Violent Conflict, Transport Costs, and Poverty: An Instrumental Variables Approach with Geospatial Data for Nigeria

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Abstract

The nexus of conflict, transportation costs, and poverty is one which has received scant attention in the literature. This paper explores the effect of conflict on poverty in Nigeria, taking accessibility into account. The analysis relies on household data from the Living Standards Measurement Study (LSMS) and on conflict data from Armed Conflict Location Events Dataset (ACLED). To account for methodological challenges in the conflict data, we implement a 'hot spot' strategy whereby incidents within a limited geographic area over time are grouped. To address the potential endogeneity of conflict, we use past incidences of violence to instrument for more recent conflict. Transport costs are instrumented using the natural path, the time it takes to reach the market absent any roads. We find that decreasing transportation costs decreases multidimensional poverty and that its impact is stronger in areas of low conflict. We also find suggestive evidence that conflict and poverty are negatively correlated in Nigeria.

Keywords: Multi-dimensional poverty, conflict, Nigeria, geospatial
JEL Codes: O1, I3, L9

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1. Introduction

The relationship between poverty and conflict is complicated. As Blattman and Miguel (2010) note, wading into the vast literature on internal conflict, "one feels caught in a complex web of root and proximate causes (not to mention endogeneity)." (p. 9) Domestic conflict is more likely to occur in countries that are poor, have negative income shocks, have weak institutions, have sparsely populated peripheral regions, and mountainous terrain (Blattman and Miguel 2010). Teasing out the direction of causation in this tangled web of factors is challenging. Conflict influences poverty and vice versa. As Collier and Hoeffler (1998; 2004) point out, while grievances are universal, economic incentives to rebel are not. A better understanding of the link between poverty and conflict is important for designing policies aimed at fighting both.

To better understand this conflict-poverty relationship, we turn to Nigeria. Nigeria is an informative case study, with its mountainous terrain in the north-east, its oil reserves in the south, and its vulnerability to commodity price shocks. Nigeria has long struggled with internal conflict, most recently with the Boko Haram insurgency in the north. As a result of its size and importance, anything that happens in Nigeria resonates across the continent and can even have global repercussions.

In this paper, we focus on the impact of conflict on multidimensional poverty and pay special attention to the role played by transportation costs. By focusing on multidimensional poverty, we capture the impacts of conflict beyond monetary income, namely on education, health, and standards of living. We focus on transportation costs as they are a crucial factor

influencing poverty and conflict. Good roads facilitate economic commerce but also violent raids.

Analytically, one can distinguish between the direct and the indirect effects of violent conflict on wellbeing. The former consists of the loss of household members' lives, property and livestock, as well as the destruction of infrastructure such as schools, health centers, and irrigation systems. Even when a particular household is spared from such direct effects, it may be affected by indirect, or community-wide effects such as price increases, scarcity of food, the absence of medicines or qualified health personal, the closure of banks, to name a few. In extreme cases this may lead households to turn to subsistence farming, which undermines economic growth.

Our analysis relies on household data from the Living Standards Measurement Study – Integrated Survey of Agriculture (LSMS-ISA) and on conflict data from Armed Conflict Location Events Dataset (ACLED). To account for methodological challenges in the conflict data, the team implements a 'hot spot'—kernel density estimation—strategy whereby incidents within a limited geographic area over time are grouped. To mitigate the endogeneity of conflict, we use past violence to instrument for more recent incidences of conflict. We instrument for transport costs with the natural path, the time it would take to walk to the market in the absence of any roads. To minimize the threat of omitted variables bias, a rich assortment of covariates including distance to roads, rain level, temperatures, and other geographic and spatial variables are included.

We find compelling evidence that transport costs are positively related to poverty. Decreasing transport costs by 10%, would decrease the probability of being multidimensionally poor by roughly 1%. This finding is statistically significant, robust, and

consistent with the wider literature (see section 2). Decomposing the poverty index into its three components, we find that transportation costs are positively related to both education and standard of living. The impact on health is less robust. Splitting the sample into areas of high and low conflict, we find that transportation costs have a stronger impact where there's little to no conflict.

The relationship between poverty and conflict is less clear. We find suggestive evidence that conflict is negatively correlated with poverty in Nigeria. The sign on conflict is almost consistently negative, but its level of significance varies depending on which IV we use for conflict. This is counterintuitive as one would expect the relationship to go in the other direction. Though surprising, this result is not unheard of. Conflict undermines economic growth, but can also lead to an accumulation of wealth through a "war economy," i.e. all economic activities that are carried out during wartime (Mokose and Solomon 2016). For example, arms trading, theft, bribery, and trade in contraband to finance the fighting. As Fearon (2005) argues, when there is more wealth to loot, there is more to be gained from fighting. This is especially true when coupled with weak institutions.

The remainder of the paper is structured as follows: Section 2 reviews the related literature and the situation in Nigeria. Section 3 presents our empirical approach, discusses our data sources and descriptive analysis. Section 4 discusses our identification strategy, Section 5 presents our empirical results, and Section 6 concludes.

2. Background

Related Literature on poverty, transportation cost, and violent conflict

Our research relates to two strands of literature, namely the impacts which transport cost and conflict have on poverty. Here, a selection of the most relevant examples is briefly discussed.

Perhaps the closest precursor to our paper is Ali et al (2015) which examines the impact of transport infrastructure on household welfare in the conflict-prone environment of the Democratic Republic of Congo (DRC). Specifically, the authors estimate the impacts of transport cost and conflict on a multidimensional poverty index, among other indicators of wellbeing. The results suggest that in areas of low conflict, reducing transport costs increases measures of wellbeing. However, in areas of high conflict the reduction of transport costs may have perverse affects by facilitating the movement of violent groups. This finding resonates with a statement of the late kleptocrat of Zaire (present-day DRC), Mobutu Seso Seko, who in a conversation with Juvenal Habyarimana, ruler of Rwanda at the start of the civil war (1990), famously said "Your problem is that you built roads. They are coming down those roads to get you." (Orvis and Drogus, 2014, p. 408).

There is a wide literature on the effects of transport on welfare. For a concise summary of transport policies in developing countries, see Berg et al (2017). Better transport infrastructure reduces the cost of reaching markets, thus decreasing interregional price gaps (Donaldson, 2018; Casaburi et al 2013) and thereby affecting input and output prices for agricultural products (Minten and Kyle 1999). In Uganda, Kyeyamwa et al (2008) find that high transport costs deter farmers from selling their cattle in local markets. In rural Kenya, land devoted to cash crops is typically located close to markets (Omano 1998). In China,

better roads to domestic and international markets improve per capita consumption for the rural poor (Emran and Hou 2013), a finding corroborated for Nepal by Jacoby (2000). The presence of good governance in the transport sector and its collorary, the extent of corruption, can have an important effect on transport costs. Olken and Barron (2009) demonstrated this in the context of Aceh, Indonesia where on average drivers spent about US$40 per trip, or about 13 percent of the total cost of a trip, on bribes, extortion, and protection payments.

There is a large range of recent papers investigating the relationship between wellbeing on the one hand and violent conflict on the other. For a general overview, see Blattman and Miguel (2010) which surveys research on the economic impacts of civil war. Justino and Verwimp (2006, 2013) compare the welfare of rural households in Rwanda before and after the 1994 genocide, and find that households whose home was destroyed or lost land ran a higher risk of falling into poverty.

A sub-strand of the conflict literature explores the economic motivations for participation in armed conflict. Many people support and cooperate (voluntarily or involuntarily) with armed groups not simply for opportunistic reasons, but rather to guarantee their survival and the fulfilment of basic economic needs (Humphreys and Weinstein 2008; Richards 1996). In particular, levels of poverty may drive individuals into conflict as some may gain more from being fighters than from peacetime activities, notably when productive activities are scarce, unemployment is high and returns from agriculture work are low (Collier and Hoeffler 1998; Grossman 2002; Walter 2004). As is often the case, the material benefits from such fighting accrues more to the leadership rather than the rank and file doing the fighting (Justino 2011; Humphreys and Weinstein 2008; Verwimp 2005).

A well-established literature, using cross-country datasets, has investigated the impacts of poverty on conflict, demonstrating that low-per capita income is one of the most robust explanations for the outbreak and duration of violent internal conflict (Collier et al. 2003; Collier and Hoeffler 1998, 2004; Do and Iyer 2007; Doyle and Sambanis 2006; Elbadawi and Sambanis 2000, 2002; Fearon and Laitin 2003; Hegre and Sambanis 2006; Murshed and Gates 2005; Stewart and Fitzgerald 2001). It is worth acknowledging that (northern) Nigeria may be trapped in a vicious cycle of poverty and violent conflict, whereby one fuels the other. This points to the endogeneity of conflict, where the direction of causation between conflict and poverty is a two-way street, necessitating the use of an instrumental variable strategy.

This does not necessarily mean that fighting always occurs in the poorest places, even within poor countries there are better-off areas which may be particularly prone to violence. Such areas may have interesting property to loot, resources to confiscate or taxes to collect. This is called the rapacity effect in the literature (Fearon, 2005). In Colombia for example, Dube and Vargas (2013) found an increase in conflict in oil-rich areas after a positive oil-price shock. Another mechanism highlighted in the literature is the redistributive nature of violent conflict. In a wide-ranging historical overview, Scheidel (2017) shows that violent conflict acts as a levelling force and redistributes wealth from rich to poor, for example when the rich are taxed to pay for the wages of soldiers, or when the rich loose their wealth as result of warfare or confiscation. Justino and Verwimp (2013) demonstrate this levelling effect for the case of the Rwandan genocide in 1994: they find that provinces with intense battles and destruction of infrastructure experienced an increase in poverty, where provinces with a massive loss of population show the largest decrease in poverty afterwards.

In summary, in the transport-poverty-conflict triangle the relationships between transport and poverty, as well as between poverty and conflict, have received a fair amount of attention by the scholarly community. Robust findings across studies are that conflict exacerbates poverty (at least in the short run), that past conflict increases the recurrence of conflict and that the reduction of transport costs improves wellbeing. The relationship between transport costs and violent conflict is less researched and thus less well understood.

The Nigerian setting

One of the most populated countries in West Africa, Nigeria is home to 184 million. With abundant natural resources, especially oil, its GDP grew on average 5.3 percent per year between 2006 and 2016 (from +8.2% in 2006 to -1.5% in 2016), driven by volatile oil prices. Despite its resource wealth, Nigeria remains a poor country with 53.5 percent of its population living under less than $1.90 per day (2009, World Development Indicators). Recently, Nigeria has overtaken India as home to the world's greatest concentration of people living in extreme poverty (Kharas et al 2018). Among its many challenges, Nigeria has a long and ongoing history with violent conflict.

Following independence from England in 1960, civil war in the late 1960s, Nigeria spent thirty years under a military regime until 1990 when the first democratically elected government took power. It has been democratic since but remains marred by conflict. Between 2006 and 2009, southeastern Nigeria grappled with a violent resistance in the Niger Delta. This conflict was brought under control in 2009 following the Presidential Amnesty Program, whereby the government granted amnesty and bought back weapons (Hönig 2017). Violence continues in the northeastern part of the country, the stronghold of Boko Haram.

Since 2009, Boko Haram has been waging an insurgency and is active beyond Nigeria, in Cameroon, Chad, and Niger. It is responsible for tens of thousands of deaths and displacing over 2 million people. In 2014, it abducted more than 200 school girls to be sold into slavery and forced marriages (BBC 2016). In 2015, it was ranked as the deadliest terror group by the Global Terrorism Index (Searcey and Santora 2015).

3. Empirical Approach

Datasets and the construction of poverty, transport, and conflict variables

This paper makes use of several datasets to analyze the effects of conflict and transport costs on multi-dimensional poverty. Our main sources include the Living Standards Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) for Nigeria and the Armed Conflict Location Events Dataset (ACLED[1]). LSMS-ISA is a nationally representative survey on household welfare conducted by the Nigerian Bureau of Statistics and the World Bank. It provides information on household members education, health, and standards of living. ACLED reports information on the location, date, and characteristics of politically violent events for countries in Africa in 1997-2013.

We construct our multi-dimensional poverty measure using the LSMS-ISA data for Nigeria, following the Alkire-Foster methodology (Alkire and Foster 2011). Briefly, the multidimensional poverty index (MPI) is constructed from ten indicators of deprivation within three groups: education, health, and standard of living. A household is deemed to be multidimensionally poor if it is deprived in a third of these indicators. (For further details, see Appendix A.)

Our indicator of conflict is calculated from ACLED data. Specifically, we focus on the number of fatalities which occurred within a 25-km radius of the household's enumeration

[1] Raleigh et al (2010), version 4.

area during three periods: 1999-2004, 2005-2009, and 2010-2013. The choice of these three periods is guided by Nigeria's recent history of violent conflict. As discussed above in Section 2, Nigeria faced a violent uprising in the south between 2006 and 2009 followed by Boko Haram's insurgency in the north. Figure 1 depicts the evolution of conflict in Nigeria between 1999 and 2013, both in raw numbers of fatalities (top row) and as kernel density estimates of conflict intensity (bottom row). Focusing first on the raw data, the left-hand column (a), illustrate the level of conflict between 1999-2004. During this period, there were several high casualty events throughout the country, mostly concentrated in the southeast. Between 2005 and 2009 (b), we see that violence in the country subsided substantially, with only a few high-impact events. In 2010-13 (c), we see that violence has intensified and spread. The highest concentration of violence is now centered in the northeast, namely in Boko Haram territory.

The bottom panel of Figure 1 illustrates the kernel density estimates of conflict intensity within a 25-km radius.[2] Hot spots are concentrations of incidents within a limited geographic area that appear over time. In particular, a kernel density interpolation technique was chosen because it allows conflict points to be transformed into a smooth surface, thus generalizing conflict locations. When using kernel density estimation, two decisions must be made: what kernel function to use and what bandwidth or radius to search over. We decided to use a quadratic kernel function[3], and the choice of radius was guided by the results of the Moran's I index (Figure 2), because that is the distance at which the spatial autocorrelation peaks. Using this 25km bandwidth, we construct a smoothed surface of conflict by applying a kernel density function to the raw ACLED conflict point data. Essentially, to calculate the value at

[2] Our conflict measure is inspired by that used for DRC in Ali et al (2015).
[3] See also Silverman (1986) for details of the quadratic kernel function used.

any point, the kernel density function takes a weighted average of all the fatalities around that point (up to 25km) to create the surface. The magnitude of the weight declines with distance from the point according to the chosen kernel function. The final output is a raster surface that measures the distance weighted number of fatalities within a radius of 25km for every square kilometer in Nigeria.

There are several reasons why applying a kernel density function is appropriate here. First, the raw ACLED data assigns conflict to specific points and so does not capture the effect of conflict on surrounding areas. Second, in its raw form it fails to capture the intensity of clustered as opposed to dispersed conflict. Third, it is subject to some geographic imprecision, for example rural conflict is typically assigned to the nearest village. To illustrate the increased precision when using distance to a conflict event as means to capture household exposure we refer to Akresh et al (2012). In their paper on the health consequences of the Ethiopian-Eritrean war, they show that assigning the same conflict exposure value to all children (of a given cohort) residing in one province leads to substantially different estimates compared to the use of distance to the conflict event. In our approach, the degree of exposure to the conflict event diminishes with distance.

To estimate transport cost to market, we apply the same methodology as in Russ et al (2017) and Damania et al (2017). In brief, we estimate the total travel cost to the cheapest market by finding the optimal route along the road network from any location using an iterative cost-minimizing process in which every possible travel path to every available market is calculated, and then the least-cost one is chosen. A market is defined as a city of at least 100,000 inhabitants. We use vector road data from Delorme,[4] which contains information on the location of every road, paved or unpaved, urban or rural, in Nigeria. This

[4] Delorme is a company specializing in construction of georeferenced data.

data was enhanced with information on class (primary, secondary, or tertiary), condition (good, fair, or poor), surface (paved or unpaved), and slope (flat, rolling, or mountainous) sourced from Nigeria's Federal Roads Management Agency (FERMA) and from the World Bank's Africa Infrastructure Country Diagnostic and Fadama Project. All roads lacking attributes from any of these sources were assumed to be unpaved, tertiary, and in poor condition. To estimate a cost per ton per kilometer of traversing a road, we use the Highway Development Management Model (HDM-4) programming tool, which takes into account the roughness of the terrain, quality and condition of the road, and country level factors (such as the price of fuel, average quality of the fleet, the price of a used truck, and wages).

To account for endogenous road location, we follow Russ et al (2017) and Damania et al (2017) and use the natural path as an instrumental variable for transport cost. The natural path measures the time taken to walk along the time-minimizing route from a given location to the nearest market, absent any roads and taking into account terrain slope and land cover. Construction of the natural path follows a similar approach to that used in the *Global Map of Accessibility* in World Bank (2009) and Uchida and Nelson (2009). Briefly, the map of Nigeria is divided into a "fishnet" grid of 10 x 10 km cells (approximately 11,000 in total). An off-path friction-surface raster was calculated, in which each pixel contains the estimated time required to cross that pixel on foot. Walking speed is calculated using Tobler's (1993) velocity equation, the main determinant of which is the slope of the terrain. The slope raster is from NASA's Shuttle Radar Topography Mission Digital Elevation Models, with a resolution of 90 meters.

Descriptive Analysis

Table 1 reports the summary statistics of the variables used in this analysis. Almost half of our sample is multi-dimensionally poor under our definition. This is comparable to the World Bank's poverty headcount ratio at $1.90 a day (53.5% in 2009). The average MPI is 0.32 and when we decompose the index into its three dimensions, we find that deprivations in the standard of living measure accounts for most of this poverty.

It costs the average household roughly $4 to transport a ton of goods to the nearest market. There is considerable heterogeneity, with transport costs ranging from negligible to $16. If we split our sample into areas with or without conflict (based on the kernel), we find that areas in conflict are relatively less remote (mean=3.58) relative to conflict-free areas (mean=4.14).

Between 2010 and 2013, the average village experienced less than one death within 25km when we consider the raw data (Table 1). Our kernel density measure of conflict indicates that the average village felt the impact of 15 deaths.

Figure 3 illustrates the conflict and poverty levels across Nigeria. The color ranges from light, indicating low poverty and conflict, to dark, signifying high poverty and conflict. Areas in the south-west and central regions are relatively better off in terms of both indicators. In the north-eastern part of the country, near the border with Cameroon and Chad, we find areas with relatively low-medium poverty and high conflict (reds). Note that this area is the stronghold of Boko Haram. Just south of these areas, we find regions of high poverty both with (dark red) and without (dark blues) conflict. While there is certainly some spatial clustering of both poverty and conflict, from this bird's eye view it is difficult to discern a clear relationship between poverty and conflict. To better understand this relationship, we turn to our econometric analysis below.

4. Identification Strategy

To determine the impact of conflict and transport costs on the likelihood that a household is multidimensionally poor, we estimate the following model:

$$P_i = \beta_0 + \beta_1 C_i + \beta_2 T_i + X_i'\gamma + \varepsilon_i \qquad (1)$$

where P_i is an indicator of whether household i is multidimensionally poor, C_i is our kernel density measure of conflict, T_i is the transport cost from household i to the nearest market, and X_i is a vector of exogenous controls.

We consider several indicators of poverty. First, we follow Alkire and Foster (2011) in defining a household as being multidimensionally poor if it is deprived in a third of its indicators. In other words, if its multidimensional poverty index is greater than one third (i.e. MPI > 1/3). Second, we take the continuous MPI itself as a measure of the household's level of poverty. The higher the MPI value, the poor the household is. Finally, we consider the households decomposed MPI scores for education, health, and standard of living. We regress these poverty measures on the natural logarithm of the kernel density of conflict which occurred between 2010 and 2013 within the village.

To minimize the threat of omitted variables bias, we include a set of carefully chosen controls. These include age of the household head; a dummy indicating whether the household is female headed; total land area; household size; and a dummy indicating whether the household is in the rural sector. In addition to these, we further control for community and climate characteristics using average annual rainfall; average temperature; access to health care; access to ICT; presence of a school, police station, bus stop, or market.

Our two variables of interest – conflict and transport cost – are most likely endogenous, so any OLS estimate of equation (1) would be biased. Conflict can lead to lower investment,

lower incomes, lower economic opportunities, and poor institutions. This in turn can lead to further conflict, resulting in two-way causality. Transport costs are endogenous in large part because roads are non-randomly placed. If a road is built to connect areas of high economic potential, OLS will over-estimate the impact of roads. If instead, roads are built to target disadvantaged areas, OLS will instead underestimate their impact.

To address these issues, we implement an instrumental variable strategy. Specifically, we instrument for conflict in 2010-2013 with earlier conflict. The logic is that past conflict is a strong determinant of current conflict (Collier and Sambanis, 2002), but the direct impact on poverty dissipates over time (as in Miguel and Roland for Vietnam, 2012). Collier and Sambanis (2002) demonstrate that once violence is initiated, it may follow a path-dependent process. It is an empirical regularity that the risk of war recurrence in postwar societies is higher than the risk of the onset of a new war in countries with no prior war history, what Collier and Sambanis (2002) term a conflict trap. Of the 58 cases of civil war that ended between 1945 and 1996, 22 experienced renewed war (36%). Miguel and Roland (2012) studied the bombing campaign in Vietnam and found no evidence of long-term effects on welfare today. Thus, historical conflict should only influence current poverty though its effect on current conflict—especially after relevant controls are included. We consider alternative instruments for conflict in 2010-2013: conflict in 1999-2004, conflict in 2005-2009, and both.

We instrument for transport costs with the natural path, that is, the time it takes to walk from the household to the market along the cost-minimizing path absent any roads. The intuition is that the natural path is the route a road would be built along if it were not diverted

by bias-causing economic reasons. For more on this instrument, see Russ et al (2017) and Damania et al (2017).

5. Results

This section presents our estimation results. We first consider preliminary OLS estimates to get a general idea of the correlations. We next turn to our 2SLS estimates employing the aforementioned instrumental variabels. We then explore various robustness checks to address identification concerns. Finally, we look at the heterogeneous impacts, splitting the sample into high and low conflict areas.

OLS Estimates

Table 2 reports the preliminary OLS estimates of the impact of conflict and transportation costs on poverty. Column (1) considers the impact on the likelihood that a household is multidimensionally poor. Column (2) reports the estimated impact on the MPI. Columns (3)-(5) report the estimated impacts on the decomposed dimensions of poverty: education, health, and standard of living, respectively. From these, we see that transport costs are positively correlated with poverty, significant at the 1% level. Conflict does not appear to have a significant impact on poverty. However, these results have not yet addressed the endogeneity of either transport cost or conflict. Next, we turn to the 2SLS results reported in Tables 3-6, which use the natural path and past conflict as IVs for transport cost and current conflict, respectively.

2SLS Estimates

We consider three alternative IVs for conflict in 2010-2013: conflict in 1999-2004, conflict in 2005-2009, and together.[5] These estimates are reported in Tables 4-6. In each

[5] There is a tradeoff in using conflict in 1999-2004 versus in 2005-2009 as the instrumental variable. The first is arguably more exogenous to current poverty as it occurred longer ago, while the second is more relevant to

case, we find that our test statistics give confidence to our estimation approach (Table 2). Both the F-test and Weak Identification Test are significant at the 1% level. The coefficient on past conflict are all statistically significant at the 1% level in the first stage of the current conflict equations (columns 1-3). Similarly, the coefficient on the natural path is significant at the 1% level in the first stage of the cost to market equations (columns 4-6).

In Table 4, we use both conflict in 1999-2004 and in 2005-2009 as IVs for current conflict (2010-2013). Note that these 2SLS estimates are noticeably larger as compared with the OLS results in Table 2, suggesting that the omitted variables bias is negative. This is indicative of roads being built through poorer areas and consistent with results found in Damania et al (2017) and Russ et al (2017). The sign on the coefficient for conflict is negative, but statistically not significant for any of the poverty outcomes along the usual thresholds.

Table 5 reports the estimates using more recent conflict, 2005-2009, as the IV. We again find that the coefficient on transport costs is robustly positive and significant for every outcome except MPI-health. The coefficient on conflict has a negative impact on poverty for each of the five indictors, significant at least at the 10% level.

Table 6 reports the results using the first IV, conflict in 1999-2004. We find that decreasing transport costs has a significant negative impact on poverty for every outcome except the MPI-health component. These results are consistent with those in Table 4 and 5, namely that decreasing transport costs decreases poverty and conflict is inversely related to poverty.

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current conflict as it is more recent. We present both sets of results, together with the overidentified case, and let the reader decide.

The positive relationship between transport costs and poverty is to be expected, but the negative relationship between conflict and poverty is more surprising. One would expect that areas of high conflict to be poorer as violence impedes commerce and destroys assets, as has been demonstrated by earlier research (see section 2 above). However, our research echoes findings elsewhere (Fearon, 2005; Dube and Vargas, 2013, for the rapacity effect and Justino and Verwimp, 2013; Scheidel, 2017 for the redistributive effect). During times of strife, especially where there are weak institutions, groups are able to seize sources of revenue in eastern DRC and other fragile economies (Anten et al 2012, and Mokose et al 2016). Ali et al (2015) found that road improvements may not be a advisable in a high-conflict environment such as is found in DRC. In Nigeria, our findings are consistent with an economy of war where conflict and wealth tend to coincide, via a rapacity effect or a redistributive effect. By the same token, subsistence farming in remote areas is associated with higher poverty but may be more isolated and so less vulnerable to the effects of conflict.

Robustness Checks

Our instrumental strategy rests on the assumption that past conflict only affects current poverty through current conflict. This assumption is more credible in the case of current poverty (flow) rather than accumulated poverty (stock). Out of the ten indicators of deprivation making up the MPI (see Appendix), two in particular might credibly be impacted by past conflict. These are highest degree earned and child mortality, in the education and health dimensions, respectively. To address this concern, we re-calculate the education and health poverty indices omitting these two indicators. Table 7 reports the OLS and 2SLS estimated coefficients on conflict and cost to market using the three alternate IVs for conflict in 2010-2013. We include all the previous controls and use the natural path to instrument for

transport costs. The estimated coefficients on the MPI education and health subcomponents retain their significance for the impact of conflict on education only when using the 2005-2009 IV, as in Table 5. When considering the overall MPI (omitting the two problematic indicators), the coefficient on cost to market is consistently positive and significant.

Thus far, our analysis has focused on the nationwide relationship between poverty, conflict, and transport. This begs the question of whether our results hold across the different sub-regions of the country? To address this concern, we re-estimate our model including zone fixed effects (Table 8). Nigeria is divided into six zones: North Central, North East, North West, South East, South South, and South West. Comparing these to our main results in Tables 4-6, we find them to be broadly consistent. The coefficient on transport cost once again remains positive and significant, except in the case of health. The coefficient on conflict remains negative and significant when using the 2005-2009 IV, except in the case of education.

As another check on the credibility of our instrumental variables strategy, we regress our poverty indicator on all the separate periods of conflict. These estimates are reported in Table 9. For three of the five poverty outcomes, past conflict is insignificant in the presence of current conflict. The exceptions are for MPI and its standard of living component where conflict in 2005-2009 is the only one picking up significance. If both current and past conflict retained their significance, it would undermine the credibility of our strategy.

Heterogeneous Impacts

Finally, we consider the heterogeneous effects of transport costs on poverty depending on whether the level of conflict present is "high" or "low". We consider alternative definitions of high conflict: kernel fatalities above the 75^{th} percentile, above the mean, and above zero.

As reported in Table 10, which again instruments for transport cost with the natural path, we see that systematically, the impact of transport cost on poverty is stronger in areas of low conflict as compared to high. In some cases of high conflict, the effect of transport cost becomes insignificant. These findings are consistent with those of Ali et al (2015).

6. Conclusion

This paper assesses the impacts of conflict and transportation costs on multidimensional poverty. We address endogeneity by using instrumental variables. Specifically, we use past conflict to instrument for more recent conflict. This was motivated by the observations that past conflict fuels future conflict and that the direct effects of conflict dissipate over time. The natural path—the time it takes to walk to the market absent any roads—is used to instrument for transport cost to market. By only taking the effects of the terrain into account, the natural path is not influenced by bias causing economic factors.

Overall, we find compelling evidence that reducing transportation costs decreases multidimensional poverty. This decrease is driven by improved access to education and asset accumulation. The impact on health deprivation was not statistically significant. The effect of transportation costs is stronger in areas with low conflict, robust to alternative definitions of high and low conflict.

The relationship between conflict and poverty is less clear. We consistently find a negative correlation between conflict and poverty, suggesting that violence is concentrated in less poor region. Turning to Figure 3, we see this overlap between high conflict and lower poverty is found in parts of northeast Nigeria. This would seem to contradict a widespread finding in the literature that conflict exacerbates poverty. In the context of weak institutions, as is the case in Nigeria, conflict gives opportunities to enterprising warlords to benefit

financially from the chaos. This is an example of a war economy as described by Mokose and Soloman (2016). As Fearon (2005) notes, while the less poor have more to lose from conflict, when there is more wealth available to appropriate there is also more to be gained from fighting. The result is also compatible with violent conflict acting as a redistributive force in Scheidel's sense. It is also conceivable, that during times of strife many are forced to flee the violence and take shelter in the more remote areas. Subsistence farmers in remote, rural areas, while poor, are at least further away from the violence. This would seem to correspond to the southwestern part of the country (Figure 3).

In sum, while the impact of transportation costs on poverty in the fact of conflict is clear, the impact of conflict on poverty is less pronounced. Given Nigeria's long history of conflict, it was not possible to obtain poverty variables that predate the violence. Even so, the estimates we present tell an interesting story and point to an important area for future research to better understand the tangled web of the conflict-poverty-transportation triangle.

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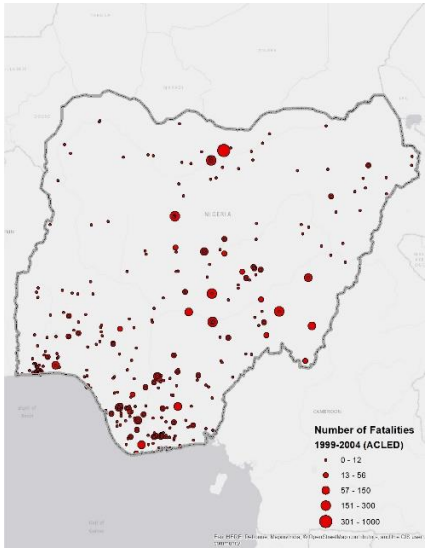
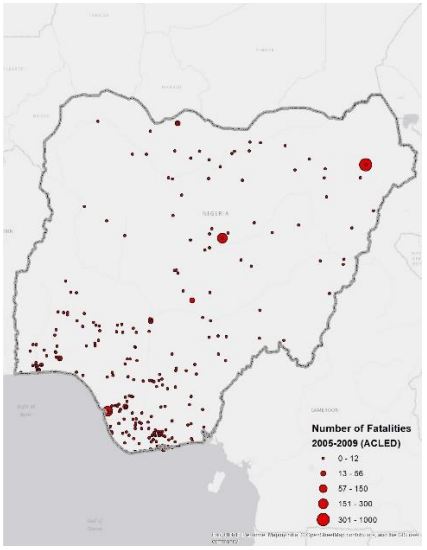
Figure 1: Raw ACLED Conflict Data (top) versus Kernel Density Estimate of Conflict Intensity (bottom)

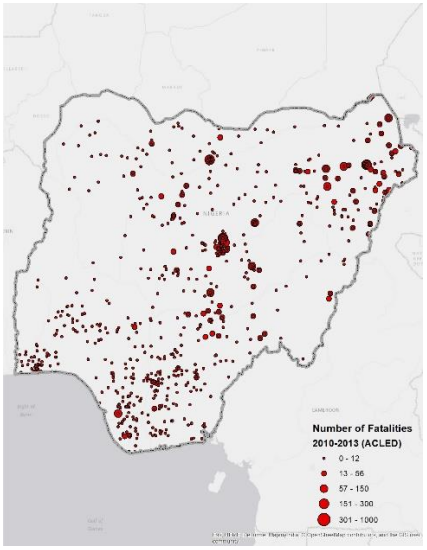
a. Number of Fatalities, 1999-2004



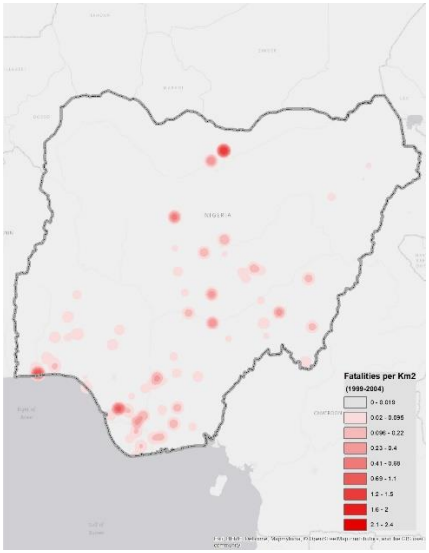
b. Number of Fatalities, 2005-2009



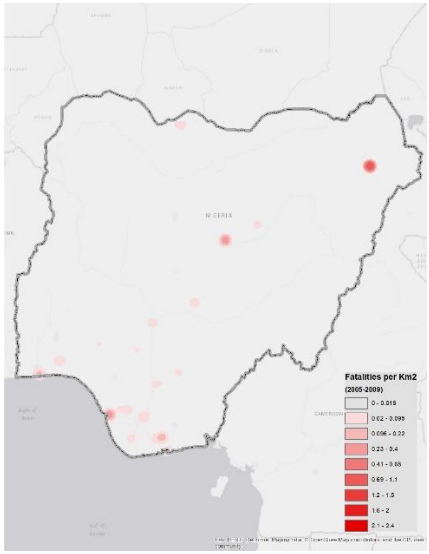
c. Number of Fatalities, 2010-2013



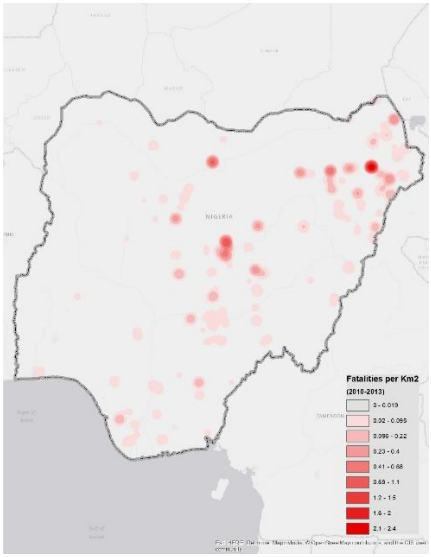
d. Conflict Kernel, 1999-2004



e. Conflict Kernel, 2005-2009

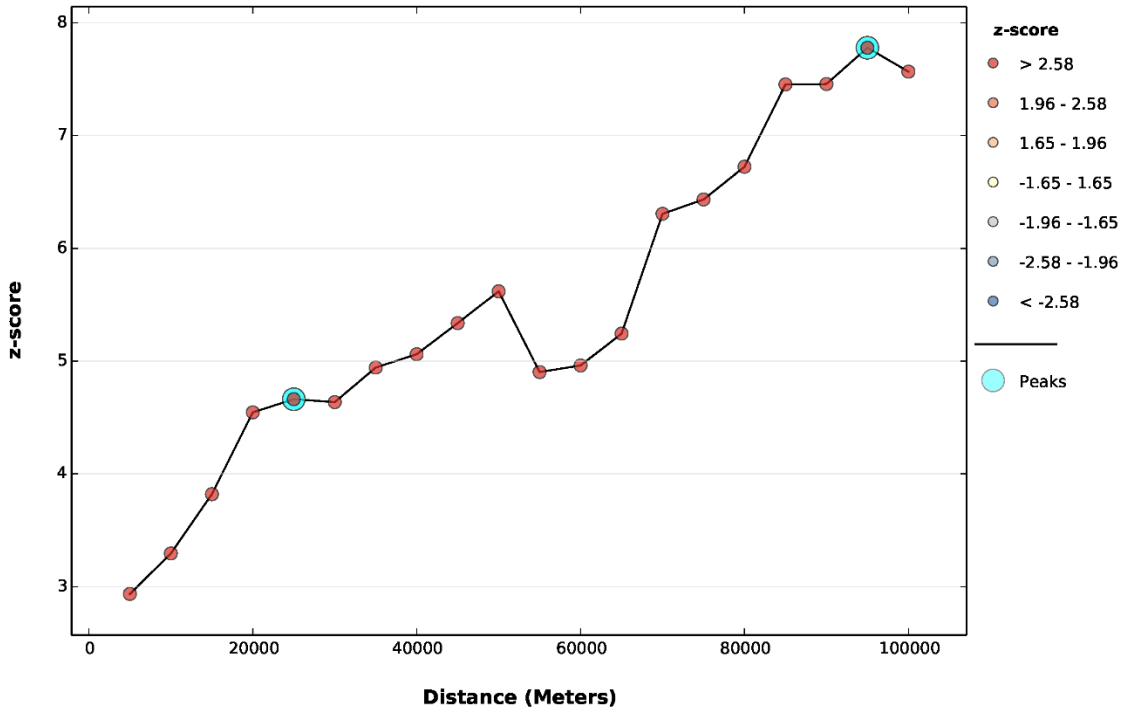


f. Conflict Kernel, 2010-2013



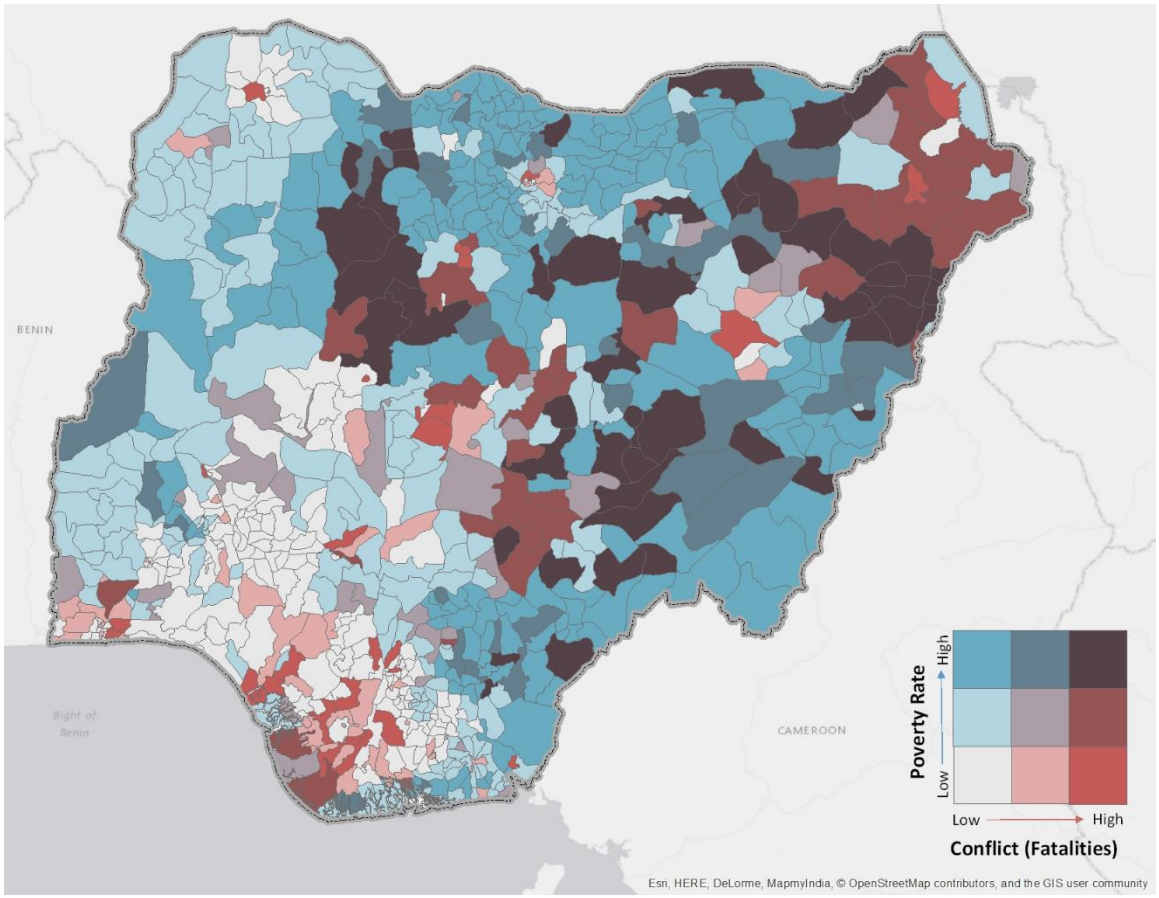
Source: Calculations by authors following Raleigh et al (2010). Note: ACLED = Armed Conflict Location Event Dataset.

Figure 2: Moran's I Statistic, Spatial Autocorrelation by Distance



Note: The Moran correlogram calculates the degree of spatial autocorrelation as a function of distance.
Source: Calculations by authors following Raleigh et al (2010).

Figure 3: Poverty and Number of Fatalities from Violent Events in Nigeria



Source: Accumulated conflict, 1999-2013 from ACLED and poverty in 2012 from LSMS, World Bank staff calculations.

Note: The different colors in the legend represent 1/3 of the distribution of the poverty rate and conflict, respectively. For example, the top-right color (dark red) indicate districts with the highest 1/3 poverty and conflict.

Table 1: Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
Multi-dimensionally poor (yes=1)	4,814	0.479	0.500	0	1.000
Multi-dimensional poverty index (MPI)	4,814	0.316	0.150	0	0.944
MPI, education	4,814	0.047	0.078	0	0.333
MPI, health	4,814	0.043	0.077	0	0.333
MPI, standard of living	4,814	0.226	0.074	0	0.333
Cost to Market (USD/ton)	4,801	3.892	3.303	0.025	16.161
Natural Path (hours)	4,801	1.592	1.312	0.028	11.207
Number of Fatalities, 2010-2013	4,802	0.033	0.155	0	2.191
Number of Fatalities, 1999-2004	4,742	0.037	0.116	0	0.943
Number of Fatalities, 2005-2009	4,722	0.007	0.021	0	0.187
Kernel measure of conflict, 2010-2013	4,801	15.637	56.162	0	579
Kernel measure of conflict, 1999-2004	4,801	10.114	43.328	0	580
Kernel measure of conflict, 2005-2009	4,801	2.127	11.892	0	202
Age of the household head	4,453	51.797	15.087	18	112
Total land (m2)	2,977	8,832	13,536	0	238,259
Number of household members	4,746	6.177	3.204	1	31
Rural sector (yes=1)	4,898	0.683	0.465	0	1
Female headed household (yes=1)	4,746	0.155	0.362	0	1
Access to school (yes=1)	4,746	0.888	0.316	0	1
Access to health care (yes=1)	4,746	0.794	0.405	0	1
Access to formal credit (yes=1)	4,746	0.250	0.433	0	1
Access to communication technology (yes=1)	4,746	0.398	0.490	0	1
Access to police or fire station (yes=1)	4,746	0.429	0.495	0	1
Presence of a bus stop (yes=1)	4,746	0.511	0.500	0	1
Presence of a market (yes=1)	4,746	0.691	0.462	0	1

Table 2: OLS estimates of the effects of transport costs and conflict on poverty

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
ln(conflict)	-0.215	-0.078	-0.031	-0.019	-0.028
	(-1.24)	(-1.18)	(-0.93)	(-0.67)	(-0.82)
ln(cost to market)	0.080***	0.035***	0.013***	0.003	0.019***
	(4.27)	(6.31)	(4.22)	(1.05)	(6.54)
ln(age)	-0.075*	-0.017	0.003	-0.011**	-0.009*
	(-1.89)	(-1.58)	(0.44)	(-2.04)	(-1.71)
ln(land)	0.007	0.003*	0.002	-0.000	0.002***
	(1.37)	(1.91)	(1.57)	(-0.61)	(2.82)
ln(number of members)	-0.051**	-0.011*	-0.019***	0.021***	-0.014***
	(-2.52)	(-1.91)	(-5.15)	(7.51)	(-4.86)
Rural sector (yes=1)	0.038	0.015	-0.004	-0.005	0.024***
	(0.81)	(1.13)	(-0.56)	(-0.73)	(3.49)
Female headed (yes=1)	-0.068*	-0.024**	-0.012**	0.002	-0.013***
	(-1.84)	(-2.27)	(-1.98)	(0.31)	(-2.73)
Access to school (yes=1)	-0.034	-0.011	-0.016	0.007	-0.001
	(-0.71)	(-0.65)	(-1.57)	(1.04)	(-0.21)
Access to health care (yes=1)	-0.098***	-0.046***	-0.022***	-0.014**	-0.010
	(-2.81)	(-3.24)	(-2.78)	(-2.39)	(-1.54)
Access to formal credit (yes=1)	-0.064	-0.013	-0.009	0.002	-0.006
	(-1.23)	(-0.76)	(-1.04)	(0.25)	(-0.76)
Access to communication (yes=1)	-0.082**	-0.027**	-0.004	-0.021***	-0.002
	(-2.03)	(-1.97)	(-0.44)	(-3.08)	(-0.30)
Access to police or fire station (yes=1)	0.024	0.006	0.010	-0.001	-0.003
	(0.63)	(0.54)	(1.38)	(-0.16)	(-0.41)
Presence of a bus stop (yes=1)	0.053	0.022*	0.014*	0.017***	-0.009
	(1.41)	(1.80)	(1.92)	(3.18)	(-1.58)
Presence of a market (yes=1)	-0.092***	-0.030***	-0.023***	0.000	-0.007
	(-2.62)	(-2.61)	(-3.33)	(0.01)	(-1.14)
Constant	0.951***	0.427***	0.099***	0.062**	0.266***
	(5.61)	(8.86)	(3.41)	(2.50)	(11.67)
Observations	2,869	2,869	2,869	2,869	2,869
R-squared	0.087	0.143	0.089	0.044	0.193

Notes: Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 3: First Stage Results

	(1) ln(Conflict, 2010-13)	(2) ln(Cost to market)	(3) ln(Conflict, 2010-13)	(4) ln(Cost to market)	(5) ln(Conflict, 2010-13)	(6) ln(Cost to market)
ln(Conflict, 1999-04)	0.390***	-1.245			0.296**	-1.321*
	(3.33)	(-1.63)			(2.52)	(-1.68)
ln(Conflict, 2005-09)			1.890***	-1.491	1.444**	0.496
			(4.12)	(-1.03)	(2.16)	(0.48)
ln(Natural Path)	-0.003	1.054***	-0.003	1.052***	-0.002	1.046***
	(-0.83)	(33.22)	(-0.82)	(33.44)	(-0.49)	(33.13)
ln(age)	-0.005	-0.006	-0.005	-0.022	-0.006	-0.018
	(-1.13)	(-0.22)	(-1.04)	(-0.87)	(-1.21)	(-0.74)
ln(land)	0.001**	0.004	0.001*	0.005	0.001**	0.004
	(2.28)	(0.57)	(1.92)	(0.87)	(2.32)	(0.67)
ln(number of members)	0.005***	0.053***	0.004***	0.051***	0.004***	0.052***
	(3.15)	(3.67)	(2.65)	(3.53)	(2.59)	(3.57)
Rural sector (yes=1)	-0.024*	0.104	-0.020	0.089	-0.021	0.090
	(-1.88)	(1.55)	(-1.48)	(1.36)	(-1.54)	(1.37)
Female headed (yes=1)	-0.002	0.027	-0.000	0.012	-0.003	0.024
	(-0.87)	(1.06)	(-0.13)	(0.45)	(-1.18)	(0.94)
Access to school (yes=1)	0.003	-0.012	0.001	-0.011	0.001	-0.010
	(0.55)	(-0.20)	(0.18)	(-0.18)	(0.14)	(-0.16)
Access to health care (yes=1)	-0.002	-0.079*	-0.002	-0.077*	-0.001	-0.082*
	(-0.31)	(-1.69)	(-0.37)	(-1.70)	(-0.22)	(-1.75)
Access to formal credit (yes=1)	-0.009	0.089	-0.010	0.101*	-0.010	0.102*
	(-0.86)	(1.58)	(-0.87)	(1.75)	(-0.95)	(1.87)
Access to communication (yes=1)	0.018*	0.022	0.020	0.014	0.018*	0.020
	(1.71)	(0.44)	(1.61)	(0.28)	(1.68)	(0.39)
Access to police or fire station (yes=1)	0.004	-0.013	0.005	-0.015	0.004	-0.010
	(0.55)	(-0.30)	(0.76)	(-0.32)	(0.65)	(-0.23)
Presence of a bus stop (yes=1)	-0.003	0.119***	-0.004	0.129***	-0.002	0.121***
	(-0.79)	(3.27)	(-0.82)	(3.63)	(-0.50)	(3.31)
Presence of a market (yes=1)	0.001	-0.074*	0.001	-0.078**	0.000	-0.075*
	(0.15)	(-1.94)	(0.22)	(-2.04)	(0.07)	(-1.95)
Constant	0.029	0.708***	0.031	0.763***	0.029	0.770***
	(0.98)	(4.65)	(0.97)	(5.33)	(0.94)	(5.41)
Weak Id. Test	14.7***	213.9***	148.4***	267.1***	787.8***	1,829.8***
Hansen J			0.153			0.153
			(P=0.6956)			(P=0.6956)
Observations	2,824	2,824	2,814	2,814	2,814	2,814
F-statistic	2.06**	100.38***	21.22***	109.51***	1.94**	103.47***
R-squared	0.160	0.855	0.173	0.849	0.221	0.853

Note: Robust t-statistics clustered at the enumeration area in parenthesis.
*** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 4: 2SLS estimates of the effects of transport costs and conflict on poverty (instrument conflict in 2010-2013 with conflict in 1999-2004 and in 2005-2009)

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
ln(conflict)	-0.484**	-0.204***	-0.042	-0.057*	-0.105***
	(-2.03)	(-3.00)	(-1.13)	(-1.74)	(-2.73)
ln(cost to market)	0.103***	0.041***	0.014***	0.001	0.026***
	(4.73)	(5.94)	(3.82)	(0.32)	(7.08)
ln(age)	-0.062	-0.017	0.004	-0.012**	-0.008
	(-1.56)	(-1.51)	(0.55)	(-2.18)	(-1.49)
ln(land)	0.005	0.003*	0.001	-0.000	0.002**
	(1.02)	(1.66)	(1.43)	(-0.52)	(2.32)
ln(number of members)	-0.050**	-0.011*	-0.019***	0.021***	-0.013***
	(-2.47)	(-1.84)	(-5.01)	(7.32)	(-4.69)
rural sector (yes=1)	0.021	0.008	-0.003	-0.004	0.015**
	(0.45)	(0.56)	(-0.47)	(-0.64)	(2.12)
female headed (yes=1)	-0.060	-0.021**	-0.011*	0.001	-0.011**
	(-1.64)	(-2.04)	(-1.83)	(0.28)	(-2.39)
Access to school (yes=1)	-0.044	-0.013	-0.018*	0.007	-0.003
	(-0.94)	(-0.80)	(-1.69)	(1.10)	(-0.43)
Access to health care (yes=1)	-0.088**	-0.043***	-0.021***	-0.015**	-0.006
	(-2.51)	(-2.98)	(-2.63)	(-2.48)	(-1.01)
Access to formal credit (yes=1)	-0.079	-0.017	-0.011	0.001	-0.007
	(-1.51)	(-0.97)	(-1.27)	(0.13)	(-0.88)
Access to communication (yes=1)	-0.065	-0.021	-0.002	-0.020***	0.001
	(-1.54)	(-1.49)	(-0.27)	(-2.87)	(0.17)
Access to police or fire station (yes=1)	0.021	0.005	0.010	-0.001	-0.004
	(0.53)	(0.43)	(1.36)	(-0.17)	(-0.55)
Presence of a bus stop (yes=1)	0.043	0.020	0.013*	0.016***	-0.009*
	(1.11)	(1.55)	(1.69)	(3.01)	(-1.66)
Presence of a market (yes=1)	-0.084**	-0.029**	-0.022***	-0.000	-0.007
	(-2.35)	(-2.41)	(-3.08)	(-0.01)	(-1.13)
Constant	0.899***	0.426***	0.094***	0.069***	0.264***
	(5.30)	(8.83)	(3.24)	(2.69)	(11.12)
Observations	2,814	2,814	2,814	2,814	2,814
R-squared	0.087	0.140	0.091	0.043	0.178

Notes: We instrument for the conflict kernel in 2010-13 with that from 1999-2004 and from 2005-2009. We instrument for transport cost to market with the natural path. Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 5: 2SLS estimates of the effects of transport costs and conflict on poverty (instrument conflict in 2010-2013 with conflict in 2005-2009)

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
ln(conflict)	-0.437**	-0.228***	-0.054*	-0.053*	-0.121***
	(-2.12)	(-3.49)	(-1.87)	(-1.84)	(-2.74)
ln(cost to market)	0.102***	0.042***	0.014***	0.001	0.026***
	(4.66)	(5.97)	(3.88)	(0.30)	(7.04)
ln(age)	-0.062	-0.016	0.004	-0.013**	-0.008
	(-1.57)	(-1.50)	(0.56)	(-2.18)	(-1.46)
ln(land)	0.005	0.003*	0.001	-0.000	0.002**
	(1.02)	(1.66)	(1.43)	(-0.52)	(2.32)
ln(number of members)	-0.050**	-0.011*	-0.019***	0.021***	-0.013***
	(-2.48)	(-1.81)	(-5.00)	(7.36)	(-4.62)
rural sector (yes=1)	0.023	0.007	-0.004	-0.004	0.015*
	(0.49)	(0.47)	(-0.55)	(-0.60)	(1.95)
female headed (yes=1)	-0.061*	-0.021**	-0.011*	0.001	-0.011**
	(-1.65)	(-2.02)	(-1.82)	(0.27)	(-2.35)
Access to school (yes=1)	-0.043	-0.013	-0.018*	0.007	-0.003
	(-0.93)	(-0.81)	(-1.70)	(1.10)	(-0.43)
Access to health care (yes=1)	-0.088**	-0.042***	-0.021***	-0.015**	-0.006
	(-2.52)	(-2.96)	(-2.61)	(-2.48)	(-0.99)
Access to formal credit (yes=1)	-0.079	-0.017	-0.011	0.001	-0.008
	(-1.51)	(-0.97)	(-1.26)	(0.13)	(-0.88)
Access to communication (yes=1)	-0.066	-0.020	-0.002	-0.020***	0.002
	(-1.59)	(-1.43)	(-0.23)	(-2.87)	(0.23)
Access to police or fire station (yes=1)	0.021	0.005	0.010	-0.001	-0.004
	(0.53)	(0.42)	(1.35)	(-0.17)	(-0.55)
Presence of a bus stop (yes=1)	0.043	0.020	0.013*	0.016***	-0.010*
	(1.12)	(1.53)	(1.67)	(3.02)	(-1.68)
Presence of a market (yes=1)	-0.084**	-0.029**	-0.022***	-0.000	-0.007
	(-2.36)	(-2.40)	(-3.07)	(-0.01)	(-1.12)
Constant	0.899***	0.426***	0.094***	0.069***	0.264***
	(5.31)	(8.81)	(3.24)	(2.69)	(11.05)
Observations	2,814	2,814	2,814	2,814	2,814
R-squared	0.087	0.139	0.091	0.043	0.175

Notes: We instrument for the conflict kernel in 2010-13 with that from 2005-2009. We instrument for transport cost to market with the natural path. Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 6: 2SLS estimates of the effects of transport costs and conflict on poverty (instrument conflict in 2010-2013 with conflict in 1999-2004)

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
ln(conflict)	-0.766	-0.138	-0.014	-0.074	-0.050
	(-1.54)	(-0.87)	(-0.13)	(-0.96)	(-0.60)
ln(cost to market)	0.095***	0.041***	0.014***	0.001	0.027***
	(4.16)	(5.86)	(3.65)	(0.21)	(6.96)
ln(age)	-0.069*	-0.018	0.002	-0.012**	-0.008
	(-1.73)	(-1.64)	(0.33)	(-2.12)	(-1.57)
ln(land)	0.006	0.003*	0.002	-0.000	0.002**
	(1.19)	(1.68)	(1.47)	(-0.48)	(2.22)
ln(number of members)	-0.046**	-0.011*	-0.019***	0.021***	-0.014***
	(-2.24)	(-1.81)	(-4.95)	(7.14)	(-4.86)
Rural sector (yes=1)	0.006	0.006	-0.005	-0.005	0.016**
	(0.13)	(0.47)	(-0.61)	(-0.72)	(2.24)
Female headed (yes=1)	-0.060	-0.021**	-0.012*	0.002	-0.011**
	(-1.64)	(-2.07)	(-1.86)	(0.31)	(-2.45)
Access to school (yes=1)	-0.042	-0.013	-0.017*	0.007	-0.003
	(-0.91)	(-0.77)	(-1.65)	(1.09)	(-0.41)
Access to health care (yes=1)	-0.091***	-0.043***	-0.022***	-0.015**	-0.006
	(-2.60)	(-3.00)	(-2.66)	(-2.49)	(-1.02)
Access to formal credit (yes=1)	-0.068	-0.015	-0.009	0.001	-0.007
	(-1.30)	(-0.86)	(-1.07)	(0.16)	(-0.86)
Access to communication (yes=1)	-0.062	-0.023	-0.003	-0.019***	0.000
	(-1.43)	(-1.61)	(-0.37)	(-2.83)	(0.01)
Access to police or fire station (yes=1)	0.023	0.005	0.010	-0.001	-0.004
	(0.59)	(0.45)	(1.39)	(-0.15)	(-0.56)
Presence of a bus stop (yes=1)	0.042	0.021	0.013*	0.016***	-0.009
	(1.08)	(1.63)	(1.78)	(2.97)	(-1.55)
Presence of a market (yes=1)	-0.085**	-0.029**	-0.022***	-0.000	-0.007
	(-2.37)	(-2.43)	(-3.10)	(-0.02)	(-1.13)
Constant	0.940***	0.431***	0.100***	0.066***	0.264***
	(5.55)	(8.97)	(3.44)	(2.65)	(11.26)
Observations	2,824	2,824	2,824	2,824	2,824
R-squared	0.080	0.139	0.087	0.043	0.185

Notes: We instrument for the conflict kernel in 2010-13 with that from 1999-2004. We instrument for transport cost to market with the natural path. Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 7: Calculate MPI without highest degree earned and child mortality indicators

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
OLS					
Conflict, 2010-13	-0.102	-0.023	-0.025	0.030	-0.028
	(-0.68)	(-0.30)	(-1.01)	(0.78)	(-0.82)
Cost to Market	0.070***	0.022***	0.004*	-0.002	0.019***
	(4.17)	(4.68)	(1.72)	(-0.56)	(6.54)
IV1: Conflict, 1999-2009					
Conflict, 2010-13	-0.639	-0.176	-0.063	-0.048	-0.065
	(-1.63)	(-1.53)	(-1.03)	(-0.48)	(-0.99)
Cost to Market	0.086***	0.024***	0.004	-0.006	0.026***
	(3.95)	(3.68)	(1.08)	(-1.30)	(7.10)
IV2: Conflict, 2005-2009					
Conflict, 2010-13	-0.043	-0.156***	-0.047**	0.012	-0.121***
	(-0.26)	(-3.01)	(-2.10)	(0.16)	(-2.74)
Cost to Market	0.091***	0.024***	0.004	-0.006	0.026***
	(4.17)	(3.70)	(1.22)	(-1.39)	(7.04)
IV3: Conflict, 1999-2004					
Conflict, 2010-13	-0.807*	-0.185	-0.065	-0.070	-0.050
	(-1.84)	(-1.25)	(-0.82)	(-0.54)	(-0.60)
Cost to Market	0.085***	0.024***	0.004	-0.007	0.027***
	(3.83)	(3.63)	(1.16)	(-1.37)	(6.96)
HH and Village Controls	Yes	Yes	Yes	Yes	Yes

Note: The above table defines poverty without considering the highest degree earned or child mortality indicators. Weights have been adjusted so that health and education still account for 1/3 of the overall MPI, respectively. All models control for the variables discussed above and instrument for transport cost with the natural path. Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 8: Controlling for Zone Fixed Effect

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
OLS					
Conflict, 2010-13	-0.405***	-0.136**	-0.057**	-0.040	-0.039
	(-2.84)	(-2.53)	(-2.31)	(-1.51)	(-1.08)
Cost to Market	0.041**	0.022***	0.005*	0.000	0.016***
	(2.35)	(4.39)	(1.77)	(0.07)	(5.90)
IV1: Conflict, 1999-2009					
Conflict, 2010-13	-0.255	-0.111	0.011	-0.061*	-0.061
	(-1.04)	(-1.02)	(0.19)	(-1.79)	(-1.26)
Cost to Market	0.066***	0.028***	0.006*	-0.001	0.022***
	(3.06)	(4.26)	(1.81)	(-0.20)	(6.21)
IV2: Conflict, 2005-2009					
Conflict, 2010-13	-0.317*	-0.180***	-0.024	-0.060*	-0.096***
	(-1.78)	(-3.40)	(-0.99)	(-1.94)	(-4.02)
Cost to Market	0.066***	0.029***	0.007*	-0.001	0.022***
	(3.05)	(4.36)	(1.92)	(-0.20)	(6.24)
IV3: Conflict, 1999-2004					
Conflict, 2010-13	-0.107	0.113	0.120	-0.064	0.056
	(-0.20)	(0.56)	(1.07)	(-0.89)	(0.54)
Cost to Market	0.065***	0.031***	0.008**	-0.001	0.024***
	(2.79)	(4.43)	(2.04)	(-0.19)	(6.18)
HH and Village Controls	Yes	Yes	Yes	Yes	Yes
Zone Fixed Effect	Yes	Yes	Yes	Yes	Yes

Note: All models control for the variables discussed above and instrument for transport cost with the natural path. In addition, zone fixed effects have been added. Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 9: OLS estimates including conflict from each of the three periods

	(1) Poor (yes=1)	(2) MPI Overall	(3) MPI Education	(4) MPI Health	(5) MPI St. of Living
ln(cost to market)	0.082***	0.035***	0.015***	0.002	0.019***
	(4.14)	(6.05)	(4.77)	(0.76)	(5.54)
ln(conflict, 2010-2013)	0.079	0.039	-0.013	0.005	0.046
	(0.26)	(0.41)	(-0.28)	(0.13)	(1.00)
ln(conflict, 1999-2004)	-0.284	-0.037	0.015	-0.019	-0.032
	(-1.18)	(-0.53)	(0.34)	(-0.54)	(-0.86)
ln(conflict, 2005-2009)	-1.008	-0.630***	-0.115	-0.111	-0.405***
	(-1.23)	(-2.66)	(-0.86)	(-0.90)	(-3.17)
ln(age)	-0.064	-0.017	0.004	-0.012**	-0.009*
	(-1.60)	(-1.55)	(0.57)	(-2.09)	(-1.71)
ln(land)	0.005	0.003*	0.001	-0.001	0.002**
	(0.98)	(1.65)	(1.43)	(-0.71)	(2.56)
ln(number of members)	-0.050**	-0.012*	-0.019***	0.020***	-0.013***
	(-2.52)	(-1.93)	(-5.07)	(7.34)	(-4.74)
Rural sector (yes=1)	0.050	0.016	-0.004	-0.004	0.024***
	(1.02)	(1.22)	(-0.49)	(-0.61)	(3.26)
Female headed (yes=1)	-0.059	-0.022**	-0.012*	0.002	-0.012**
	(-1.58)	(-2.06)	(-1.82)	(0.36)	(-2.52)
Access to school (yes=1)	-0.038	-0.011	-0.018*	0.008	-0.001
	(-0.80)	(-0.65)	(-1.66)	(1.13)	(-0.20)
Access to health care (yes=1)	-0.096***	-0.045***	-0.021***	-0.015**	-0.009
	(-2.65)	(-3.06)	(-2.60)	(-2.47)	(-1.38)
Access to formal credit (yes=1)	-0.066	-0.013	-0.011	0.002	-0.004
	(-1.24)	(-0.74)	(-1.24)	(0.20)	(-0.48)
Access to communication (yes=1)	-0.079*	-0.027**	-0.003	-0.021***	-0.004
	(-1.90)	(-2.02)	(-0.36)	(-2.96)	(-0.57)
Access to police or fire station (yes=1)	0.024	0.006	0.010	-0.001	-0.003
	(0.62)	(0.49)	(1.34)	(-0.21)	(-0.40)
Presence of a bus stop (yes=1)	0.046	0.022*	0.013*	0.017***	-0.008
	(1.20)	(1.71)	(1.74)	(3.04)	(-1.45)
Presence of a market (yes=1)	-0.084**	-0.029**	-0.022***	0.000	-0.007
	(-2.33)	(-2.41)	(-3.06)	(0.05)	(-1.14)
Constant	0.908***	0.427***	0.093***	0.066**	0.268***
	(5.25)	(8.67)	(3.21)	(2.58)	(11.33)
Observations	2,814	2,814	2,814	2,814	2,814
R-squared	0.090	0.146	0.091	0.044	0.192

Note: Robust t-statistics clustered at the enumeration area in parenthesis. *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 10: Heterogeneous Effects of Transport in High or Low Conflict Areas

2SLS		dpoor	MPI	MPI_edu	MPI_health	MPI_standard
1. Split along 75th percentile	High conflict	0.043	0.015	-0.006	-0.005	0.026***
	(N = 479)	(1.04)	(1.59)	(-1.03)	(-0.77)	(4.21)
	Low Conflict	0.107***	0.049***	0.018***	0.004	0.027***
	(N = 2,390)	(4.47)	(6.31)	(4.27)	(1.16)	(6.62)
2. Split along mean fatalities	High conflict	0.006	0.012	-0.003	-0.007	0.021***
	(N = 276)	(0.16)	(1.17)	(-0.40)	(-0.80)	(3.74)
	Low Conflict	0.105***	0.046***	0.016***	0.002	0.028***
	(N = 2,593)	(4.53)	(6.34)	(3.86)	(0.68)	(7.25)
3. Split along any fatalities	High: Any	0.070**	0.031***	0.007	0.004	0.021***
	(N = 1,178)	(2.30)	(3.51)	(0.005)	(1.14)	(4.21)
	Low: Zero	0.120***	0.052***	0.020***	0.000	0.032***
	(N = 1,691)	(3.81)	(5.07)	(3.32)	(0.11)	(6.12)
HH and Village Controls		Yes	Yes	Yes	Yes	Yes

Note: The above rows the point estimates on transportation costs for different subsamples of high and low conflict. All models control for the variables discussed above and instrument for transport cost with the natural path. Robust t-statistics clustered at the enumeration area in parenthesis. * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

APPENDIX

A. LSMS Multidimensional Poverty Index

The multidimensional poverty index is constructed following the Alkire-Foster method, with three main components each receiving equal weight: education, health and standard of living. Table A1 gives a detailed description of the components of this index.

Table A1: LSMS multi-dimensional poverty index components

Dimension	Indicator	Deprived if…	Relative Weight
Education	Highest degree earned	No household member has completed six years of education, i.e. earned at least the First School Leaving Certificate (FSLC)	1/6
	Child School Attendance	Any school-aged child is not attending school (children 6-16)	1/6
Health	Child Mortality	Any child has died in the family	1/6
	Nutrition	Any household member has gone to sleep hungry during the past week	1/6
Standard of Living	Electricity	The household has no electricity	1/18
	Improved Sanitation	The household does not have a toilet that flushes or a ventilated improved pit, or must share one with other households	1/18
	Safe Drinking Water	Household does not have access or must walk more than 30-minutes round trip to get safe water. (safe water includes: pipe borne water, bore hole/hand pump, well/spring protected, rainwater)	1/18
	Flooring	The household has a straw, dirt, sand, or mud floor	1/18
	Cooking fuel	The household cooks with firewood, coal, grass, or kerosene (as opposed to electricity or gas)	1/18
	Asset Ownership	The household does not own more than one radio, TV, bike, motorbike, or fridge, and does not own any landline, car or other vehicle	1/18