increases gradually such that between four and six years it increases by 26 percent and from seven or more years by 83.6 percent. These results hold after controlling for the general equilibrium effect. We find this positive impact for overall investment and for commercial trees. Indeed, farmers apparently learn to live amid conflict and make investments they have postponed for several years.

Table 8. Investment: State Fixed Effects, Pseudo Region Fixed Effects, and General Equilibrium Controls

	=1 if at Least One Investment			=1 if Investment in Permanent Structures			=1 if investment in fruit trees			=1 if investment in other commercial trees		
	SFE	PRFE	GEC	SFE	PRFE	GEC	SFE	PRFE	GEC	SFE	PRFE	GEC
Shock Intensity 1	-0.00904	-0.00324	0.0146	-0.00705	0.0336	0.0775	0.00399	0.125	0.135	-0.00458	-0.130***	-0.137***
	[0.0122]	[0.124]	[0.114]	[0.0121]	[0.0542]	[0.0570]	[0.00809]	[0.0906]	[0.0830]	[0.00337]	[0.0354]	[0.0454]
Shock Intensity 2	-0.0589**	-0.230***	-0.200***	0.0163	0.281***	0.277***	-0.0134	0.125	0.150	-0.000579	-0.214***	-0.217***
	[0.0271]	[0.0562]	[0.0683]	[0.0185]	[0.0814]	[0.0922]	[0.0177]	[0.0838]	[0.0904]	[0.00709]	[0.0294]	[0.0303]
Shock Intensity 3	-0.0629	-0.366***	-0.320***	0.0470*	0.283***	0.285***	-0.118***	-0.0533	-0.0154	0.0290	-0.168***	-0.174***
	[0.0626]	[0.0581]	[0.0862]	[0.0252]	[0.0559]	[0.0750]	[0.0215]	[0.0635]	[0.0707]	[0.0315]	[0.0192]	[0.0221]
Years of Presence 1-3	0.00664	-0.269***	-0.268***	0.00956	-0.0730	-0.0809	0.00893	-0.119*	-0.118*	0.000565	-0.0354	-0.0347
	[0.0153]	[0.0914]	[0.0855]	[0.00957]	[0.0752]	[0.0708]	[0.0130]	[0.0644]	[0.0602]	[0.00747]	[0.0432]	[0.0436]
Years of Presence 4-6	0.0781**	0.260*	0.263*	0.0195	0.108	0.0613	0.0612**	0.0669	0.0746	0.00218	0.0701	0.0742
	[0.0360]	[0.140]	[0.133]	[0.0216]	[0.104]	[0.0923]	[0.0216]	[0.118]	[0.102]	[0.0159]	[0.0741]	[0.0671]
Years of Presence 7-9	0.0215	0.836***	0.788***	-0.0313**	-0.253	-0.297	0.0635***	0.163	0.127	-0.0263	0.252**	0.262***
	[0.0449]	[0.234]	[0.223]	[0.0108]	[0.168]	[0.180]	[0.0209]	[0.203]	[0.184]	[0.0272]	[0.0869]	[0.0878]
Observations	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760	3,760
R-Squared	0.089	0.146	0.147	0.053	0.109	0.109	0.057	0.123	0.124	0.166	0.215	0.215
Household and landplot characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conflict history controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Pseudo Region Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
General Equilibrium controls	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Clusters by municipality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in brackets. * p<0.10, ** p<0.05, *** p<0.01
Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel

Our results show that the impact of conflict shocks and the presence of non-state armed actors on household decisions differ. The resilience of households and their ability to navigate conflict become evident when we explore the impact of the years of presence. Examining only the impact of conflict shocks provides an incomplete picture in which violence has a negative effect with little capacity of households to minimize it. The findings also show a high non-linearity of both effects. As conflict shocks increase, the negative impact becomes stronger. On the other hand, households react with sharp reductions in agricultural production and investment at the initial stages of presence of non-state armed actors, and gradually learn to live among armed groups.

4.5. Robustness Check

Spillovers across boundaries of the rural district are a potential confounding factor to the identification strategy. These spillovers may arise because the presence of non-state armed actors may have an impact beyond the borders of the rural district, and households may migrate to neighboring districts to avoid the impacts of conflict.

We perform three robustness checks. First, similarly to Naidu (2012), we create alternative pairs such that we compare results for the immediate neighbor with results using the immediate neighbor of the original pair. We drop the original pairs from the estimation, reducing our sample to 2.496. Second, we use propensity scores to match rural districts with presence of non-state armed actors to five rural districts without presence with the closest PSM. Third, we drop migrants from the estimations in order to estimate the effect only for those households whose members were born and have lived in the rural district in which they were interviewed.

We present results for the three robustness checks in Tables 9 and 10. The first column reports the results for the immediate neighbor of the contiguous region (INCR), the second for the propensity score matching (PSM), and the third for the sample of permanent residents. Our results are robust to the different specifications, yet some coefficient estimates lose significance, as for all cases we have fewer observations. We expect that the coefficient estimates for the INCR and the PSM are weaker in terms of magnitude and significance. In both cases, our ability to control for unobservables is lower, particularly for the PSM. For the INCR, the sample size is smaller, which may reduce the precision of the coefficient estimates. This is indeed the case. Many coefficient estimates are no longer significant, and their magnitude is lower. However, the results for the coefficient estimates coincide for more than half the cases.

Table 9: Use of Land (Percentage of total land plot): Non Contiguous Fixed Effects, Propensity Score Matching, and Permanent Residents

	Perennial Crops			Seasonal Crops			Pastures			Idle Land		
	NCFE	PSM	PR	NCFE	PSM	PR	NCFE	PSM	PR	NCFE	PSM	PR
Shock Intensity 1	-0.0218	-0.0315*	-0.650***	0.0346	0.0223	0.0526	-0.0194	-0.00163	-0.232*	0.0824***	0.0109	-0.0924
	[0.0406]	[0.0170]	[0.0743]	[0.0395]	[0.0154]	[0.0769]	[0.0235]	[0.00918]	[0.129]	[0.0168]	[0.00966]	[0.0785]
Shock Intensity 2	0.0851	-0.000364	-0.525***	-0.0357	-0.0135	-0.0722	-0.0138	-0.00596	-0.281*	0.0403	0.0569**	-0.0732
	[0.0678]	[0.0442]	[0.158]	[0.0638]	[0.0233]	[0.119]	[0.0417]	[0.0198]	[0.141]	[0.0279]	[0.0209]	[0.0769]
Shock Intensity 3	-0.391	-0.412***	1.153*	0.690***	0.225***	0.0394	-0.0261	0.0503	0.934***	0.0339	-0.0721**	-0.0963
	[0.242]	[0.0607]	[0.615]	[0.151]	[0.0651]	[0.255]	[0.159]	[0.0462]	[0.290]	[0.0885]	[0.0252]	[0.393]
Years of Presence 1-3	0.0755*	0.0869***	-0.379***	-0.0143	-0.0148	-0.0347	-0.0485	-0.0210	-0.0438	0.0106	-0.00385	-0.114
	[0.0369]	[0.0149]	[0.129]	[0.0341]	[0.0108]	[0.0632]	[0.0296]	[0.0121]	[0.0951]	[0.0216]	[0.0126]	[0.0869]
Years of Presence 4-6	-0.227	0.106**	-0.0635	-0.0165	-0.0353	-0.0454	0.0396	-0.0384**	0.325	0.0662	0.0832***	0.0946
	[0.152]	[0.0384]	[0.192]	[0.0969]	[0.0334]	[0.143]	[0.0767]	[0.0180]	[0.216]	[0.0434]	[0.0207]	[0.128]
Years of Presence 7-9	0.360	0.145***	-1.201***	-0.460***	-0.153***	0.143	0.167	-0.0271	-0.432*	-0.0436	0.00507	0.0974
	[0.218]	[0.0495]	[0.241]	[0.122]	[0.0518]	[0.136]	[0.153]	[0.0287]	[0.240]	[0.0672]	[0.0375]	[0.212]
Observations	2,496	3563	1,767	2,496	3563	1,767	2,496	3563	1,767	2,496	3563	1,767
R-Squared	0.218	0.176	0.287	0.168	0.148	0.269	0.177	0.127	0.240	0.130	0.087	0.173
Household and landplot characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conflict history controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo Region Effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Non Contiguous Pseudo Region Effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Clusters by municipality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in brackets. * p<0.10, ** p<0.05, *** p<0.01

Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel

Table 10: Investment: Non Contiguous Fixed Effects, Propensity Score Matching, and Permanent Residents

	=1 if at Least One Investment			=1 if Investment in Permanent Structures			=1 if investment in fruit trees			=1 if investment in other commercial trees		
	NCFE	PSM	PR	NCFE	PSM	PR	NCFE	PSM	PR	NCFE	PSM	PR
Shock Intensity 1	-0.0316	0.0121	0.248	-0.0720	-0.0179	-0.00455	0.0425*	-0.00674	0.127	-0.00254	0.00531	-0.0594
	[0.0661]	[0.0152]	[0.207]	[0.0470]	[0.0187]	[0.177]	[0.0235]	[0.0203]	[0.122]	[0.0275]	[0.00699]	[0.0522]
Shock Intensity 2	0.0760	0.00960	-0.170	0.232***	0.0753	0.242*	0.0866*	-0.0126	-0.255***	0.0288	0.00832	-0.139**
	[0.0486]	[0.0216]	[0.103]	[0.0734]	[0.0656]	[0.120]	[0.0415]	[0.0258]	[0.0640]	[0.0350]	[0.0131]	[0.0640]
Shock Intensity 3	0.116	-0.276***	-0.536	0.0475	-0.0793*	-0.519	-0.420***	-0.166***	0.209	0.0577	-0.00786	0.145
	[0.244]	[0.0710]	[0.800]	[0.155]	[0.0377]	[0.651]	[0.0942]	[0.0538]	[0.374]	[0.142]	[0.0259]	[0.149]
Years of Presence 1-3	0.0364	0.0193	-0.347***	0.0148	0.0181	-0.241***	0.00459	0.0112	-0.0607	-0.0135	0.0146	-0.0278
	[0.0446]	[0.0247]	[0.117]	[0.0291]	[0.0171]	[0.0731]	[0.0196]	[0.0144]	[0.108]	[0.0225]	[0.00870]	[0.0377]
Years of Presence 4-6	0.225	0.108***	0.163	0.210**	-0.0331	0.350***	-0.133**	0.0782***	-0.203	0.158***	0.0757***	0.107*
	[0.174]	[0.0289]	[0.162]	[0.0918]	[0.0294]	[0.104]	[0.0621]	[0.0175]	[0.129]	[0.0388]	[0.0221]	[0.0507]
Years of Presence 7-9	0.0104	0.0731	0.748	-0.0393	-0.0784***	0.435	0.431***	0.0918***	-0.0731	-0.0350	-0.00190	-0.0844
	[0.232]	[0.0566]	[0.547]	[0.141]	[0.0254]	[0.390]	[0.0870]	[0.0253]	[0.251]	[0.113]	[0.0181]	[0.116]
Observations	2,496	3563	1,767	2,496	3563	1,767	2,496	3563	1,767	2,496	3563	1,767
R-Squared	0.153	0.118	0.235	0.120	0.069	0.206	0.138	0.084	0.196	0.209	0.185	0.443
Household and landplot characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Conflict history controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo Region Effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Non Contiguous Pseudo Region Effects	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Clusters by municipality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in brackets. * p<0.10, ** p<0.05, *** p<0.01
Source: Authors' calculations based on ELCA (Wave I), National Government, IDEAM, IGAC and CEDE Municipal Panel

The results for the sample of permanent residents show a stronger impact. Permanent residents have stronger ties to their communities and are less likely to migrate. Thus, we expect their reactions to shocks and to the presence of non-state armed actors to be stronger. The coefficient estimates for permanent residents have in most cases the same signs as the original results, yet their magnitude is larger, and some additional ones become statistically significant.

5. Conclusions

This paper studies how conflict induces changes in households' agricultural decisions. We explore whether households respond differently to conflict shocks and uncertainty, risk, and the governance structures imposed by non-state armed actors. Households may react strongly to violent shocks and the presence of non-state armed actors if conflict is recent.

However, households may learn to live amid conflict, adapt their behavior to prevent aggression from non-state armed actors, and mitigate the economic consequences of violence.

We first propose a model that highlights the distortions faced by a small farmer living in autarky who is hit by violent shocks but is uncertain of the nature of the shocks. Shocks may arise when either the government or the non-state armed actor is hegemonic in the region; in the latter case, shocks tend to be worse (in the likelihood ratio sense). Therefore a more violent shock leads the farmer to update beliefs and think that there is a higher probability that the non-state armed actor will dominate in his region. We concentrate on the impact of violent shocks and uncertainty on land use and investment.

The study shows that more pessimistic beliefs and more violent shocks lead the agent to exchange perennial crops for seasonal ones, which are less risky but also less profitable. On the other hand, if the farmer is sufficiently risk averse, then the more pessimistic the farmer's beliefs, the more he invests to self-insure. This generates a non-linear effect on investment once a violent shock arises. On the one hand, a violent shock decreases investment since production decreases, but on the other, he updates his belief and increases investment for self-insurance reasons. The more uncertain the farmer is, the stronger the latter effect tends to be.

We apply a household survey representative of four Colombian micro-regions to test these predictions. Colombia has faced civil war for more than half a century; thus, it is the ideal context in which to investigate how households adjust their decisions in conflict-ridden regions. Because the presence of non-state armed actors is not random, our empirical strategy creates contiguous pairs of rural districts with and without the presence of non-state armed actors. We include fixed effects for each contiguous pair, which control for unobservables that are potentially correlated with armed group presence and may bias our coefficient estimates. We also include a rich set of controls at the household, land plot, rural district, and municipality levels.

The results of the study show that households' responses to violent shocks and to the presence of non-state armed actors differ. High-intensity shocks induce changes in land use such that households in rural districts with a larger number of violent shocks use less land on perennial crops and pasture, and more on seasonal crops or they leave the land idle. In

addition, the conflict shock causes a decrease in overall investment. The impact of shocks is highly non-linear such that the magnitude increases significantly as the incidence becomes stronger.

The presence of non-state armed actors prompts different responses from households. Similarly to Kalyvas (2006), we find that the presence of armed groups does not necessarily coincide with violent assaults against the civilian population. In fact, the incidence of violent shocks is lower in rural districts where non-state armed actors are present. This implies that households may adjust their behavior to prevent future assaults, become less visible to armed groups, or reduce other costs of conflict. Household responses to the presence of non-state armed actors signal that they learn to live amid conflict. When the presence of non-state armed actors is recent, households sharply cut back land use for perennial crops and pasture and the amount of land left idle, and they reduce investment. As the presence of non-state armed actors is more prolonged, farmers increase the amount of land used for perennial crops and pasture, yet more land is left idle. Moreover, investments rebound as the presence of non-state armed actors persists for a longer time. These results show that households habituate to conflict, yet at a lower equilibrium.

Traditional post-conflict policies concentrate on reconstruction efforts, which are necessary to increase production in a short period of time, as this paper shows. However, policies should also create favorable conditions to reduce uncertainty. An initial step would be to rapidly improve the rule of law. In addition, policies that go beyond individual beneficiaries and target the community could improve trust among households, reducing the perception of uncertainty. Reducing uncertainty, paired with increased access to formal credit, induce households to expand investment and avoid sub-optimal decisions.

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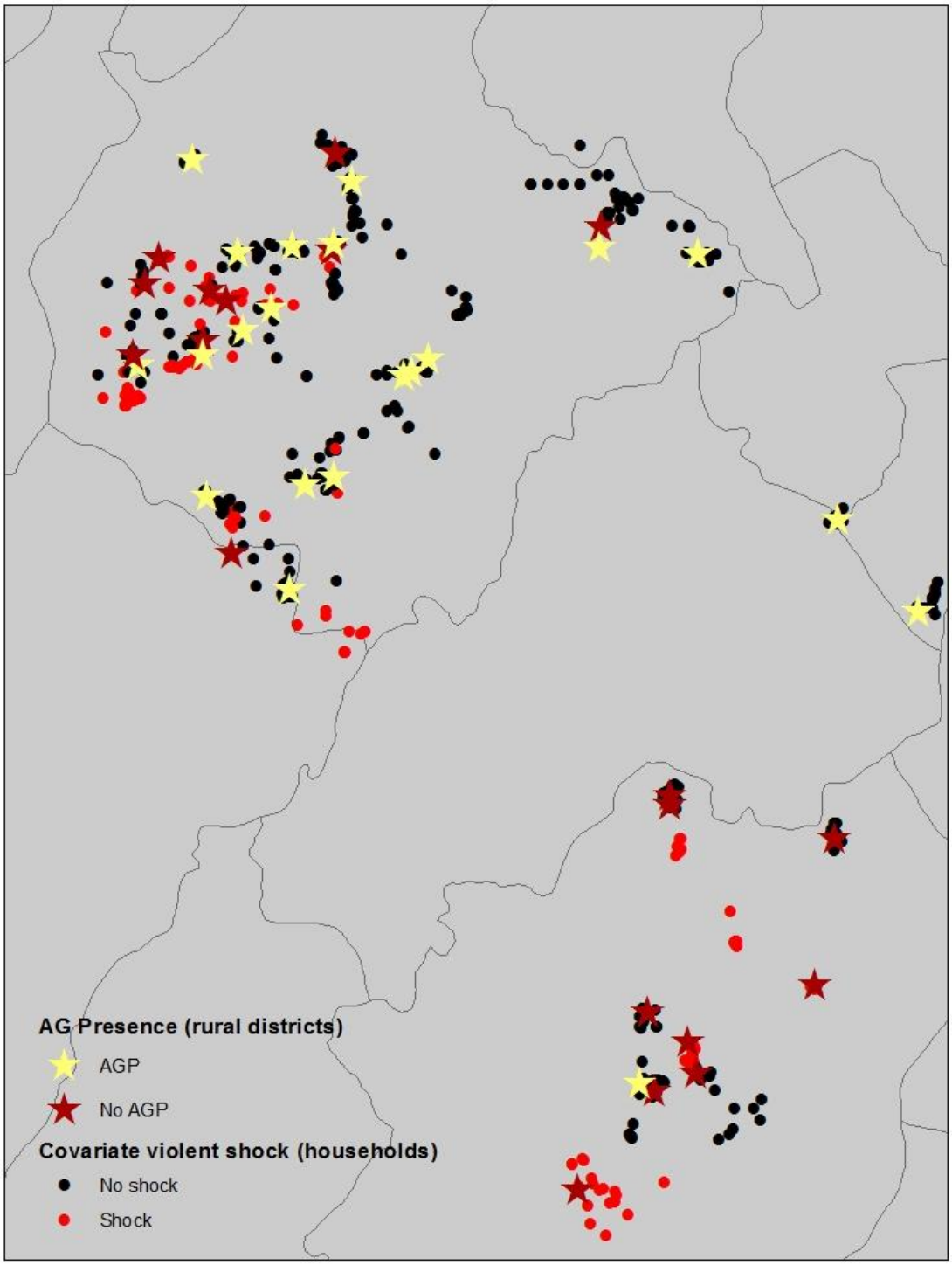
Map 1. Presence of Non-state Armed Actors and Incidence of Conflict-induced Shocks



Source: Authors' calculations based on ELCA (Wave I) and National Government