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Does Violent Conflict Affect Labor Supply of Farm Households? The Nigerian Experience

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ABSTRACT

Does Violent Conflict Affect Labor Supply of Farm Households? The Nigerian Experience*

Nigeria has experienced bouts of violent conflict in different regions since its independence leading to significant loss of life. In this paper, we explore the average effect of exposure to violent conflict generally on labor supply in agriculture. Using a nationally representative panel dataset for Nigeria from 2010-2015, in combination with armed conflict data, we estimate the average effect of exposure to violent conflict on a household's farm labor supply. Our findings suggest that on average, exposure to violent conflict significantly reduces total family labor supply hours in agriculture. We also find that the decline in family labor supply is driven by a significant decline in the household head's total number of hours on the farm.

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* Comments are appreciated.

1 Introduction

The agricultural sector holds a significant role in developing countries and Nigeria is no exception. According to data from the World Bank, agriculture is the largest employer of labor in Nigeria. Employment in agriculture (% of total employment) in Nigeria was reported at 36.38% in 2019. The sector is also the largest income generating activity, with contributions to Gross Domestic Product (GDP) of about 24-30%. Unfortunately, the agricultural sector is particularly vulnerable to violent conflict[1]. In particular, through killings, injuries, maiming of individuals, threats, fear, migration and displacement, violent conflict affects directly the labor supply and demand of agricultural households.

Over the last few years, studies examining the impact of violent conflict on agricultural outcomes using microlevel data have increased. Many of these papers provide evidence of the adverse effect of conflict on agricultural production through different pathways including reduced access to credit and decline in labor supply (See Verpoorten, 2009; Blattman & Miguel, 2010; Brück, d'Errico, & Pietrelli, 2019; Verwimp, Justino, & Brück, 2018.). With respect to Nigeria, research on the impact of conflict on agriculture related outcomes has increased. However, there is still room for more knowledge on the impact of conflict in Nigeria on certain agricultural outcomes.[2] In particular, while Adelaja and George (2019a) examined the effects of Boko Haram insurgency on output and input demand including the demand for hired labor and supply of family labor, the impact of conflict on the labor supply of a household head, spouse and children were not examined separately. Given the possibility of heterogeneous impact of conflict on labor supply, a more robust investigation

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[1]See Adelaja and George, (2019a) and Adelaja and George, (2019b) for reasons behind this vulnerability.

[2]See the literature review section for a detailed summary of past literature on Nigeria.

is useful and is one of the motivations for our research.

The main motivation for our research is the current gap in the conflict literature on Nigeria. In particular, the recent past literature on conflict in Nigeria focused primarily on the impact of the Boko Haram insurgency on different health, economic and labor market outcomes. This focus on Boko Haram political violence could be limiting in perspective given Nigeria's past history of violent conflict in different locations, at different times, driven by different actors and perpetrators. The reality is that armed conflict has plagued Nigeria long before the onset of the Boko Haram crises. Currently in Nigeria violence from the farmer-herdsmen conflict, bandit attacks and Fulani militia have increased precipitously and has led to a significant number of fatalities. A research focus on Boko Haram cannot provide perspective for the current growing crises as the states, local government, towns, and villages that have had direct exposure to this growing violent conflict are different from the communities that have been significantly affected by Boko Haram attacks and abductions. The changes in violence hot-spots in Nigeria over time is evidence of the proliferation and wide spread nature of conflict in Nigeria. Moreover, the differences in perpetrators and location is a reminder of the heterogeneity in conflict exposure across communities. Given violent conflict in Nigeria goes beyond Boko Haram or the farmer-herdsman current conflict, and recent results on Nigeria by Odozi and Uwaifo Oyelere (2019) suggest negative welfare effects of violent conflict in general, then, examining the effect of violent conflict generally on labor supply, one of the potential channels that could explain their finding, is promising and could provide valuable insights. This is the goal of our paper.

In this paper, we focus on two related questions as we attempt to bridge the gap in the existing literature on the effect of conflict on farm labor supply. First, does recent exposure to violent conflict affect total family labor hours and is there heterogeneity

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in effect on the number of hours worked by the household head, spouse, children and relatives? Second, does long term accumulated exposure to conflict (direct or indirect) affect total family labor hours supplied and is there heterogeneity in effect on the number of hours worked by the household head, spouse, children and relatives? For both questions we focus on small holder farm households.[3] We attempt to answer these questions using household survey panel data for Nigeria in combination with data from The Armed Conflict Location & Event Data (ACLED).

To examine both the short term and long term effects of conflict exposure on labor supply, we construct two measures of conflict exposure based on conflict related fatalities. We refer to our first measure as recent exposure to conflict and the second measure as long-term accumulated exposure to conflict.[4] To estimate the effect of conflict on farm labor supply, we initially use a Heckman selection model which can attenuate self selection bias. However, given the limitations of the Heckman model we consider it simply as our baseline model.[5] To derive consistent estimates, we subsequently use a fixed effects approach exploiting the panel nature of our data. The fixed effects approach is our preferred method for our analysis because this approach uses within household variation over time, thereby attenuating potential biases in estimated effects. In particular it eliminates biases linked with unobserved time invariant differences across households that affect labor supply and are also correlated to conflict exposure.[6]

Our results provide evidence of the significant negative effect of both recent ex-

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[3]We define farm households as agricultural households with at least one plot.

[4]We explain in detail how we construct these measures in other sections of the paper.

[5]It is challenging to come up with an excluded variable that does not directly affect the outcome and affects the selection.

[6]In earlier versions of the paper, we also explored the effect of conflict on labor force participation using multiple estimation strategies including a fixed effect logit model, a linear probability fixed effect model and a probit model with correlated random effects. In all specifications, we did not find a significant effect of conflict exposure on participation in the labor force.

posure to conflict and accumulated exposure to conflict on total family farm labor supply. When we consider the different sources of farm labor, we find that the significant effect of conflict is driven by decline in labor supply of household heads. We do not find any significant effect on farm labor of children or spouse. Our results using the Heckman selection model corroborate our fixed effect results.

Our paper contributes to the literature by providing the first analysis in Nigeria on the overall average effect of exposure to violent conflict between 1999 and 2015 on farm labor supply of agricultural households. While we are not the first to examine the effect of specific conflicts in Nigeria on agricultural outcomes such as productivity or number of hours worked, our paper provides a broad perspective which is value adding and fills a gap in the literature. Adelaja and George (2019a) focusing solely on the effects of Boko Haram did not find any impact of that particular conflict on total family labor supply. In contrast, our results suggest that violent conflict in Nigeria on average negatively affects total family labor supply and within households, the farm labor supply of household heads is significantly reduced.

Another contribution of our paper is that our results suggest significant lingering negative effects of armed conflict on labor supply which has relevant policy implications. As mentioned above, the agricultural sector in Nigeria is a major employer of labor and contributes significantly to GDP. Farm households are both users and suppliers of labor for upstream primary agricultural production activities whether planting, rearing, weeding, nurturing and harvesting. The link of farm household activities with down stream agricultural activities raises the policy importance of farm labor supply as a channel of poverty reduction and national food security. Hence, shocks that negatively affect labor supply have downstream effects that ultimately could affect welfare negatively, leading to increases in poverty incidence and severity. Odozi and Uwaifo Oyelere (2019) provide evidence that exposure to violent conflict

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significantly reduces income and increases poverty incidence, depth and severity in Nigeria. However, the pathways through which conflict decreases income or increases poverty were not investigated. The results in our paper also contributes to the literature by providing evidence of one possible pathway through which conflict could have increased poverty. In particular, violent conflict reduces hours of labor supplied by farm households. This reduction in labor supply decreases production and earnings and increases the vulnerability of farm households to falling under the poverty line or sinking deeper into poverty.

The rest of our paper proceeds as follows. In the next section we provide a background of conflict in Nigeria. In section 3 we review the past literature. Section 4 is a synopsis of our conceptual framework. Section 5 focuses on our empirical strategy for answering our questions of interest. In section 6 we present our data and descriptive analysis. In section 7 we present our results. We conclude in the last section.

2   Background: Conflict in Nigeria

Violent conflict is a significant part of Nigeria's history and is still an ongoing reality for many Nigerians today. While the ongoing global COVID-19 pandemic has claimed many lives and is dominating government and different stakeholders conversations, violent conflict which has been escalating in Nigeria has not gotten as much attention.[7] The challenge with the inadequate attention is the neglect for the significant impact violent conflict is having on groups, particularly farming communities. It is worth noting that between 2020 and 2021, violent conflict has led to higher

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[7]As of June 3rd 2021 Official COVID-19 related deaths in Nigeria was 2099 - source https://www.worldometers.info/coronavirus/.com

fatalities compared to COVID-19 related deaths.[8]

Nigeria's episodes of violent conflict are not just a recent occurrence of the 21st century. Violent conflict in Nigeria is somewhat eclectic and may be defined as low intensity. What appears to be changing with respect to conflict in Nigeria are the players or perpetrators and the intensity of fatalities and frequency of events which have escalated over the last 15 years. Odozi and Uwaifo Oyelere (2019) provide a detailed summary of the history and nature of conflict in Nigeria. They note that in the 60s the violent conflict events in Nigeria were linked with political challenges instigated by state creations (Tiv Riots), political unrest, military coups and attempts of a region of Nigeria to secede. The Biafran Civil War of 1967-1970 was the end product of some of the crises that characterized this decade. While political conflict as a source of violence in Nigeria continues to persist, other dimensions of conflict have emerged that have led to significant fatalities and new hot-spots. In the 70s, 80s and 90s violent conflict in Nigeria was also common place. The conflicts were heterogeneous with respect to location and perpetrator. Some known examples are the Bakolori Massacre, Odi massacre and the 1980 Kano riot. One reoccurring type of conflict is religious conflict, usually between Christians and Muslims. Religious and ethno-religious conflict events became quite common place in Nigeria in the 80s and 90s especially in the Northern part of the country.

Another major source of conflict since the early 90s is the Niger Delta conflict. The conflict in this region has been driven by the struggle among local communities, multinational oil companies, and the Nigerian state for control over the resource rich territory and the oil revenues. The Movement for the Emancipation of the Niger Delta (MEND) emerged and became violent since 2006(Courson,2009). Their violent

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[8]Data from The Nigeria Security Tracker (NST) shows at least 3801 conflict deaths between 2020 and June 2021.

activities were characterised by oil worker abductions, attacks of government forces and oil installation sabotages.

Since 2000 violent conflict in Nigeria has increased precipitously. According to estimates from Nigeria's National Commission for Refugees between 2003 and 2008, there were an estimated 3.2 million Internal Displaced Persons (IDPs) in Nigeria resulting from conflict. Within communal conflict, there has also been a significant increase in both ethno-religious and farmer-herder conflict but farmer-herder conflict increases are more common. Recent data suggests that between 2010-2019 nearly 19,000 people had died as a result of conflict of this type.[9] . The last 5-6 years have been characterized by significant increase in massacres by herdsmen and while most of these attacks were localized within Benue and Plateau state, there have been a proliferation of killings linked with herdsmen in multiple location across Nigeria. [10] In fact the farmer herder conflict has evolved into armed banditry involving cattle rustling, destruction or theft of farm crops, kidnapping and armed robbery. As noted in Olaniyi(2015), unlike the sedentary Fulani, the Bororo Fulani herders are considered very aggressive and always fully armed with AK-47s, charms, cutlasses and attack farmers and communities with lethal weapons.

Another major kind of perpetrator of conflict in Nigeria emerged in 2009 and has gotten the most attention internationally. Since 2009, the rise of Boko Haram has added to the already significant sources of conflict in Nigeria. This terrorist group has been oppressing communities in Northern Nigeria and causing havoc on education and health facilities, and attacks on markets and farms, closure of cattle markets, and restricted access to lands. Using data from 2000 to 2020, ICON reports

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[9]See report, entitled "Nigeria's Silent Slaughter: Genocide in Nigeria and the Implications for the International Community," put together by ICON (International Committee on Nigeria).

[10]Indigene /settler conflicts have also increased and intensified during different times between 1980 and 2015. The violent conflict in Jos in Plateau state in 2001 is one example.

that Boko Haram has killed more than 43,000 Nigerians, the vast majority of these deaths were women and children.

While there is a lot of attention on Boko Haram and growing attention on farmer-herder conflict, it is important to mention that Boko Haram conflict has expanded beyond terrorism to banditry particularly in the North West. Different groups are also emerging and asking for the right to self-determination. The year 2020 led to a rise of militia groups that target communities in certain states especially southern Kaduna state. This new campaign of violence targeting communities has been linked with Fulani militia and may be viewed as an ethno-religious conflict given the religious and ethnic links.

The heterogeneity in conflict in Nigeria and the proliferation of hot spots over time and across regions is our motivation for looking at the impact of conflict in Nigeria holistically. We do not focus on one conflict type but all violent conflict types. However, it is important to note that while most parts of Nigeria have had some exposure to violent conflict since 1960, the intensity of violent conflict exposure varies across regions. The three zones with the highest prevalence rates of conflict over the last few decades are the North East, North Central and South South regions of Nigeria. It is also worth highlighting that these regions have a significant share of their population working in agriculture.

3   Literature Review

Economic literature focusing on the micro-economic consequences of conflict across African countries have increased in the last two decades.[11].) More recently, there has also been an increase in papers focused on trying to explain the rise in certain types

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[11]See Akresh and de Walque, 2008; Minoiu and Shemyakina, 2012; Justino and Shemyakina, 2012

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of conflicts within Africa. [12]

Given the pivotal role of agriculture in many developing economies, the effects of idiosyncratic shocks on labor market outcomes have been examined also. For examples, there is an established literature on shock events such as bad weather, price and unemployment shocks and their effects on off farm labour supply (Kochar, 1999; Rose, 2001; Cameron and Worswick, 2003; Lamb , 2003 Cunguara et al., 2011; Mathengea and Tschirley; 2015, Mueller and Quisumbing, 2010). This strand of literature suggests that farmers increase the supply of off-farm labor under unfavorable conditions in order to maintain consumption levels, which reduces farm work time.[13] More recently there is an increasing focus on how conflict as a specific shock affects agricultural related outcomes (Adelaja and George (2019a) and Adelaja et al,(2020)).

With respect to Nigeria, there is a growing literature on the effects of conflict on different economic and welfare related outcomes. For example, Nwokolo (2015) used the Nigerian demographic data and ACLED data to examine the effect of Boko Haram Insurgency(BHI) on child health. Child health was also considered by Ekhator and Asfaw (2019). Their study examines the effect of BHI on measures of children health. Bertoni et. al.(2018) examined the impact of civil conflict (specifically Boko Haram) on school attendance and attainment. They find an increase in the number of fatalities a child is exposed to decreases the number of completed years of education for the cohort exposed to conflict during primary school compared to the non-exposed cohort.

There is also a growing literature on the impact of conflict on food and agriculture

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[12]See McGuirk & Nunn(2020) and McGuirk & Burke (2020).

[13]In this paper given the limitations of the dataset we are using, we are unable to explore whether farmers increase their hours of off farm labor as a response to labor supply reductions on the farm linked with conflict.

related outcomes in Nigeria. The effect of conflict on food insecurity was explored by George, Adelaja and Weatherspoon(2020)). They examined the effect of armed conflicts on food insecurity using the General Household Survey (GHS) panel data for Nigeria and Boko Haram terrorist incidence data. They find that an increase in conflict intensity, measured by number of fatalities, increases the number of days where the household consumed foods that were less preferred. In addition they find negative effects on the variety of foods the household consumed and the portion size of the meals. In a related paper that focused on food insecurity, using the GHS panel data complemented with a 2017 phone survey, Kaila and Azad (2019) explored the effect of conflict victimization on consumption and food security noting heterogeneity in the effects of conflict. In particular they find that conflicts involving Boko Haram had more severe negative effects on consumption and food security than conflicts involving the Fulani herdsmen or militant groups in the Niger Delta.

With respect to agricultural related outcomes, Sidney, Zummo and Kwajafa (2017) examined the effect of Boko Haram on peasant farmers productivity in selected localities in Adamawa state (an area that has been directly affected by Boko Haram activities) finding significant negative effects. Adelaja and George (2019b) estimated the causal effects of exposure to attacks on plot ownership, cultivated land, rented land, land values and cropping patterns. They provide results suggesting that an increase in the intensity of terrorist attacks results in increases in the percentage of land left fallow, increases in the average distance between plots farmed and the homestead and increased attacks discourages mono cropping and encourages mixed cropping. They also find that farmers expectations about the values of their lands decreased with increased exposure to violent conflict.

In yet another paper, Adelaja and George(2019a) examined the effects of Boko Haram insurgency on farm output and the demand for farm inputs including the

demand for hired labour for harvest operations. Using the same data, their results suggest that violent conflict reduces the hours of hired labor but does not affect the use of family labor. Suggesting that conflict mainly affect hired labour and not family labor.[14] Mitchell(2019) also used the same data set as Adelaja to estimate the effects of conflict events on household input use, cattle holdings, and cropping decisions. The paper differs from the Adelaja and George paper in the methodology employed to estimate the effect of conflict and in some of the outcomes considered. Mitchell(2019) also differentiates between the Boko Haram conflict and the Fulani herdsmen conflict. Using an events study framework, he finds evidence of negative effects of the Fulani herdsmen conflict on a household's cattle holding in the following season. The author does not find significant effects of the Boko Haram conflict on most of the outcomes considered using the events studies method.

Our paper makes use of the same GHS panel data set used by Adelaja and George(2020 a and b) and other aforementioned papers. Like these papers, we look at the effect of conflict at an area level (LGA or EA). However, our research differs from most of the papers discussed because these studies focus either on the effect of the Boko Haram insurgency, or compare effects of that insurgency with those of the Fulani herdsmen conflict. In contrast we take a more generalized approach. We believe this approach is justified given the prolonged exposure to violent conflict in different parts of Nigeria, and the potential value of exploring the average treatment of conflict in Nigeria on labor supply of agricultural households. Moreover, we focus on the overall effect of violent conflict in Nigeria both recent and accumulated. To the best of our knowledge, our paper is the first that has attempted to explore both long term and short term effects of conflict in Nigeria on labor supply. Furthermore, another unique aspect of our paper is that we complement the covariate conflict

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[14]Our results for violent conflict in Nigeria as a whole contradicts this finding.

exposure measure with household level idiosyncratic shocks. Controlling for households idiosyncratic shocks attenuates bias in estimated effects and differentiates our paper from the aforementioned papers that assigned conflict at the community level or LGA and do not control for other idiosyncratic shocks.[15]

4 Conceptual Framework: Labor Supply and Conflict

Labor - described as human effort- is about the most easily available resource used by households in rural settings whether for on farm activities, participation in off farm labor activities or the allocation of labor across various livelihood activities. Interactions between individuals and groups can lead to conflict and such conflict can be violent with "dramatic consequences on human well-being" (Hsiang, Burke and Miguel, 2013). Through direct and indirect channels, violent conflict can impact the labor supply outcomes of households and individuals exposed to violence. First, violent conflict leads to fatalities and injuries. This exogenous shock directly affects a household's labor stock and households can experience labor shortage because certain household members are no longer participating in the labor force due to fatality or injury from conflict. The labor shortage could also be reflected in the total decrease in hours worked by the household. In particular, injury can reduce the time available to work as individuals may be temporarily disabled or need to take time to recover which directly translate to loss of labor hours on the farm.

Another channel that can lead to labor supply shortages for farm households is the destruction of farms. The destruction of farm lands (e.g., through burning or theft of crops, looting of cattle, etc.) and other productive assets, can discourage households

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[15]Only Kaila and Azad (2019) consider the impact of conflict at the individual level. However, the endogenous nature of individual level exposure to conflict could bias their estimated coefficients.

from supplying more hours of labor to agriculture activity given the unpredictability in return linked with unexpected violent attacks and looting. Furthermore, violent conflict can precipitate fear in individuals exposed to it. In this scenario, farmers are afraid to leave their homes and to cultivate more isolated farm plots. Violent conflict also leads to displacement. Displacement can be long term or short term. In either cases farmer households' labor supply is disrupted as families are forced to migrate and total hours dedicated to farm activity declines.[16]

The aforementioned pathways are likely to induce drops in agricultural production or output. We hypothesize that this decline in agricultural output will consequently force households to seek employment outside of agriculture in order to smooth consumption or income. Similar to the discouraged worker effect of unemployment shock in labor economics literature, small holder farmers could decrease their labor force participation in response to the agricultural losses or decrease the hours dedicated to farm work. However, the overall effect on a households labor supply is an empirical question. The overall effect on labor participation of agricultural households will depend on farmers' prevailing conditions. If farmers are less able to migrate, and more credit constrained and workers supply labor less elastically, then the overall labor supply response might turn out to be negative. However, if there is ample opportunity for off farm employment or labor markets are not closed or are not too dangerous to travel to, then this will give rise to positive labor supply response. Fernández, Ibáñez and Peña (2014) noted that if labor markets were available then the occurrence of a violent shock would render on-farm work less profitable and market work more attractive. However we are of the opinion that since violent conflict

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[16]Although we can hypothesize based on prima facie evidence, due to data limitations, we are unable to identify which of the aforementioned pathways is the primary driver of the decline in labor within our data.

often affects several markets including the off farm labor market, we hypothesize an overall negative labor supply response of violent conflict exposure.[17]

Intra household substitution effect can also arise from a violent conflict shock. The "added worker effect" hypothesis in the labor economics literature predicts that the labor force participation rate among women is expected to increase as women have to enter the labor force to substitute for the labor of men who were killed, injured, migrated or displaced as a result of exposure to violent conflict. As noted in Justino and Shemyakina (2012), the death of working age household head may lead to changes in the household reallocation of labor. For example, women and children replacing lost workers. In this paper we will check for evidence of intra household labor reallocation. We focus on testing for changes in the hours of labor supplied of a household head, spouse, children and relatives separately.

5 Empirical strategy

To answer both our questions of interest, we estimate the impact of armed conflict on hours of labor supplied on the farm.

We make use of two estimation strategies. First, we make use of a Heckman selection model given the potential of self selection bias. We consider this as our baseline model. Our second and preferred estimation strategy is a fixed effects(FE) approach exploiting the panel nature of our data. The Heckman selection model includes two separate equations. The first is the sample selection equation-focused on selection into labor force participation. For this equation, our dependent variable is a dummy variable and it takes the value of 1 if a household head participates in

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[17]We are not able to test this hypothesis in our paper because of the limitations of the LSMS data. In particular the lack of comprehensive information on hours spent on other productive activities in the 2010 and 2012 LSMS survey.

the labor force and 0 otherwise. The second equation is the main equation linking the covariate of interest- violent conflict to the outcome variable -hours of farm labor supply. We estimate the Heckman model multiple times changing our measure of hours of farm labor. First we consider the total family farm labor supply, then we consider separately farm labor supply by household head, spouse, children and finally relatives. [18]

For our first question, our main independent variable and our measure of the intensity of exposure to conflict is based on recent violent deaths in a households LGA. We refer to this as recent conflict exposure.[19]. For our second question we focus on accumulated exposure to conflict from 1997 to the year of the survey.[20] We refer to this conflict measure as long term/accumulated conflict exposure.

In both equations we include a series of control variables. In particular, based on past literature that established a relationship between weather/climate variables and rural labor markets(Jessoe et al.,2018), we control for plot characteristics, the nutrient availability of the soil, annual mean temperature and annual rainfall. We also control for community characteristics that vary at the local government area level used to control for the demand-side factors regarding the availability of off-farm work. These variables include distances to major road, population centre, market, border and administrative centre. In addition, we control for household characteristics to control for household preferences and includes age and age squared, level of education of the household head, gender and household size. Given the importance of health and labor supply, we control for health using two variables. The first captures if an

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[18]Since we have two ways we construct conflict exposure and five different measure of farm labor supply, we run the Heckman model 10 times.

[19]We provide a detailed description of how this variable is measured in section 6.

[20]Our accumulated exposure measure begins in 1997 because that was the year the ACLED data was first collected for Nigeria.

individual has had any illness or injury during the past 4 weeks proceeding the survey. The second variable tries to get at the severity of past illness which could have a more significant effect on labor supply. The variable captures if an individual has been hospitalized in the last 12 months. We also control for exposure to idiosyncratic shocks. Following Kochar(1995) and Rose(2001), we also control for market wage. Other variables included to control for household wealth is the value of land (self reported by farmers) and the use of land size and agricultural wage as controls for aggregate consumption. We also include state fixed effects and interaction between zone and time fixed effects.

For more robust identification, the selection equation should have at least one variable that is not in the outcome equation. This imposes the exclusion restriction. In an ideal case, the variable has a non trivial impact on the probability of labor force participation. For our analysis we use the total number of conflict events in a LGA from 1997 until the year of the survey. Our argument is that these accumulated events provides institutional history and a rough measure of the stability of the LGA which could affect if an individual participates in the labor force. However we do not expect that history would directly affect the hours an individual will choose to work currently (hence its non inclusion in the outcome equation). [21]

While the Heckman selection model can attenuate issues of self selection bias, its limitations in addressing potential endogeneity issues and the difficulty in making the case that our exclusion restriction is valid leads us to our preferred estimation strategy, the fixed effects (FE) approach.[22] The FE model can be specified as follow

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[21]As an added check we test to see if this variable has an independent effect on hours of labor supply on the farm conditional on all the control variables we include in our outcome equation. The regression results provide no evidence of a significant relationship between the historic number of conflict events in a LGA and hours of labor supply in agriculture.

[22]The results from estimation shows a negative coefficient for the excluded variable but the coefficient was not statistically significant which casts doubt on its validity.

$$H_{ijt} = \beta_0 + \textbf{ConflictEXP}_{\textbf{jt}}\beta_1 + \textbf{x}_{\textbf{ijt}}\rho + \textbf{c}_{\textbf{ijt}}\beta_2 + \gamma_t + \delta_i + \psi_{zt} + \epsilon_{ijt} \qquad (1)$$

H_{ijt} is the total family hours of labor worked in household i in LGA j and year t. $\textbf{ConflictEXP}_{\textbf{jt}}$ is a measure of violent conflict in LGA j and year t. $\textbf{x}_{\textbf{ij}}$ is a vector of individual and household variable regressors that affect hours worked and $\textbf{c}_{\textbf{ij}}$ represents time varying local government area characteristics such as the rainfall levels, population density, nutrient availability in plots, temperature. δ are time-invariant household-specific effects that could be correlated with the observed covariates and also includes state fixed effects; γ_t are year fixed effects; ψ_{zt} are interactions of zone and year dummies to control for time-varying zone effects; ϵ_{ijt} is the idiosyncratic error term. β_1 is the parameter of interest to be estimated and captures the effect that exposure to conflict has on labor supply.[23]

Using panel data and a fixed effect strategy attenuates biases in coefficients, and increases the likelihood that estimated effects are consistent. The fixed effect approach accounts for time invariant characteristics of households that could be correlated with conflict and also correlated with our variable of interest- hours worked on farm. Hence biases emanating from household heterogeneity are attenuated with this method. While the fixed effect strategy cannot remove biases stemming from unobserved time varying household characteristics, we can attenuate this kind of bias by including as many time varying controls as possible in our analysis.[24]

It is useful to mention that reverse causality and simultaneity can hinder deriving consistent estimates even when a fixed effects strategy is used for estimating the effect of conflict. In the case of the question we are interested in, we do not worry as much

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[23]We include similar variables as controls in both our Heckman model and our fixed effect model.

[24]In every regression, we cluster the standard errors at the level of the household to allow household decisions to be correlated over time.

about reverse causality even though we cannot rule it out. In particular in both the questions we consider, we are looking at the effect of past conflict on current farm labor supply. It is harder to argue that an individual's current farm labor supply is causing a change or driving their past accumulated conflict exposure.

6   Data and Descriptive analysis

The socioeconomic data used in this study is the Nigeria General Household Survey (GHS). As noted on the World Bank's Central Microdata Catalog website, "the GHS is implemented in collaboration with the World Bank Living Standards Measurement Study (LSMS) team as part of the Integrated Surveys on Agriculture (ISA) program and was revised in 2010 to include a panel component (GHS-Panel)". [25] The survey was undertaken by the National Bureau of Statistics in partnership with the Federal Ministry of Agriculture and Rural Development(FMARD), the National Food Reserve Agency (NFRA), the Bill and Melinda Gates Foundation (BMGF) and the World Bank (WB).

All sampled households were administered a multi-topic household questionnaire. The questionnaire geo-references the dwelling's location and collects individual-disaggregated information on demographics, education, health, employment, anthropometrics, various income sources, housing, food and non-food consumption and expenditures, and asset ownership. There is also an agricultural questionnaire module with observations on geo-referenced plot locations and Global Positioning System (GPS)-based plot areas, plot-level information on input use, cultivation and production, (the household members that manage and/or own each plot, and individual-disaggregated labor input at the plot-level. The survey information is provided for post-planting/pre-

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[25]The World Bank in its description of the data also notes that the panel data survey was launched for tracking farm and rural households social economic changes over time.

harvest and the post-harvest outcomes. The GHS-Panel is a nationally representative survey of approximately 5,000 households, which is also representative of the geopolitical zones in Nigeria at both the urban and rural level. There are four waves currently of the panel (2010, 2012, 2015 and 2018) and we used the labor file questions in the agricultural and household modules. The labor file in the agricultural module which we used for the analysis of labor supply in terms of hours worked, provides information on the total hours of work supplied to farm work during harvest season. The file is disaggregated across hours of labor work for the household head, the spouse, the children and the relatives. To arrive at total hours of work supplied by farm families, we added hours of work supplied by each household member including the relatives. While the labor file in the agricultural module focused on the hours of labor supplied by farm families at the plot level and dis-aggregated across household members, the labor file in the household module focused on the different employment status of households without a clear demarcation of the hours worked across wage employment, farm employment and off farm employment particularly for Waves 1 and 2. We used the labor file in the agricultural module in analysing hours of labor supplied by agricultural households while we used the labor file in the household module in analysing labor participation of agricultural households.

Despite the availability of the four waves, we only made use of the first 3 waves in our analysis because of observed significant inconsistency in the labor file for wave 4 compared to the earlier waves of the survey. For example, in wave 4, the labor time is not disaggregated by household head, spouse, children and relative which was available in the first 3 waves and is of interest to us. In addition wave 4 does not provide information on labor time in weeks. In waves 1,2 and 3, the labor file has information on the number of weeks, days and hours of work, disaggregated by household head, spouse, children and relatives. These shortcomings in how the data

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Long Conflict Exposure
Events,1997-2018
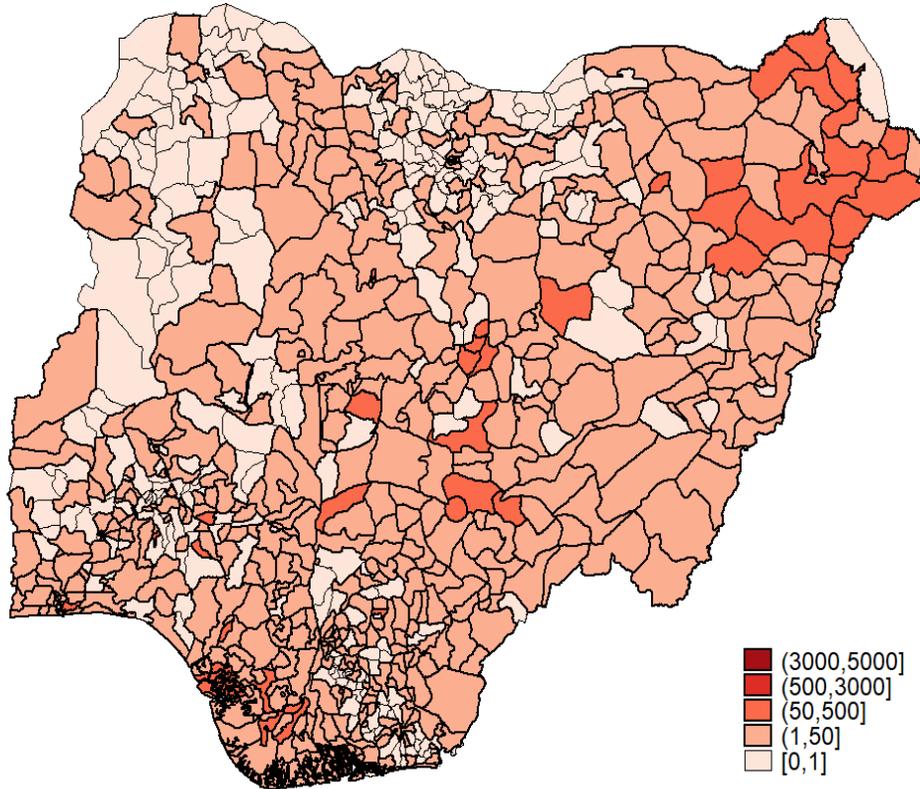
Figure 1: Conflict Events in Nigeria between 1997 and 2018

was collected in wave 4 makes it impossible to construct labor supply for household heads, spouse, children and relatives, in similar ways we were able to do so in the first 3 waves.

For our analysis, we derived total hours worked by household heads by combining hours worked on each plot. The hours worked on each plot is derived using information from the harvest survey. Information is collected on the number of hours worked on the plot, the number of days worked on the plot, the number of weeks worked in

the season on the plot. The data set also includes a number of specific household and individual characteristics which we include as controls.[26]

To measure conflict exposure, we turn to the Armed Conflict Location and Event Data (ACLED) by Raleigh, Hegre, and Carlson, (2009). This database focuses on a range of violent and non-violent actions by governments, rebels, militias, communal groups, political parties, rioters, protesters and civilians. It records event date, event type, location and conflict fatalities and covers period from 1997-2021 for all countries including Nigeria.[27] Following Odozi and Uwaifo Oyelere (2019) we use this data to construct two measures of conflict exposure using fatalities at the local government area level. We also create a conflict event measure using the ACLED data. This measure captures all the conflict events in a LGA. Figure 1 provides a map of accumulated conflict events in LGA in Nigeria from 1997-2018. We present this data visually in figure 1 to provide readers with a visual representation of the intensity and widespread nature of conflict events in Nigeria. Notice that most parts of Nigeria have experienced violent conflict events, and a fewer number of locations have had very high number of conflict events over time.

Figure 2 shows conflict events in different periods of time over 10 years. This evolution style map of conflict events shows that the number of conflict events have been increasing in different communities in Nigeria and the location of these events exhibit significant heterogeneity over time.[28]

While conflict events have been frequently used by many past researchers to

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[26]For our analysis we restricted our sample to household heads in agricultural households who participated in labor supply during the survey. We also restrict our analysis to the balanced panel of the sample.

[27]We only make use of data from 1997 to to 2016.

[28]While we present conflict events or fatalities up until 2018 in figures 1-4, we limit our analysis to the first 3 surveys. We are unable to use the more recent conflict data from 2016-2018 in our analysis because we do not include wave 4 of the household survey for reasons mentioned above.

proxy for conflict exposure, we do not follow this approach. We are interested in the intensity of impact which we argue is better captured by violence related fatalities. Hence for measuring recent exposure in our analysis, we consider the total number of conflict related fatalities in the local government in the year of the survey plus the two years preceding it. We choose to construct our recent measure as noted above because households' response to shocks such as violence related fatalities are not knee jerk and are too often delayed.In some cases, a farmer may choose to reduce labor on a plot not after one incidence of violence in the LGA but after a series, or after a long enough period of violence, or after observations in the next planting season which would affect labor supply during the next harvest season. To capture these potential nuances in how violent conflict exposure directly or indirectly can after decision making, we use conflict deaths over a wider range of time to measure recent intensity of exposure. For the long-term measure of conflict, we consider the total number of conflict related fatalities in the local government area in the year of the survey plus all other preceding year of available data (1997 to the year of the survey). We normalized these two measures using projected population figures for the local government for the respective survey years to better capture the intensity of exposure in a community. For example, 10 conflict related fatalities in a low population LGA is clearly going to have more impact than 10 fatalities in a high population LGA.[29]

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[29]We construct our conflict measures as percentages of the population in each LGA to better get at intensity of effect and also to ease interpretation.

Figure 3 provides a mapping of total violent fatalities in Nigeria from 1997-2018. This map provides extra support as to why we take the approach of estimating the average effect of violent conflict in Nigeria. Notice that a significant part of the country has been exposed to violent conflict as captured by fatalities in different parts of the country. Figure 3 also highlights that the zones with the most intense conflict exposure in Nigeria are the North East, the South South and the North Central parts of Nigeria. Figure 4 shows 4 maps of Nigeria designed to capture how conflict fatality has evolved over the 2008-2018 period. Notice over time that not only has the locations experiencing fatalities increased, the areas with the most intense conflict exposure in terms of fatalities have changed.

Figures 1-4 provide further support for our approach. We focus on estimating the overall effect of conflict in Nigeria given its wide spread prevalence rather than focus solely on the effect of particular conflicts on households exposed to it. Apart from the ACLED data, we also made use of information on rainfall and population density in our analysis. We obtained rainfall data from the Central Bank of Nigeria(CBN) annual statistics for 2016. Information on land surface area and population for each states were sourced from the National Population Commission.

7   Results

Tables 1 and 2 present summary statistics of the variables used in the regression analyses. In Table 2 we present summary statistics of some of our key dependent variables for the balanced and unbalanced panel data. Table 2 shows that 91% of farm household heads supplied labor in 2010 but this figure declined slightly in 2012 and 2015 respectively to 90% and 87%. Total labor hours supplied by household heads to harvest season farm work was on average 540.19 hours in 2010. This share

increased in 2012 to 556.06 hours but declined to 476.31 hours in 2015. We find a substantial decline in total hours of work for spouses and children across years. While spouses supplied 319.41 hours of labor in 2010, hours declined respectively to 299.30 hours and 266.28 hours in 2012 and 2015.

Table 1: Summary Statistics

Variables	2010 N= 5,009		2012 N= 4,807		2015 N= 4,622	
	Mean	SD	Mean	SD	Mean	SD
Prop labor force	0.91	0.28	0.90	0.30	0.87	0.34
Total hours worked (Head)	540.19	1736.10	556.06	2938.72	476.31	1169.58
Total hours worked (Spouse)	319.41	1053.79	299.30	909.89	266.28	752.13
Total hours worked (Children)	181.03	2271.06	138.34	538.87	129.80	599.01
Total hours worked (Relatives)	62.98	285.23	71.34	402.27	52.71	257.95
Total hours worked	1206.69	5616.96	1317.46	5428.83	1065.69	2683.21
Recent event per LGA	1.527	5.474	2.818	15.843	4.900	13.529
Long term event per LGA	4.389	14.442	6.033	23.361	12.021	39.934
Recent death per LGA pop(%)	0.002	0.013	0.005	0.022	0.013	0.049
Long term death per LGA pop(%)	0.011	0.054	0.012	0.047	0.025	0.079
Exposed to shock	0.30	0.46	0.41	0.49	0.30	0.46
Age in years	50.20	15.21	52.37	14.90	53.01	14.55
Age squared	2751.16	1653.92	2964.45	1681.81	3021.44	1633.51
Years of schooling	6.81	5.64	6.74	5.79	7.21	5.81
Household size	5.84	3.02	6.31	3.11	7.02	3.46
Distance to major road (Km)	7.99	12.19	7.80	11.81	7.63	11.66
Distance to pop center(Km)	19.40	17.61	18.96	17.59	18.85	17.70
Distance to market (Km)	62.85	44.39	63.39	44.97	62.88	45.32
Distance to border post (Km)	294.77	181.24	292.46	180.07	292.19	180.99
Distance to Administrative center(Km)	58.99	52.21	57.81	51.54	56.63	51.21
Annual mean temperature	263.42	9.59	263.44	9.58	263.42	9.45
Annual precipitation(mm)	1471.40	633.01	1475.05	627.56	1486.46	626.58
Nutrient availability	1.95	0.95	1.93	0.93	1.95	0.97
Total rainfall(average 12 months)	1283.68	412.87	1285.35	409.36	1292.24	405.55
Population density	304.28	343.58	319.43	362.25	344.40	392.71
Farm daily wage(Male)	1904.86	4915.74	1980.19	4633.89	1936.15	4467.16

Recent Conflict Exposure
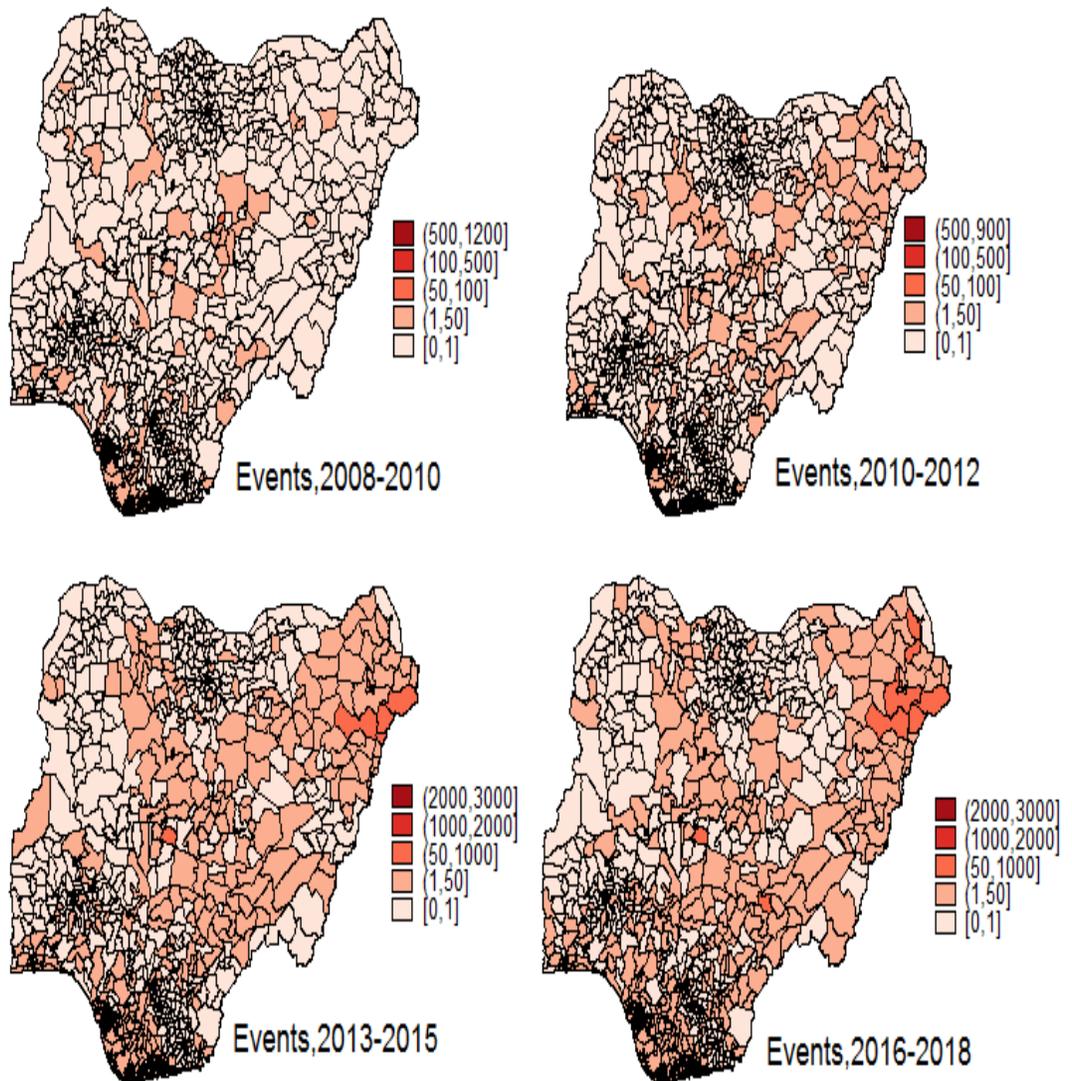
Figure 2: Evolution of Conflict Event in Nigeria 1997-2018

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Long Conflict Exposure
Fatalities,1997-2018

(3000,5000]
(500,3000]
(50,500]
(1,50]
[0,1]
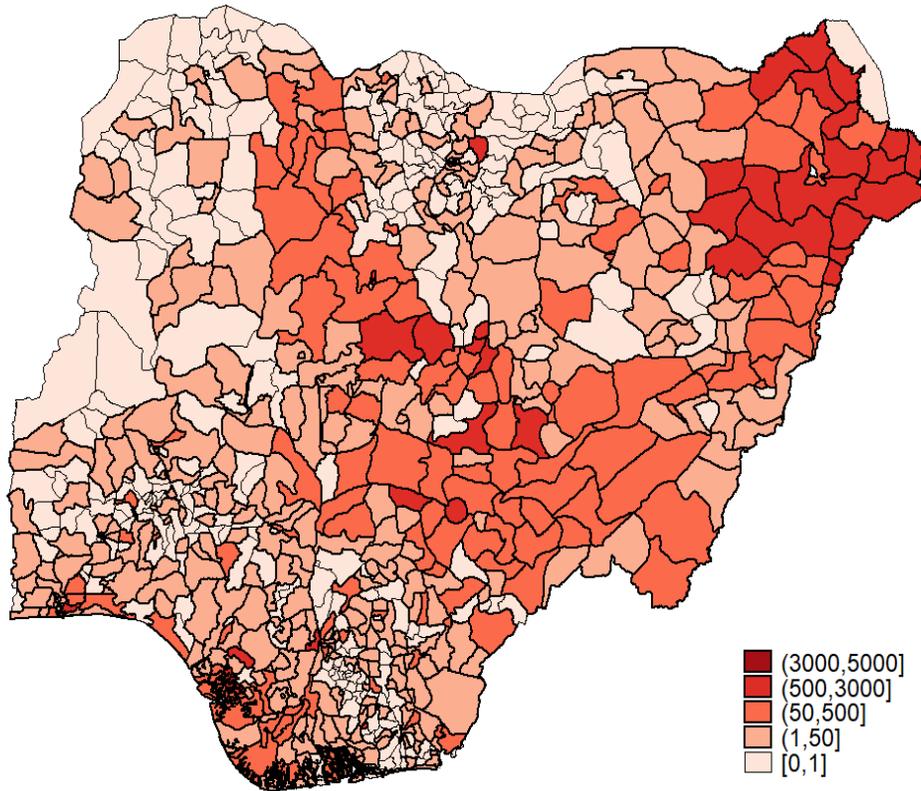
Figure 3: Conflict Fatalities in Nigeria between 1997 and 2018

Recent Conflict Exposure
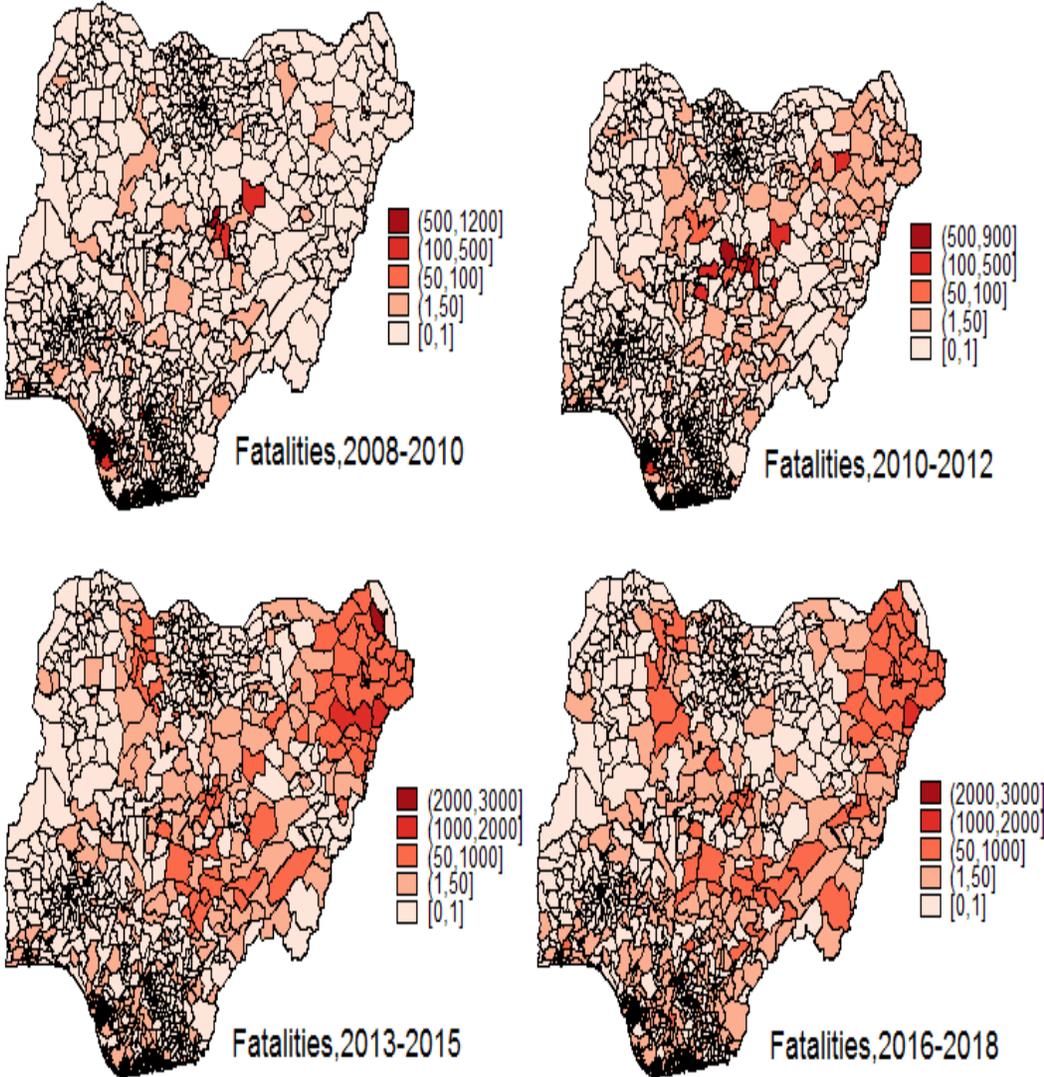
Figure 4: Evolution of Conflict Fatalities in Nigeria 1997-2018

Table 2: Summary Statistics Additional Variables

Variables	2010 (N= 4,137)		2012 (N= 4,132)		2015 (N= 4,054)	
	Mean	SD	Mean	SD	Mean	SD
BALANCED PANEL						
Prop labour force	0.91	0.28	0.90	0.30	0.88	0.33
Total hours worked(Head)	541.75	1739.77	558.57	2954.04	477.88	1174.46
Total hours worked(Spouse)	319.78	1055.75	301.42	914.39	271.53	766.96
Total hours worked(Children)	181.38	2276.10	139.56	541.55	133.99	613.78
Total hours worked(Relatives)	62.92	285.21	71.88	404.34	54.51	262.80
Total hours worked	1156.18	4709.72	1332.30	5671.86	1089.92	2751.85
	(N= 5,009)		(N= 4,807)		(N= 4,622)	
Variables	Mean	SD	Mean	SD	Mean	SD
UNBALANCED PANEL						
Prop labour force	0.91	0.28	0.90	0.30	0.87	0.34
Total hours worked(Head)	540.19	1736.10	556.06	2938.72	476.31	1169.58
Total hours worked(Spouse)	319.41	1053.79	299.30	909.89	266.28	752.13
Total hours worked(Children)	181.03	2271.06	138.34	538.87	129.80	599.01
Total hours worked(Relatives)	62.98	285.23	71.34	402.27	52.71	257.95
Total hours worked	1206.69	5616.96	1317.46	5428.83	1065.69	2683.21

Table 1 also shows that on average, conflict exposure increased from 2010 to 2015. An interesting observation from Table 1 is the percentage of households that are exposed to idiosyncratic shocks in the past year. This share increased between 2010 and 2012 but decreased to its 2010 levels by 2015.

The results of our baseline model (Heckman selection) can be found in Tables 5 and 6 of the appendix of the paper. In Table 5, we focus on the effect of recent violent conflict exposure on hours worked for farm households while in Table 6, we summarize the results focused on the effects on labor supply of accumulated long term conflict exposure. Part A of these tables presents results for select variables from the participation equation and part B summarizes select results for the main outcome

equation. In columns (1) of both tables we present the result for the household head. In columns (2) we present the results for spouse hours, column (3) children, column (4) relatives. In column (5) the result for the total hours worked for the entire household is presented.[30]

As we earlier noted in our empirical section, we include accumulated conflict events in an LGA from 1997 to the survey year in our participation equation but we exclude it from our outcome equation. We tested to see if this variable does not affect hours of labor supplied conditional on other control variables, and we noted no significant impact on household head's labor supply. However we still worry about the estimated effects from this model because the excluded variable though negative is not statistical significant in our selection equation in both Tables 5 and 6. This finding casts doubt on the validity of this exclusion restriction since the variable should have a nontrivial impact on the probability of selection. Furthermore, the Wald test of the independence of equations suggests that using a Heckman selection model may not be necessary as we fail to reject the hypothesis that $\rho = 0$ in all but one sub sample (relatives). Hence, the hypothesis that the two equations are independent cannot be rejected. Given the aforementioned limitations, we review the Heckman results with caution as these estimates could be biased and not consistent.

The results from the outcome equation in Tables 5 and 6 part B column (5) suggest that an increase in exposure to conflict is negatively correlated with hours of farm family labor supplied. To get at potential heterogeneity within the household in this effect, we focus on the results summarised in columns (1)- (4). These results suggest that an increase in exposure to conflict is correlated with a statistically significant decline in the hours the household head worked on the farm. We do not note any significant effects for hours worked by spouse, children and relatives.

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[30]This includes household head, spouse, children and relatives.

Table 3. The Effect of Violent Conflict on Family Total Labour Supply During Harvest Season

	(1) Recent Conflict b/se	(2) Long Conflict b/se
Conflict recent death as % of LGA		-2067.368*
		(1099.191)
Conflict long term death as % of LGA	-1864.661***	
	(702.282)	
Exposed to shock	-100.119	-99.807
	(167.526)	(167.442)
Age	35.702	34.181
	(40.102)	(40.108)
Age^2	-0.111	-0.100
	(0.412)	(0.412)
Years of Schooling	-31.768	-31.803
	(26.623)	(26.637)
Household size	-4.918	-7.486
	(41.720)	(41.910)
Pop Density	-0.190	-0.169
	(1.026)	(1.027)
Value of land self-reported by households	0.000*	0.000*
	(0.000)	(0.000)
Distance to major road	-0.590	-0.594
	(3.097)	(3.101)
Distance to population center	-1.586	-1.530
	(2.853)	(2.851)
Distance to market	44.830	46.112
	(36.229)	(36.258)
Distance to border post	-3.357	-3.334
	(2.952)	(2.952)
Distance to administrative centerr	0.576	0.507
	(3.047)	(3.042)
Annual mean temperature	-12.559	-11.778
	(25.460)	(25.449)
Annual mean precipitation	4.810	4.864
	(4.173)	(4.181)
Nutrient availability	-41.534	-38.112
	(193.786)	(193.165)
Total rainfall	-2.681	-2.668
	(3.207)	(3.205)
Farm daily wage(Men)	0.021***	0.021***
	(0.008)	(0.008)
Constant	-1946.915	-2298.459
	(6844.162)	(6863.564)
R^2	0.012	0.012
N	7654.000	7654.000

Note:Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For a description of the variables, see Table 1. The following variable estimates are not shown:time fixed effect, zone fixed effect, zone and time interaction variables. Also the health variables are not shown(suffered from illness/injury, admitted in hospital or health facility).

In Tables 3 and 4 we present the labor supply estimates using our fixed effects (FE) model which is our preferred empirical strategy. As noted in the empirical section of the paper, the FE model controls for time invariant unobservable household-level characteristics, which attenuates bias in estimated effects of conflict on labor supply (hours worked). To further reduce potential bias linked with time varying unobservables correlated with our conflict measure and farm labor supply, we include several controls. In particular, we include in our analysis several time varying controls such as idiosyncratic shocks, health related variables, controls for time varying social characteristics of the LGA, precipitation, average farm wages and population density. We also include year and zone fixed effects and zone and year interactions.

In Table 3 we present the results for total hours worked for the entire family on plots in the harvest season. In column (1) of Table 3 we present the results using the recent conflict measure and in column (2) we present the results using the long term measure of conflict. The results suggests a significant negative effect of conflict exposure on total hours of labor on the farm for a family. The results of the test for heterogeneity across family members is summarized in Table 4. In Column (1) of Table 4 we present the results for the model with hours worked by household head as the dependent variable. In column (2) the dependent variable is hour worked by spouse. In column (3) the dependent variable is hours worked by children and in column (4) the dependent variable is hours worked by relatives. In Panel A we present the relevant estimates using the recent exposure to conflict measure and in Panel B we present the estimates using the long term accumulated exposure to conflict measure. The results summarized in Table 4 suggest that exposure to conflict (recent or over a long time), reduces hours worked significantly for household heads. We do not find any significant effect on labor of spouse, children or relatives. Given this finding, it is reasonable to infer that the noted decline in total farm labor supply

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of households is driven by a decline in the labor supply of household heads.

Comparing our preferred estimates with our baseline model (Heckman) we notice that the estimates using the Heckman model are mostly consistent in inference with the results from our preferred model (fixed effects). In particular, for families' total labor supply, our fixed effects model suggests significant negative effects of both recent and long term conflict exposure. In contrast with the Heckman model, we only find significant negative effects on total family labor supply using the long term measure. For household heads, both model estimates suggest that exposure to conflict (recent or over a long time), reduces hours supplied on the farm significantly. For hours worked by children and spouse, both methods do not find evidence of significant negative effects of recent or longer term exposure to conflict. For hours supplied on farm by relatives, we also note no significant effects using our preferred method. However the estimates using the baseline model suggests a significant negative correlation with the longer term exposure measure but not using the recent exposure measure.

It is worth noting that our results are in contrast with Adelaja and George(2019a) who do not find a significant effect of the Boko Haram conflict on total family hours supplied. In contrast, we find significant negative effects of both recent and longer term violent conflict exposure, on total family hours supplied using our preferred estimation method. It is important to note that the aforementioned paper focused solely on the Boko Haram conflict while we focus on any violent conflict in Nigeria from 1997-2015. This could explain the differences in our findings. Also Adelaja and George(2019a) measures conflict exposure using conflict event which we do not use. Our argument for not using conflict event count as a measure of conflict exposure is that it may not be as effective for capturing intensity of exposure. A conflict event in a LGA where there is violence or riots but no deaths is different in impact from

Table 4. The Effect of Violent Conflict on Total Hours of Labour Supply During Harvest Season

	(FIXED EFFECT MODEL)			
	(1)	(2)	(3)	(4)
	Head	Spouse	Children	Relatives
	b/se	b/se	b/se	b/se
Panel A	RECENT CONFLICT EFFECT)			
Conflict recent term death as % of LGA	-726.877*	-620.820*	-186.067	-276.045
	(384.556)	(372.788)	(270.542)	(215.127)
Exposed to shock	-134.751	18.030	28.870	8.753
	(154.505)	(23.420)	(18.239)	(9.715)
age	10.923	26.586**	5.917	0.112
	(28.514)	(11.730)	(7.101)	(2.959)
Age^2	0.046	-0.186**	-0.046	-0.016
	(0.330)	(0.094)	(0.058)	(0.024)
Years of Schooling	-34.352	-0.290	0.098	2.233
	(24.455)	(4.064)	(2.730)	(1.919)
Household size	9.678	-21.893	7.138	3.122
	(20.058)	(21.910)	(8.919)	(4.779)
Farm daily wage(Men)	0.012***	0.003	0.001	0.002*
	(0.003)	(0.003)	(0.002)	(0.001)
Constant	-1507.713	512.049	-1980.731	-686.068
	(4708.136)	(2973.082)	(1287.902)	(711.996)
R^2	0.007	0.005	0.003	0.008
N	7654	7654	7654	7654
Panel B	LONG CONFLICT EFFECT			
Conflict long term death as % of LGA	-696.232*	-604.697	-169.257	-162.858*
	(403.948)	(394.992)	(114.719)	(87.186)
Exposed to shock	-134.893	17.918	28.826	8.614
	(154.581)	(23.414)	(18.255)	(9.759)
Suffered from illness or injury	-10.408	-58.732	-8.091	-5.355
	(52.898)	(39.774)	(23.650)	(11.964)
Admitted in hospital or health facility	151.498	67.318	-38.284	-38.017
	(105.591)	(70.616)	(50.644)	(26.901)
Age	11.420	27.021**	6.035	0.190
	(28.575)	(11.812)	(7.111)	(2.962)
Age^2	0.043	-0.189**	-0.047	-0.017
	(0.330)	(0.095)	(0.058)	(0.024)
Years of Schooling	-34.347	-0.287	0.101	2.250
	(24.447)	(4.062)	(2.728)	(1.921)
Household size	10.633	-21.065	7.372	3.363
	(20.018)	(21.554)	(8.927)	(4.764)
Farm daily wage(Men)	0.012***	0.003	0.001	0.002*
	(0.003)	(0.003)	(0.002)	(0.001)
Constant	-1385.718	616.081	-1949.357	-638.094
	(4696.596)	(2995.034)	(1280.877)	(709.887)
R^2	0.007	0.005	0.003	0.008
N	7654	7654	7654	7654

se statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: For a description of the variables, see Table 1. The following variable estimates are not shown:time fixed effect, zone fixed effect, zone and time interaction variables, Distance to major road, Distance to pop center, Distance to market. Distance to border post. Distance to Administrative center, Annual mean temperature, Annual precipitation, Nutrient availability, Total rainfall and Population density.Also the health variables are not shown(suffered from illness/injury, admitted in hospital or health facility).

a conflict event in an LGA that leads to multiple fatalities. This is why we measure conflict exposure using deaths via armed conflict and to further get at intensity we normalized fatalities with the LGA population.

How can we interpret the results in Tables 3 and 4? For total family labor supply, our results summarized in Table 3 suggest that a 0.01% point increase in recent conflict exposure leads to a decrease of approximately 20.7 hours of total family farm labor supply. While the accumulated impact of past conflict exposure is approximately 18.6 hours decrease. These are significant impacts of conflict. Moreover some states in the North Eastern part of Nigeria and the North Central parts of Nigeria have experienced conflict increases far greater than this. For example between 2012 and 2015 the mean recent conflict exposure increase in the North Eastern part of Nigeria was 0.043. This significant increase was linked primarily with the Boko Haram insurgence. If we calculate what such an increase in conflict will lead to using our FE model estimates, we find that a 0.043% point increase in recent exposure suggests approximately 88.9 hours decline in total family farm labor supply. A decline of such magnitude in labor supply for farm households is substantial.

Our findings suggest heterogeneity in effect across household members with significant effects solely for household heads. For household heads the results in Table 4 suggest that a 0.01% point increase in recent exposure to conflict leads to an approximate decrease of 7.3 hours worked in the harvest season. Similarly, a 0.01% increase in accumulated long-term exposure to conflict leads to approximately 7 hours decrease in labor supplied in the harvest season by the household head. These are also significant impacts of conflict. Again if we consider the mean change in conflict exposure in the North Eastern zone between 2012 and 2015 and do similar calculations, a 0.043% point increase in recent conflict exposure reduces farm hours by household

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head by 31.3. This decline in labor supply is also significant.[31]

8   Summary and Conclusion

In this paper we examine the average impact of conflict in Nigeria on farm labor supply of agricultural households. We focus on two related questions: first, does recent exposure to violent conflict affect total family labor hours and is there heterogeneity in effect on the number of hours worked by the household head, spouse, children and relatives? Second, is there evidence that long term accumulated exposure to conflict affects total family labor hours supplied and is there heterogeneity in effect on the number of hours worked by the household head, spouse, children and relatives? We attempt to answer these questions combining household survey panel data for Nigeria with ACLED data, exploiting a fixed effect estimation strategy.

Our results suggest that conflict negatively affects total farm labor supply of a family. We also note heterogeneity in this effect across household members. In particular, we find that violent conflict leads to a decline in the farm labor supply of the household head but we do not find any significant negative effects on labor supply of children, spouse and relatives. Simple back of the envelope calculations based on our estimates suggest that the impact on farm household labor supply could be severe in magnitude in areas with sudden spikes in violent conflict. For example the Boko Haram crises in the North Eastern region of Nigeria, the farmers-herdsmen conflict in the North Central region of Nigeria and the current crises in southern Kaduna. Finding significant negative effects of conflict on total family labor supply is new given Adelaja and George(2019a) do not find significant effects of the Boko Haram conflict on family labor supply. While both papers use similar methodology,

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[31]If we assume a 40 hour week, the estimated decline is nearly a week less of labor supply on average.

our analysis differs from theirs in many ways. First, we look at the effect of any recent conflict in Nigeria (focused on exposure to conflict in the last 3 years) while they consider only one year. In addition, we focus on the average treatment effect of any type of violent conflict while they focus on the effect of Boko Haram. Finally, we measure exposure to conflict using fatalities normalized with population in LGA while they focus on conflict events count.

Odozi and Uwaifo Oyelere (2019) provide evidence of the negative impact of violent conflict on income, poverty incidence, poverty severity and poverty depth in Nigeria. The results in our paper provide one possible pathway for their findings. In particular, if agricultural households affected by violent conflict are forced to decrease their labor hours worked, then assuming no substitution to other activities, their incomes will decline, and the probability they slip into poverty will increase.

It is important to mention one caveat when using ACLED fatality data. In particular, the collectors of the ACLED dataset are very careful in attributing any death to being linked to armed conflict. Many deaths that could have been caused by armed conflict may not have been included in the data if there was uncertainty and lack of clear information on if the death was caused by armed conflict or other factors. This limitation in the reporting of deaths by armed conflict in ACLED data can create potential downward bias in the estimated effects. Hence the actual effect on hours worked could be greater.

While our paper provides answers to the question we focused on, there are still so many unanswered questions related to conflict in Nigeria that are relevant but we are unable to address in our paper for a number of reasons including data limitation and paper scope. We hope to explore some of these questions in future work. In particular the question of if small holder farmers are making labor substitution from agriculture to some other labor market activities or if instead they are simply reducing

overall hours of labor. We hypothesize the latter based on Odozi and Oyelere (2019) which suggests decline in welfare on average linked to conflict. However concrete analysis to confirm our prior is one area of potential future work. Also, exploring the pathways through which conflict affects labor supply is important. We discuss potential pathways in our paper but we are not able to identify which pathway is at work in our survey period. While we can hypothesize the more important pathways using prima facie evidence, the limitations of the LSMS data makes it impossible to provide concrete answers to the exact channels or pathways. Another potential extension to our paper is to test for heterogeneity in the effect of conflict on labor supply based on type of conflict.

Finally, it is worth noting that while the FE model mitigates biases in estimated effects, it does not deal with possible time varying unobservables that could be correlated with our measures of conflict, and also correlated with our dependent variable. Such variables if they exist can confound estimated causal effects. We attenuate this possible source of bias by including as many time varying controls in our regression analysis as are available in our data. Two important control groups we include are controls for idiosyncratic shocks and controls for economic, weather and social conditions in the LGA. However, despite these aforementioned controls and others we include, we do not claim we completely eliminate the potential for this source of bias.

As stated at the beginning of this paper, a good portion of Nigeria's labor force is employed in agriculture and it still remains the largest sector of the Nigerian economy. The agricultural sector is particularly vulnerable to violent conflict and investigating the impact of conflict in this sector is necessary. Given the significant lingering negative effect of conflict on agricultural labor supply noted in our paper, there is need for Nigeria's leadership to do more to curb the growth of violent conflict

in Nigeria. This is a social justice issue as rural vulnerable agricultural households bare disproportionately the welfare and labor supply effects of violent conflict.

Designing policies in Nigeria aimed at alleviating both the short and longer term micro and macro effects of reductions in labor supply in agriculture is paramount. As policy design can be challenging, partnerships between academics and policy makers aimed at creating policy alternatives, and testing their effectiveness is one potential strategy the Nigerian governments may consider to facilitate effective targeted policy initiatives.

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Appendix

Table 5. The Effect of Recent Violent Conflict on Total Hours of Labor Supply During Harvest Season(Heckman Model)

	(1)	(2)	(3)	(4)	(5)
	Head	Spouse	Children	Relatives	Family
	b/se	b/se	b/se	b/se	b/se
Panel A			Participation Equation		
Recent Conflict death as % of LGA	1.021	0.958	0.523	1.040	1.023
	(1.483)	(1.425)	(24.924)	(1.488)	(1.484)
Accumulated conflict events	-0.003	-0.003	-0.004	-0.003	-0.003
	(0.004)	(0.002)	(0.177)	(0.004)	(0.004)
Exposed to Shock	-0.222***	-0.231***	-0.217	-0.221***	-0.222***
	(0.066)	(0.072)	(12.330)	(0.066)	(0.066)
Suffered from illness or injury	-0.271***	-0.259**	-0.260	-0.271***	-0.271***
	(0.093)	(0.102)	(8.946)	(0.093)	(0.093)
Admitted in hospital or health facility	-0.519***	-0.406***	-0.378	-0.519***	-0.519***
	(0.117)	(0.098)	(16.988)	(0.117)	(0.117)
Age in completed years	0.057***	0.058***	0.058	0.057***	0.057***
	(0.015)	(0.021)	(6.304)	(0.015)	(0.015)
age^2	-0.001***	-0.001***	-0.001	-0.001***	-0.001***
	(0.000)	(0.000)	(0.063)	(0.000)	(0.000)
Years of School	-0.004	-0.018**	-0.024	-0.004	-0.004
	(0.008)	(0.008)	(0.982)	(0.008)	(0.008)
Farm daily wage(Men)	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.223	-0.255	-0.273	-0.239	-0.223
	(1.717)	(1.980)	(87.781)	(1.717)	(1.717)
Panel B			Hours Supplied Equation		
	Head	Spouse	Children	Relatives	Family
Recent Conflict death as % of LGA	-1134.419**	-5.206	29.413	130.241	-1047.835
	(499.791)	(694.357)	(3312.911)	(146.300)	(1120.367)
Exposed to Shock	-11.338	-43.188*	12.001	0.643	-0.872
	(51.564)	(23.465)	(368.104)	(8.493)	(96.367)
Suffered from illness or injury	-103.231	-94.609***	-68.414	0.039	-197.198
	(86.341)	(35.468)	(266.803)	(12.549)	(121.596)
Admitted in hospital or health facility	109.291	-50.629	-202.317	15.594	202.846
	(116.321)	(62.202)	(1099.617)	(22.475)	(179.935)
Age in completed years	-5.841	9.803	10.694	2.973**	15.398
	(12.231)	(7.467)	(.)	(1.472)	(15.891)
age^2	0.061	-0.087	-0.121	-0.018	-0.090
	(0.137)	(0.075)	(1.401)	(0.014)	(0.169)
Years of School	-17.080**	1.838	-3.271	-1.200	-25.736**
	(7.709)	(2.898)	(154.676)	(0.738)	(11.106)
Farm daily wage(Men)	0.011***	0.004*	0.000	0.002	0.015**
	(0.003)	(0.002)	(0.006)	(0.001)	(0.007)
Constant	2126.798	-738.832	-1186.960	-408.752*	-111.235
	(1336.212)	(621.212)	(7366.368)	(217.415)	(1943.199)
ρ	-0.003	2.072	1.842	-0.021*	-0.005
	(0.004)	NC	(77.661)	(0.011)	(0.009)
chi^2	876.442	775.385	.	316.829	904.842
N	7631	7631	7631	7631	7631

se Robust standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: For a description of the variables, see Table 1. The following variable included in the analysis are not shown in the table: time and zone interaction variables, Distance to major road, Distance to pop center, Distance to market. Distance to border post. Distance to administrative center, Annual mean temperature,Annual precipitation, Nutrient availability, Total rainfall and Population density. NC-Non convergence.

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Table 6. The Effect of Long Violent Conflict on Total Hours of Labour Supply During Harvest Season(Heckman Model)

	(1)	(2)	(3)	(4)	(5)
			(HECKMAN MODEL)		
	Head	Spouse	Children	Relatives	Family
	b/se	b/se	b/se	b/se	b/se
Panel A			Participation Equation		
Longterm Conflict death per LGA pop(%)	1.908	1.818	1.436	1.918	1.909
	(1.546)	(1.548)	(6.614)	(1.545)	(1.546)
Accumulated conflict events	-0.007	-0.008**	-0.009	-0.007	-0.007
	(0.005)	(0.004)	(0.030)	(0.005)	(0.005)
Exposed to Shock	-0.223***	-0.233***	-0.217	-0.222***	-0.223***
	(0.066)	(0.075)	(0.899)	(0.066)	(0.066)
Suffered from illness or injury	-0.273***	-0.260**	-0.260	-0.273***	-0.273***
	(0.093)	(0.111)	(0.675)	(0.093)	(0.093)
Admitted in hospital or health facility	-0.519***	-0.414***	-0.365	-0.520***	-0.519***
	(0.117)	(0.102)	(1.047)	(0.117)	(0.117)
Age in completed years	0.057***	0.057***	0.057	0.057***	0.057***
	(0.015)	(0.022)	(0.352)	(0.015)	(0.015)
Age^2	-0.001***	-0.001***	-0.001	-0.001***	-0.001***
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)
Years of School	-0.004	-0.018**	-0.027	-0.004	-0.004
	(0.008)	(0.009)	(0.079)	(0.008)	(0.008)
Farm daily wage(Men)	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.008	-0.022	-0.044	-0.005	0.008
	(1.714)	(2.259)	(2.964)	(1.714)	(1.714)
Panel B			Hours Supplied Equation		
	Head	Spouse	Children	Relatives	Family
Longterm Conflict death per LGA pop(%)	-707.680**	-238.730	-271.696	-8.306	-1351.018**
	(299.675)	(230.760)	(282.775)	(74.769)	(659.778)
Exposed to Shock	-11.005	-42.647*	11.130	0.892	1.658
	(51.675)	(23.535)	(48.124)	(8.500)	(97.204)
Suffered from illness or injury	-104.662	-96.752***	-72.701	-0.053	-200.566*
	(86.222)	(35.765)	(49.966)	(12.526)	(121.848)
Admitted in hospital or health facility	112.461	-49.718	-218.177*	15.649	208.983
	(116.630)	(62.449)	(116.610)	(22.469)	(180.053)
Age in completed years	-5.604	9.796	10.543	2.962**	15.760
	(12.276)	(7.560)	(111.722)	(1.475)	(15.944)
Age^2	0.059	-0.087	-0.123	-0.017	-0.092
	(0.137)	(0.075)	(1.103)	(0.014)	(0.170)
Years of School	-17.147**	1.930	-2.641	-1.189	-25.769**
	(7.695)	(2.929)	(11.855)	(0.735)	(11.086)
Farm daily wage(Men)	0.011***	0.004*	0.001	0.002	0.015**
	(0.003)	(0.002)	(0.002)	(0.001)	(0.007)
Constant	2026.219	-735.198	-1175.770	-395.449*	-190.856
	(1344.571)	(652.154)	(2381.445)	(217.471)	(1960.295)
ρ	-0.003	2.158	1.886	-0.022*	-0.005
	(0.004)	NC	(5.542)	(0.011)	(0.008)
chi^2	868.777	776.813	366.830	316.402	898.417
N	7631	7631	7631	7631	7631

se Robust standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: For a description of the variables, see Table 1. The following variable included in the analysis are not shown in the table: time and zone interaction variables, Distance to major road, Distance to pop center, Distance to market. Distance to border post. Distance to administrative center, Annual mean temperature,Annual precipitation, Nutrient availability, Total rainfall and Population density. NC- Non convergence