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Commodity Shocks, Factor Intensity and Conflicts in Africa

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COMMODITY SHOCKS, FACTOR INTENSITY AND CONFLICTS IN AFRICA*

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Abstract

Natural resources are often related to conflicts. The Dal Bó & Dal Bó (2011) theory states that income shocks affect capital- and labor-intensive sectors differently. Using sub-national cells covering the African continent for 1997-2010, I find that conflicts react differently to positive commodity price shocks depending on their factor intensity. The results show that a positive shock in the capital-intensive mining sector increases conflict likelihood, whereas a positive shock in the labor-intensive agricultural sector reduces it. These impacts are higher for sub-Saharan Africa. When testing heterogeneous effects for the degree of commodity appropriability, historical African-specific factors, and quality of institutions, I find that easily taxed crops behave differently to an increase in international crop prices. In the same vein, I find that neither historical African-specific factors nor the quality of institutions seem to induce differential responses in conflicts to commodity price shocks.
JEL code: O130, Q320, Q340, D740.
Keywords: Natural Resources, Conflicts, Commodity Shocks.

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Resumen

Los recursos naturales suelen estar relacionados con conflictos. La teoría de Dal Bó & Dal Bó (2011) establece que las perturbaciones de ingreso afectan los sectores de uso intensivo de capital y de uso intensivo de mano de obra de manera diferenciada. Utilizando celdas sub-nacionales que cubren el continente africano en el periodo 1997-2010, este documento evidencia que los conflictos reaccionan de manera diferenciada a perturbaciones positivas en los precios de las materias primas en función de la intensidad de los factores productivos. Los resultados muestran que un impacto positivo en el sector minero de uso intensivo de capital aumenta la probabilidad de experimentar conflictos, mientras que un impacto positivo en el sector agrícola de uso intensivo de mano de obra reduce esta probabilidad. Dichos impactos muestran ser mayores para el África subsahariana. Al analizar la existencia de efectos heterogéneos considerando el grado de apropiación de las materias primas, factores históricos específicos de África y la calidad de las instituciones, se evidencia que aquellos cultivos sujetos fácilmente a gravámenes se comportan de manera diferenciada ante un incremento en los precios internacionales. De la misma manera, los resultados sugieren que los factores históricos específicos de África y la calidad de las instituciones no parecen inducir respuestas diferenciadas en los conflictos ante las perturbaciones de los precios de las materias primas. Esta investigación fue desarrollada en el Instituto de Investigaciones Socio-Económicas (IISEC) de la Universidad Católica Boliviana "San Pablo". Las opiniones presentadas pertenecen únicamente al autor y no necesariamente reflejan las opiniones del Instituto de Investigaciones Socio-Económicas (IISEC).

JEL code: O130, Q320, Q340, D740.

Keywords: Recursos Naturales, Conflictos, Commodity Shocks.

1 INTRODUCTION

Commodity-driven income shocks are often related with civil conflicts (Dube & Vargas, 2013; Bazzi & Blattman, 2014; Berman & Couttenier, 2015; Berman et al., 2017; Harari & La Ferrara, 2018). However, theoretical models state an ambiguous relationship between conflicts and income shocks. On the one hand, the opportunity cost channel establishes that an increase in wages raises the opportunity cost of being engaged in war. In this sense, a positive income shock leads to a reduction of conflicts. On the other hand, if the increase in income raises state revenues disproportionately, the expected benefits of challenging the government outweigh the opportunity cost; in this situation, the state as prize mechanism dominates leading to an increase in conflicts. According to the Dal Bó & Dal Bó (2011) theory, an income shock in a labor-intensive sector should decrease conflicts as the opportunity cost is higher than the state as prize. By contrast, if the income shock affects a capital-intensive sector, the state as prize mechanism drives the relationship increasing conflict incidence. This paper addresses empirically the relationship between commodity price shocks and conflict incidence in the African continent considering both capital- and labor-intensive sectors.

Following Dube & Vargas (2013) and building on Berman et al. (2017), this study focuses on two commodity types: a relatively capital-intensive commodity (mining) and a relatively labor-intensive commodity (agriculture). Using 10,335 sub-national cells of 0.5 degrees of latitude $\times$ 0.5 degrees of longitude for the entire African continent, I estimate a panel data model with two high-dimensional fixed-effects, which controls for both unobserved heterogeneity at the cell level and unobserved time-varying effects at the country level (Guimaraes & Portugal, 2010). To address how commodity price shocks affect conflict incidence, I use exogenous international price variations during the period 1997-2010. The results show that commodity shocks affect each sector differently. For sub-Saharan Africa, on average, a 10% increase in mineral prices increases the conflict likelihood by 0.91 percentage points (14.38% relative to the unconditional mean). In comparison, a 10% increase in crop prices leads to a reduction in conflict likelihood of approximately 0.16 percentage points (2.5% relative to the unconditional mean). These results are robust to different samples, control variables and robustness checks. Overall, the findings suggest that positive commodity price shocks in the capital-intensive sector could have detrimental effects on social peace.

The second part of the analysis tests the presence of heterogeneous effects. The first exercise shows that agricultural income shocks have different effects depending on the degree of crop appropriability. This result sheds light on the importance of differentiating agricultural shocks according to different crop characteristics. The second exercise relies on the literature of historical African-specific events and their long-run impacts. When testing heterogeneous effects on ethnic partition, pre-colonial centralisation and slave trades, I find that none of these presents differentiated impacts under a commodity price shock, which suggests that these detrimental events for the continent are not exacerbating the conflicts derived from commodity price shocks. Finally, the estimates suggest that the quality of institutions has a negligible effect on commodity price shocks and conflict incidence.

1.1 Related Literature

This study builds on the literature of natural resources and civil conflict. The conflict literature states that economic variables such as per-capita income, ethnic differences, and natural resources, are strong predictors of social unrest (Collier & Hoeffler, 1998, 2004). Similarly, political variables such as weak institutions are shown to be strongly related to conflict likelihood (Fearon & Laitin, 2003; Fearon, 2005). This literature identifies at least three channels that explain how natural resources affect conflicts – state capacity, opportunity cost and the state as prize (Bazzi & Blattman, 2014), with the latter two being the most relevant for this analysis. The Dal Bó & Dal Bó (2011) model states that labor-intensive sectors are less prone to experience conflicts because a positive shock in this sector translates to workers through wages, increasing their opportunity cost of being engaged in conflicts. By contrast, income shocks in capital-intensive sectors can easily be appropriated by the state, and do not reach workers directly. If this shock is large enough, the state becomes a valuable prize, increasing conflict incidence.

This research makes several contributions to the literature. First, it studies the relationship of both capital- and labor-intensive commodity shocks with conflict incidence taking a sub-national approach. Since Dube & Vargas (2013), papers have adopted this perspective to address this relationship. Studies that focus their attention on a capital-intensive commodity find that a positive commodity price shock raises conflict incidence (Berman et al., 2017; Fetzer et al., 2018). In contrast, studies on labor-intensive commodities identify a negative relationship between an increase in commodity prices and social unrest (Berman & Couttenier, 2015; Harari & La Ferrara, 2018). Unlike these papers, this study considers both a capital-intensive and a labor-intensive commodity sector in the same sample, finding comparable estimates by addressing the same commodity shock. Moreover, this document estimates the effects for the entire African continent, providing external validity to the results found by Dube & Vargas (2013) for Colombia. Furthermore, different from Berman & Couttenier (2015) and Harari & La Ferrara

(2018), I approximate the labor-intensive sector with agricultural production at the cell level, finding different impacts of international crop prices depending on the degree of crop revenues appropriability.

Second, this study sheds light on the literature of conflicts and historical African-specific factors.[1] A vast literature studies the effects of historical African events that are closely related to conflicts (Besley & Reynal-Querol, 2014; Fearon & Laitin, 2014; Depetris-Chauvin, 2015; Wig, 2016; Michalopoulos & Papaioannou, 2016; Fenske & Kala, 2017; Dincecco et al., 2019). Unlike these studies, this research addresses the heterogeneous effects of historical African factors in contemporary conflict driven by commodity price shocks. Based on the literature, I evaluate possible moderating effects of the Scramble for Africa, pre-colonial centralization and the slave trades.

The reason behind choosing historical African-specific factors is as follows. Colonisers divided the African continent without taking into consideration the adverse effects their decisions would have on the people who inhabited the region. Some authors claim that the Scramble for Africa had detrimental repercussions for the region. Alesina et al. (2011) show that countries with artificial borders have performed worse than those with natural borders. In the same vein, Michalopoulos & Papaioannou (2016) argue that partitioned ethnic groups present a lower cost of going to war because they rely on their co-ethnics who live across the border as providers of war equipment and back-up troops. This study builds on these theories, testing whether a commodity price shock affects partitioned ethnic groups differently. The results suggest that regions with partitioned ethnic groups do not react differently to a commodity price shock.

Regarding pre-colonial centralization, several studies conclude that regions which had centralized ethnic groups present greater current development (Gennaioli & Rainer, 2007; Fenske, 2013, 2014; Michalopoulos & Papaioannou, 2013, 2015; Bandyopadhyay & Green, 2016). These studies argue that pre-colonial centralized ethnic groups established a better organization system, and therefore were able to develop stronger institutions over time. However, the literature that evaluates the relationship between pre-colonial centralization and conflict is far from reaching an agreement. While some papers show that societies exposed to more centralized forms of state present less contemporary conflict, arguing that exposure to statehood creates a better organization system that leads to higher state capacity, and therefore, fewer conflicts (Depetris-Chauvin, 2015; Wig, 2016). Other studies argue that pre-colonial centralized ethnic groups were unrepresented in the state after

[1] Nunn (2007) provides a theoretical model showing the importance of historical African-specific factors for future economic development.

colonization, and therefore, this exclusion created post-colonial conflicts (Ray, 2019). In addition, Heldring (2019) shows that in the Rwandan case, pre-colonial centralization is linked to obedience; therefore, centralized regions present stronger effects on both conflict and peaceful times. In this context, I evaluate if commodity price shocks affect regions with pre-colonial centralized ethnic groups differently. The findings suggest that pre-colonial centralized states do no behave differently from non-centralized states in the presence of a commodity shock.

In the same vein, the slave trade had significant consequences for the African continent. Nunn (2008) addresses the long-run effects of the slave trade in Africa, finding a negative relationship between countries impacted by the slave trade and current economic development. Nunn & Wantchekon (2011) show that one of the main channels of the slave trade long-run impact is the mistrust generated during and after this period. Fenske & Kala (2015) show that climatic conditions modified the dynamics of the slave trade, which predicts current economic activity. In terms of conflict, Fenske & Kala (2017) find that the abolition of the British slave trade increased conflict disproportionately in slave export regions. Given the substantial effects of the slave trade on the African continent, it is plausible to think that regions affected by the slave trade present a different behavior when hit by a natural commodity shock. Using data from Nunn & Wantchekon (2011), I test if ethnic groups that were subject to the transatlantic and Indian Ocean slave trades are more prone to natural resource-driven conflicts. The findings suggest that the number of slaves traded relative to the ethnic group's homeland area is not statistically significant.

Finally, this study contributes to the literature on the quality of institutions and conflict. Building on Besley & Persson (2011), Berman et al. (2017), Adhvaryu et al. (2018) and Fetzer et al. (2018), I evaluate if countries with a better institutional framework are less prone to experiencing a natural resource-driven conflict. Studies show that the relationship between natural resources and civil conflict loses significance in regions with strong institutions. These studies find that regions that are abundant in natural resources and have high-quality institutions do not experience a higher conflict incidence (Adhvaryu et al., 2018; Fetzer et al., 2018). The estimation suggests that commodity price shocks do not differ for countries with different levels of institutional quality.

The paper proceeds as follows. Section II describes the dataset construction. Section III explains the methodology and the identification strategy. Section IV presents the main results. Section V concludes.

2 DATA

2.1 Sources and Dataset Construction

This study uses grid cells covering the entire African continent as the unit of observation. The grid includes 10,335 sub-national units of 0.5 degrees of latitude $\times$ 0.5 degrees of longitude (approximately 55 km at the equator), covering a total of 52 countries for the period 1997-2010.[2] The cells contain information on conflict incidence, mineral and agricultural production, and region-specific factors. The final sample reaches 144,690 observations over the 14-year period.[3]

Conflict Data. Data on conflicts comes from the PRIO/Uppsala ACLED dataset. The Armed Conflict Location and Event Data Project (ACLED) collects geo-referenced information on political violence, tracking actions of governments, militias, rebels, political parties, rioters, protesters, and civilians (Raleigh & Dowd, 2016).[4] This dataset includes information on the date, location, event type, reported fatalities and other event's conflict-related characteristics. Both the conflict event date and its location (latitude and longitude) allow assigning each conflict to a particular cell for a specific year. With conflict characteristics at the cell level, I construct the dependent variable *conflict incidence*, which is a dummy variable that takes the value of 1 if the cell records any conflict event during the year. Figure 1, panel a, contains the spatial distribution of the fraction of conflicts in each cell.

Mining Data. Data on mines comes from Berman et al. (2017), who in turn used the Raw Material Data (RMD) compiled by Intierra RMG. Their dataset identifies active mining cells and their *main mineral* produced in the period 1997-2010 (Figure 1, panel c and d show the spatial distribution of mines). To determine the main mineral produced by each mine, they look at the most produced mineral during the period of study, valued at 1997 prices. Their analysis identifies 25 different main minerals. However, like Berman et al. (2017), I focus on 13 minerals for which there is world price data available.

Two caveats are worth mentioning. First, taking the main mineral as the only min-

[2]Appendix A1 contains a table with a list of the 52 countries considered.

[3]Given the absence of international prices for certain minerals and crops, the baseline regression contains 115,666 observations. However, the missing observations do not follow any deterministic pattern, the mean of conflicts between the entire sample and the one used on the baseline regressions differs in 0.001, and it is not statistically significant.

[4]Political Violence is defined as the use of force by a group with a political purpose or motivation; it includes non-violent riots and protests (Raleigh & Dowd, 2016).

eral produced in the cell could lead to the mineral price being under or overestimated.[5] However, as Berman et al. (2017) show, among the 230 mining cells, the main mineral represents 96% of the total production value. Therefore, focusing on the main mineral alone should not cause considerable bias. Second, the mine dataset contains information mostly on large-scale mines. Thus, small-scale mines are not considered in the sample. As Berman et al. (2017) explain, this could lead to an attenuation bias due to measurement error. Nevertheless, as each mine corresponds to a cell of approximately 55 km^2, if these reserves are spatially clustered mine cells will also include small-scale mines thereby minimizing the bias (Berman et al., 2017).

Agricultural and Climate Data. Both the agricultural and climate data are taken from PRIO-GRID. Based on Monfreda et al. (2008) and Portmann et al. (2010), the PRIO-GRID map shows global land use in the same resolution of the previous data (0.5 degrees of latitude $\times$ 0.5 degrees of longitude). This high resolution allows me to identify the *main crop* produced in each grid cell. Of 32 different main crops,[6] I found international real prices for 13 crops from the World Bank commodity prices dataset, covering approximately 32% of the total average African production for the period 1997-2010, and approximately 62% of the continent's landmass (see Figure A9). To increase the sample, I took producer prices from FAO-STAT for two commonly grown crops: cassava and sesame.[7] Including these crops in the sample leads to an 82% coverage of the African continent, and 47% of the African agricultural production (1997-2010) (see Figure 1, panel b).[8]

Given that perennial tree crops are likely to be appropriate through taxation by the state or rebel groups (Bazzi & Blattman, 2014), I construct the variable *perennial tree crops* to denote coffee, cocoa and oil palm. The inclusion of this variable becomes crucial when testing for heterogeneous effects in the agricultural sector.

As an alternative variable to identify the behavior of the labor-intensive commodity, I follow Harari & La Ferrara (2018) who use a drought indicator based on the Standardized Precipitation and Evapotranspiration Index (SPEI). This drought index measures precipitation and evapotranspiration during the growing season, which gives a good proxy of

[5]For example, a mine that produces both aluminum (a mineral with a slow price growth) and gold (a mineral with a fast price growth), having aluminum as the main mineral produced, will underestimate a positive price increase as the rapid variations in gold prices are not taken into account.

[6]Including the category ”no crop”.

[7]Other sources with international prices were not available for the entire period of study. The possible endogeneity problems arising at using producer prices are discussed below.

[8]Appendix A2 and A5 contains a robustness check excluding cassava and sesame, showing that there is not a significant change in the main results.

crop yield. A positive value of the indicator denotes better conditions for agricultural production while a negative value denotes drought periods. Considering that the effect of harvest conditions may take time to materialize, I further include the first and second temporal lag of the SPEI index. Figure A5 shows the average spatial distribution of the indicator for the period 1997-2010.

Historical African-Specific Factors Data. A vast literature shows that current African development is closely related to historical events that have long-run impacts. This study considers three deep-rooted factors studied in the conflict literature: the Scramble for Africa, pre-colonial centralization and the slave trades. Data on *partitioned ethnic groups* come from Michalopoulos & Papaioannou (2016), who consider partitioned ethnic groups to be those that share at least 10% of their territory with two or more countries. Accordingly, I generate the variable *partitioned* that takes the value of 1 if a national border divides the ethnic group's homeland and none of the divided sections contains more than 90% of their territory. Figure A6 presents the cells of partitioned ethnic groups.

The pre-colonial centralized variable comes from Michalopoulos & Papaioannou (2013) who based themselves on the Murdock (1967) Jurisdictional Hierarchy Beyond the Local Community Level index (a map is available in Figure A7). This index shows the level of pre-colonial ethnic political organization. It ranges from 0 to 4 where 0 denotes stateless societies, 1 petty chiefdoms, 2 paramount chiefdoms, and 3 and 4 large states. As the change from stateless societies to petty chiefdoms might not be the same as the change from petty chiefdoms to paramount chiefdoms, following Michalopoulos & Papaioannou (2013), I construct a binary variable *centralized*, which takes the value of 1 if the ethnic group belonged to a paramount chiefdom or large state and 0 otherwise.

Finally, the data on the slave trades comes from Nunn & Wantchekon (2011). At an ethnic group level, this unique dataset only contains information on the transatlantic and Indian Ocean slave trades (Figure A8 contains a map with information on the ethnic groups affected by the slave trade). However, as Nunn (2008) argues, the transatlantic slave trade route is the most important one, and therefore, the results should not be biased due to the omission of the Red Sea and the trans-Saharan slave trades. Following Nunn & Wantchekon (2011), I create a continuous variable *slave trade* that considers the value of the ratio of slaves exported over the group's homeland area in logarithms.

Political Institutions Data. Data on institutions come from The Quality of Government Institute (QoG) of the University of Gothenburg (Dahlberg et al., 2019). Following Berman et al. (2017), I use five different indicators of the quality of political institutions measured in 1996.[9] The first indicator corresponds to the *ICRG* Indicator of Quality of Government from the International Country Risk Guide (2019). This indicator considers measures of corruption, the rule of law, and bureaucracy quality. The second group contains three indicators from the World Governance Indicators from the World Bank *Control of Corruption*, *Government Effectiveness* and *Rule of Law*. The fifth indicator corresponds to the revised combined *Polity* score (Dahlberg et al., 2019).

World Prices. Finally, I use international prices from the World Bank commodity prices dataset. All the prices are in real terms (constant US dollars in 2005), and they express the value of each commodity per metric ton. There are two significant challenges, one for each factor-intensive sector. First, regarding the mining sector, as Berman et al. (2017) explain, the lack of information on diamond quality and tantalum international prices makes it challenging to estimate their real value; therefore, diamonds and tantalum are excluded from the analysis. Appendix A2 contains robustness checks, including both minerals; the results remain almost unchanged.

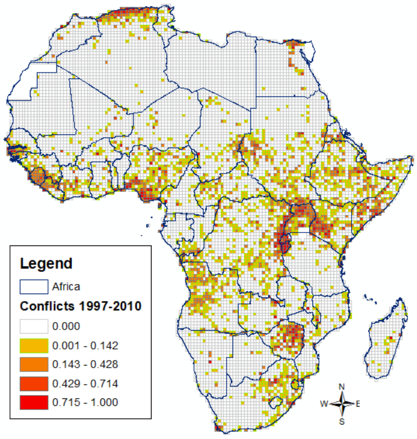
Second, regarding the agricultural sector, the main challenge is the lack of international prices for an important number of crops including cassava and sesame;[10] however, as these crops are widely produced throughout the continent, including them increases the sample considerably (for a graphical comparison compare Figure 1 panel b and Figure A9). In an attempt to calculate their value, I use the FAO producer prices received by farmers for primary crops. Given that these are collected at the point of initial sale (FAO), using these prices could introduce endogeneity problems. To minimize this problem, both cassava and sesame prices are an average of all producer countries that have information for the entire period of study.[11] A robustness check in Appendix A2 shows that including these crops does not change the main results.

[9] Appendix A3 and A4 contains results considering the average in different time frames.

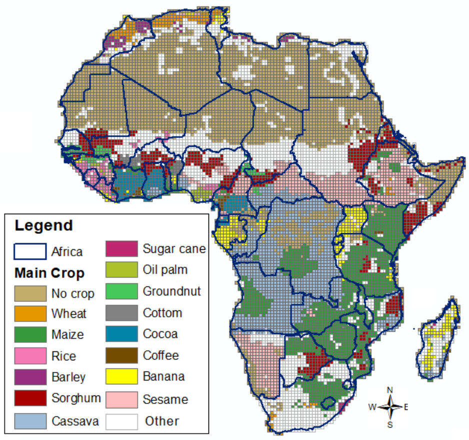
[10] This problem has been raised previously in Bazzi & Blattman (2014) and Berman & Couttenier (2015).

[11] The average cassava price includes Cameroon, Congo, Ghana, Madagascar, Mozambique and Nigeria. The average sesame price includes Ethiopia and Nigeria.

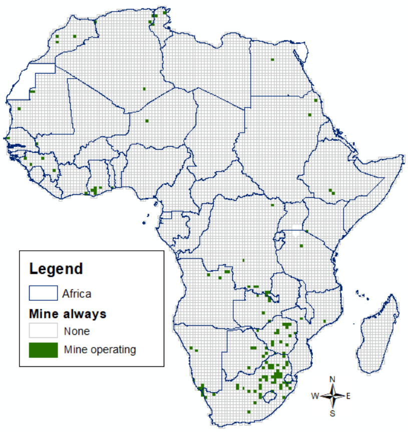
FIGURE 1: SPATIAL DISTRIBUTION CONFLICTS, CROPS AND MINES



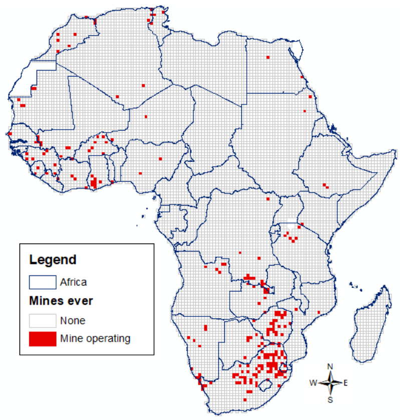
(A) CONFLICTS, 1997 - 2010



(B) MAIN CROP, 2000



(C) MINES ALWAYS OPEN, 1997-2010



(D) MINES EVER OPEN, 1997-2010

2.2 Descriptive Statistics

Table 1 contains summary statistics for the total number of cells in the period 1997-2010. It presents information on the different conflict-events types, variables related to the agricultural and mining sectors, and control variables considered for testing heterogeneous effects.

Table 1 shows that the unconditional mean of *any conflict* is 0.055. In other words, the probability of observing a conflict in a given cell for a given year is 5.5%. Of the three types of conflict considered, riots and protests, presents the lowest value with a probability of 1.5%.

Regarding the variables for agricultural products, the number of observations corresponds to approximately 81% of the total, reflecting the price availability problem discussed above. The SPEI index is constructed using crop information and therefore, does not contain observations for non-producing cells, which are approximately 34% of the continent.[12] Lastly, 3% of the observations considered in the agricultural sector contain a perennial tree crop.

The mining sector variables show that the variation in mineral prices is higher than the variation in agricultural prices. The probability of observing a mining cell during the study period is 2.2% under the first definition (mine ever), and 1.2% under the second definition (mine always).

Finally, the last two sections of Table 1 show information for the control variables. The historical African-specific factors show that 40% of the cells contain territory belonging to ethnic groups affected by the Scramble for Africa, 50% presented a mid or high degree of centralization, and ethnic groups affected by the transatlantic and Indian Ocean slave trades exported 30,000 slaves on average. The institutional country-level variables detail the distribution of the governance indicators for the year 1996.

TABLE 1: SUMMARY STATISTICS

Variable	Number of observations	Mean	Standard deviation	Min	Max
Conflicts					
Any conflict	144,690	0.055	0.228	0	1
Battles	144,690	0.028	0.166	0	1
Riots and protests	144,690	0.015	0.123	0	1
Violence against civilians	144,690	0.029	0.167	0	1
Agricultural Products					
Ln main crop price weighted	116,984	0.895	1.264	0	6.742
SPEI crop	96,401	0.091	0.133	0	1.083
Perennial Tree Crops	116,984	0.031	0.173	0	1
Mineral Products					
Ln main mineral price	144,690	0.227	1.717	0	17.762
Mine ever	144,662	0.022	0.147	0	1
Mine always	143,220	0.012	0.110	0	1
Historical African-specific factors					
Partitioned ethnic group	137,620	0.401	0.490	0	1
Pre-colonial centralized	83,412	0.506	0.500	0	1
Number of slaves exported	139,342	30,698	271,250	0	3,838,953
Institutional country level variables					
ICGR	128,506	0.461	0.175	0.111	0.875
Control of Corruption	144,690	-0.736	0.630	-1.648	1.143
Government Effectiveness	144,606	-0.742	0.653	-1.960	1.020
Rule of Law	144,690	-0.916	0.677	-2.145	1.044
Polity	144,676	-1.219	5.123	-9	10

Notes: The number of observations shows the total number of cells during the entire period of study. ICRG is the Indicator of Quality of Government from International Country Risk Guide (2013).

[12]Figure A5 show that non-producer cells are mainly clustered in the Sahara desert.

Going further, Table 2 shows the conditional mean of conflicts for each of the control variables and the results of mean difference tests. The conditional mean reveals that regardless of the measure, regions abundant in natural resources are more prone to conflict. In the case of mines, the probability of conflicts increases from 5.3% to approximately 14%. Likewise, cocoa production zones present a conflict likelihood of 6.5%, higher than regions with no crops (1.7%), being all differences statistically significant.

The next set of conditions correspond to the historical African-specific factors. Conditioning conflict events in regions with and without partitioned groups show that non-partitioned groups present a higher conflict rate in this sample. The mean of conflicts for places with pre-colonial centralized states does not differ from those with non-centralized states.[13] Finally, regions affected by the slave trades present a significantly higher probability of being engaged in conflicts.

Regarding the institutional framework, the table shows that countries with better institutions present fewer conflicts than those with weak institutions. All differences are significantly different from zero.

[13] The null hypothesis of equal mean values cannot be rejected.

TABLE 2: DIFFERENCE OF MEAN OF CONFLICTS BY CONTROL VARIABLES

	Observations	Mean	Diff. Mean	p-value
Conflict probability				
if mine not present	141,470	0.053		
if mine always present	1,750	0.139	-0.085	0.000
if mine ever not present	141,442	0.053		
if mine ever present	3,220	0.129	-0.076	0.000
if main crop is cocoa	2,548	0.065		
if no main crop	48,216	0.017	0.048	0.000
if main crop is cocoa	2,548	0.066		
if main crop is cow-pea	4,704	0.051	0.015	0.006
if non-partitioned	82,334	0.062		
if partitioned	55,286	0.051	.011	0.000
if non-centralized	41,160	0.059		
if centralized	42,252	0.059	0.000	0.931
if non-slave traded	92,652	0.050		
if slaves traded	46,690	0.072	-0.023	0.000
if low ICRG	101,360	0.058		
if high ICRG	27,146	0.054	0.004	0.018
if low Control of Corruption	113,050	0.056		
if high Control of Corruption	31,640	0.051	0.005	0.001
if low Government Effectiveness	110,446	0.059		
if high Government Effectiveness	34,160	0.044	0.015	0.000
if low Rule of Law	109,158	0.063		
if high Rule of Law	35,532	0.030	0.033	0.000
if low Polity	110,516	0.061		
if high Polity	34,160	0.034	0.026	0.000

Notes: The number of observations shows the total number of cells during the entire period of study. Slave trade is a dummy variable that takes the value of 1 if the region has exported one or more slaves. ICRG is the Indicator of Quality of Government from International Country Risk Guide (2013). Variables preceded by "high"(low) are dummy variables that take the value of 1(0) if their value is higher (lower) than the percentile 75.

3 METHODOLOGY

The objective of this study is to test the Dal Bó & Dal Bó (2011) theory. This theory states that positive income shocks, which increase country-level resources, could lead to different results in terms of conflicts. Using a general equilibrium approach, the model shows that positive shocks to labor-intensive industries diminish conflict, while positive shocks to capital-intensive industries increase it (Dal Bó & Dal Bó, 2011). This conclusion relies on the commodities' rent appropriability degree. Generally, the state easily appropriates rents from commodities that require a high level of capital investment, such as oil and minerals, contrary to agricultural products that are more difficult to tax. However, as Bazzi & Blattman (2014) state, perennial tree crops like coffee and cocoa, also require an important capital investment and are easily taxed, which could also increase conflicts through the state as prize mechanism.

Following Dube & Vargas (2013), I study the impact of an international commodity shock on conflict incidence for both a relatively capital-intensive sector (mines) and a relatively labor-intensive sector (agriculture). Next, as in Dube & Vargas (2013); Berman & Couttenier (2015); Berman et al. (2017); Fetzer et al. (2018), I exploit exogenous commodity price variations to address causality. At a grid cell level of 0.5 degrees of latitude $\times$ 0.5 degrees of longitude for the entire African continent, the commodity price is assigned to each cell based on the cell's main mineral and crop, respectively.

Following Berman & Couttenier (2015), Berman et al. (2017) and Harari & La Ferrara (2018), I estimate a panel data model with two high-dimensional fixed effects: cell fixed effects and country $\times$ time fixed effects. The advantage of considering both cell and country $\times$ time fixed effects is that they control not only for unobserved heterogeneity at the cell level but also for unobserved time-varying effects at the country level. Therefore, this approach captures all inter-cell variability by considering cell fixed effects. In addition, it also allows for the existence of different country-level patterns in time, removing unobserved heterogeneity at higher levels (Guimaraes & Portugal, 2010).

More precisely, the cell fixed effects control for unobserved time-invariant cell-specific variables that are related to conflict incidence and production of commodities. For example, it captures terrain characteristics such as elevation, roughness and distance to ports. Therefore, a variation in the commodity price shows the impact on conflicts *within* cells, i.e. with respect to the cell's long-term mean.

At the same time, the country $\times$ time fixed effects control for all the time-varying country-level variables that affect both conflict incidence and production of commodities. This approach allows capturing any country-specific event in a particular year that could affect our relationship of interest, for example, a change in a country regime from a dictatorship to a democracy in a specific year. Thus, the country $\times$ time fixed effects could be seen as both an advantage and a limitation. On the one hand, having time-varying controls allows diminishing problems of omitted variable bias. On the other hand, the controls could include important channels that explain the relationship under study.

Following Dube & Vargas (2013), the specification considers both the capital-intensive as well as the labor-intensive sector. It also controls for the battery of fixed effects discussed above. The regression adopts the following form:

$$Conflict_{i,c,t} = \beta_1(CC_{i,t} \times \ln P_{i,t}^{w,CC}) + \beta_2(LC_{i,t} \times \ln P_{i,t}^{w,wLC}) + \alpha_i + \gamma_{c,t} + \varepsilon_{i,c,t}, \quad (1)$$

where (i, c, t) are cell, country, and time, respectively. The outcome variable, denoted by $Conflict_{i,c,t}$, is a dummy variable that takes the value of 1 if cell i presents any conflict in time t. The covariate $(CC_i \times \ln P_{i,t}^{w,CC})$ denotes the interaction between the capital-intensive commodity (CC_i) and the logarithm of the capital-intensive international commodity price ($lnP_{i,t}^{w,CC}$). The former is given by the main mineral produced in cell i, while the second represents the cell's main mineral world price i in year t. Correspondingly, $(LC_i \times \ln P_{i,t}^{w,wLC})$ denotes the interaction between the labor-intensive commodity (LC_i) given by the main crop in cell i, and the logarithm of the labor-intensive international commodity price ($\ln P_{i,t}^{w,wLC}$) given by the cell's main crop world price i in year t weighted by the cell's proportion of land used for the main crop production.[14] Finally, α_i represents the cell's unobserved heterogeneity, $\gamma_{c,t}$ captures the country $\times$ time fixed effects, and $\varepsilon_{i,c,t}$ is the error term clustered at spatial and time levels in the baseline regressions.

The parameters of interest are β_1 and β_2. According to the Dal Bó & Dal Bó (2011) model, an income shock in the capital-intensive sector should drive social unrest; in contrast, if the income shock affects the labor-intensive sector conflicts should decrease. If this theory applies to the African continent, under a positive commodity shock, the coefficient β_1 should be positive while the coefficient β_2 should be negative.

The identification strategy relies on the exogeneity of the principal covariates of interest. Therefore, it is crucial to address both the exogeneity of natural resources production and the exogeneity of international commodity prices.

The first point is the most challenging to address. For both sectors, the main problem is reverse causality, where conflicts affect both mining and agricultural production. Regarding mining production, conflicts could increase the probability that a mine closes or opens, which affects the mine locations being identified. To avoid reverse causality problems in the mining sector, I follow Berman et al. (2017) and consider two measures for mining cells. The first measure identifies a cell as a mining cell if it has mines that

[14] The proportion of a cell's land devoted to the production of the main crop (θ_i) works as a measure of production intensity, which moderates the price shocks in cells with low production. The construction of the measure follows Berman & Couttenier (2015) and can be expressed as: $\ln P_{i,t}^{w,wLC} = \ln(\theta_i \times P_{i,t}^{w,LC})$.

did not close during the entire period of study. The second measure defines a mining cell as those that have had a mine at some point during the period of study.[15] The agricultural case is also prone to reverse causality problems. Given that the main crop is identified in a period close to the year 2000 (Monfreda et al., 2008), it could be argued that conflicts affected farmers' agricultural decisions. However, agricultural practices show to be stable over time, diminishing possible problems of reverse causality. For instance, important crop producers like Cote d'Ivoire and Nigeria show little variation in their country-level production between 1980-2010.[16]

The argument of exogeneity of international prices relies on the relative importance of African countries as leading producers of minerals and agricultural products. If countries produce an amount large enough to modify international prices, these are not price takers but price makers, casting doubt on the exogeneity assumption. For the mining sector, Berman et al. (2017) show that the sample does not contain mines that are large enough to modify international prices. The authors perform a robustness analysis with possible mines that could affect international prices and find that their influence on the results is negligible. Regarding the labor-intensive sector, of the 13 crops for which an international price is available only 4 are produced in an African country that belongs to the top 5 list of producers. During 1997-2010, the largest African agriculture producer was Cote d'Ivoire with 34% of worldwide cocoa production. For the rest of products African countries do not produce more than 15% of the world production.[17] Robustness checks available in appendix A5 show that excluding the crops of the top 5 producer countries for specific crops, does not change the results.[18]

Given that conflicts and natural resources are clustered on space, the standard errors are adjusted for spatial correlation (Berman et al., 2017; Harari & La Ferrara, 2018). The baseline presents spatial Heteroskedasticity and Autocorrelation Consistent (HAC) errors. This adjustment developed by Conley (1999), Hsiang (2010) and Hsiang et al. (2011) allows me to control not only for cross-sectional spatial correlation, but also for serial correlation.[19] Based on the period of study, I consider a threshold of 25 years for

[15]As discussed in section II, this approach could lead to attenuation bias due to measurement error.

[16]In 30 years the percentage of cassava in the total agricultural production in Cote d'Ivoire change from 9.87% to 11.94%, in the case of cocoa from 4.08% to 6.74%, yams from 23.51% to 27.92%; likewise, the cassava in Nigeria remained stable changing from 26.87% to 27.19% (FAO-STAT).

[17]For cocoa: Ivory Coast (34.54%), Ghana (14.77%), Nigeria (9.94%); for groundnuts: Nigeria (8.49%); for oil palm: Nigeria (3.41%); for sorghum: Nigeria (13.38%), Sudan (6.28%) (FAO-STAT).

[18]Further, Appendix A6 instruments crop prices with world production. Given the increase in the standard errors, an intrinsic feature of instrumental variables, the coefficient loses significance and changes the sign. However, the 95% confidence interval contains the baseline estimates.

[19]For the estimations I use the version of *reg2hdfespatial* shared by Nicolas Berman, Mathieu Couttenier,

the horizon of the within-cell serial correlation decay. The spatial correlation considers a radius of 500km for the spatial kernel, a distance close to the median internal distance across the African countries considered in Berman et al. (2017). Appendix A7 presents a robustness analysis with different thresholds for both the serial correlation decay and the spatial correlation radius, and appendix A8 shows a robustness check with different types of clustering. The results show that the baseline regressions are robust to different standard errors calculations.

After finding the coefficients of interest further estimations consider heterogeneous effects. I divide the possible sources of heterogeneity in three categories: perennial tree crops, historical African-specific factors, and quality of institutions. As these variables are time-invariant, and therefore captured by the cell fixed effects, the specification includes a triple interaction of each factor to test possible heterogeneities. Equation 1 is modified as follows:

$$\begin{aligned} Conflict_{i,c,t} =& \beta_1(CC_{i,t} \times \ln P^{w,CC}_{i,t}) + \beta_2(LC_{i,t} \times \ln P^{w,wLC}_{i,t}) \\ &+ \beta_3(CC_{i,t} \times \ln P^{w,CC}_{i,t} \times Z_i) + \beta_4(LC_{i,t} \times \ln P^{w,wLC}_{i,t} \times Z_i) \\ &+ \alpha_i + \gamma_{c,t} + \varepsilon_{i,c,t}, \end{aligned} \tag{2}$$

where $(CC_{i,t} \times \ln P^{w,CC}_{i,t} \times Z_i)$ denotes the triple interaction for variable Z_i considering the capital-intensive sector, while $(LC_{i,t} \times \ln P^{w,LC}_{i,t} \times Z_i)$ show the triple interaction for variable Z_i considering the labor-intensive sector.

The first exercise captures heterogeneous effects for perennial tree crops. The second category of heterogeneous effects includes ethnic partition, pre-colonial centralization and slave trade. There are data available for the three factors at an ethnic group level. Therefore, I extrapolate the ethnic level information to a cell level information using their geo-referenced data. Likewise, the regressions for these variables contain standard errors clustered at the ethnic level. The third category corresponds to the institutional framework. Following Berman et al. (2017), the specifications include different indexes that capture the quality of institutions. All the indexes included are measured one year before the period of study (in 1996), to avoid possible endogeneity problems.[20] As these are country measures, the standard errors are clustered at a country level.

Dominic Rohner, and Mathias Thoenig. This code is based on previous contributions done by Fetzer (2014), and Hsiang (2010).

[20]Robustness checks including different time-frames for the institutional measures are presented in Appendix A3 and A4.

4 RESULTS

4.1 Main Results

Table 3 contains the baseline results for the specification described in equation (1). The dependent variable is *conflict incidence*, a dummy variable that takes the value of 1 when a cell records any violent political event during a given year. The covariates of interest are both capital-intensive and labor-intensive sector commodity price shocks. *Mine* × *ln Mineral price* and *Mine ever* × *ln Mineral price* represent the two different alternatives to measure the capital-intensive commodity shock. Similarly, *Main crop* × *ln Crop price w* and *SPEI crop* show the different approximations to capture the labor-intensive commodity shock. Panel A. shows the results for the entire African continent, while Panel B. contains the results for sub-Saharan Africa. Finally, the last section of Table 3 shows the different set of options for the fixed effects controls.

The overall results are consistent with the Dal Bó & Dal Bó (2011) model, and the empirical implementation of Dube & Vargas (2013). Columns 1 to 6 show a positive relationship between capital-intensive commodity shocks and conflict incidence, with both alternative mining measures being statistically significant. On the other hand, the coefficients in columns 1 to 4 show a negative relationship between labor-intensive commodity shocks and conflict likelihood. The first alternative measure of the labor-intensive commodity (price shocks) is statistically significant when considering sub-Saharan Africa, while the second alternative (SPEI crop index) is significant for both samples. As columns 3 and 4 show, the drought index takes time to materialize with the second lag being the statistically significant coefficient.

Columns 1 and 2 show the coefficients of the commodity price shocks under the two different mining alternatives. Column 1 considers mines that produced permanently during the study period, while column 2 considers a cell to be a mining producer if it has had at least one mine open during 1997-2010. The second approach shows a lower estimate than the first measure. This could be driven by an attenuation bias due to measurement error, where cells with closed mines are considered as mining producer cells (Berman et al., 2017). Due to this possible bias, the first alternative seems to be more accurate.

Columns 1 and 2 contain the first alternative measure for the agricultural sector (weighted crop prices in logarithms), while columns 3 and 5 contain the results when using the drought index. Given that one of the main objectives of this study is to have comparable measures of commodity price shocks in both the labor- and the capital-intensive sectors, alternative one is preferred. For the sake of comparison between both shocks, commodity prices are in log transformations.

TABLE 3: CONFLICT INCIDENCE, CAPITAL- AND LABOR-INTENSIVE COMMODITY PRICE SHOCKS

	Conflict Incidence					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. All Africa						
Mine × ln Mineral price	0.076***		0.071***		0.093***	
	(0.019)		(0.019)		(0.023)	
Main Crop × ln Crop Price w	-0.010	-0.012			0.008	0.007
	(0.009)	(0.009)			(0.010)	(0.010)
Mine ever × ln Mineral price		0.044***		0.048***		0.057***
		(0.015)		(0.014)		(0.020)
SPEI crop			-0.007	-0.007		
			(0.008)	(0.008)		
SPEI crop,$_{t-1}$			-0.003	-0.003		
			(0.008)	(0.008)		
SPEI crop,$_{t-2}$			-0.021***	-0.022***		
			(0.008)	(0.008)		
Mean of the dependent variable	0.0557	0.0565	0.0739	0.0747	0.0557	0.0565
Observations	115666	116620	81198	82161	115666	116620
Panel B. Sub-Saharan Africa						
Mine × ln Mineral price	0.091***		0.074***		0.110***	
	(0.021)		(0.020)		(0.026)	
Main Crop × ln Crop Price	-0.016*	-0.018*			0.009	0.007
	(0.009)	(0.009)			(0.011)	(0.011)
Mine ever × ln Mineral price w		0.053***		0.049***		0.068***
		(0.017)		(0.015)		(0.022)
SPEI crop			-0.010	-0.010		
			(0.009)	(0.009)		
SPEI crop,$_{t-1}$			-0.001	-0.000		
			(0.009)	(0.009)		
SPEI crop,$_{t-2}$			-0.019**	-0.020**		
			(0.009)	(0.009)		
Mean of the dependent variable	0.0634	0.0643	0.0760	0.0769	0.0634	0.0643
Observations	93350	94220	74286	75213	93350	94220
Controls (for all panels)						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	No	No
Time Fixed Effects	No	No	No	No	Yes	Yes

Notes: Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500 km. radius and for 25 years serial correlation. Mine is a dummy variable that takes the value of one when the mine is open the entire period. ln Mineral price shows the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if the there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. SPEI crop is a drought index, higher values indicate better harvest conditions.

Columns 5 and 6 show the same specifications of columns 1 and 2 with different fixed effects. Instead of taking *country* $\times$ *time fixed effects*, the models only control for *time fixed effects*. The underlying assumption of *time fixed effects* relies on the homogeneity of time-varying shocks, which implies that each year shock affects all the cells to the same extent. Both columns 5 and 6 present a higher impact of the capital-intensive sector shock, while the labor-intensive commodity loses significance and changes the sign. Given that different countries produce different crops, it is unlikely that *time fixed effects* fully capture the time-variant country heterogeneity, which could explain the unexpected behavior of the coefficient associated with the labor-intensive shock. Due to the importance of capturing time-variant country-level heterogeneity, models with *country* $\times$ *time fixed effect* are preferred.

All in all, the preferred specification is the one shown in column 1, which defines mining cells as those that contain mines that continuously worked throughout the period of study, calculates the labor-intensive shocks through crop prices, and uses cell and country $\times$ time fixed effects. In line with the literature, the heterogeneous effects are estimated for both the entire African continent and sub-Saharan Africa.

Regarding the magnitude of the impacts, the coefficients in column 1 show that for the entire African continent, on average, a 10% increase in mineral prices increases the conflict likelihood by 0.76 percentage points (p.p.) in cells with mines working permanently during the period of study, relative to the cell's long term mean. This magnitude increases to 0.91 p.p. when addressing sub-Saharan Africa. Relative to the mean of the dependent variable, a 10% increase in mineral prices implies a 13.78% increase in conflict incidence considering the whole continent and a 14.35% increase in the sub-Saharan Africa sample. With respect to the impacts of the labor-intensive commodity, column 1 shows that an increase in crop prices has the opposite effect. The coefficient lacks significance for the entire African continent; however, it is statistically significant for the sub-Saharan sample. For sub-Saharan Africa, on average a 10% increase in the price of crops weighted by the cell's land use leads to a decrease in conflict likelihood of 0.16 p.p., a substantially lower magnitude than the effects of the capital-intensive commodity. In this case, a 10% increase in agricultural prices represents a drop of 2.52% in conflict incidence relative to its mean.

The former results allow addressing the impacts of the commodity price boom of the first decade of the 21st century as in Dube & Vargas (2013). During the period 2000-2010, the prices of many minerals have more than doubled. The average mineral prices increased in 2.07 log points during this time frame, which suggests that the commodity price boom in the mineral sector induced an increase of approximately 15 percentage points the conflict likelihood in mining producing cells, relative to the cell's long term mean. In the case of sub-Saharan Africa, the impact magnitude reaches 18.8 p.p. On the other hand, the price of agricultural products increased by a much lower amount. During the period 2000-2010, the average weighted crop prices increased by only 0.3 log points, which suggests that the commodity price boom led to a reduction of 0.49 p.p. in conflict likelihood in sub-Saharan Africa. These estimations indicate that the commodity price boom of the first decade of the 21st century, which had a greater effect on high-value commodities, tended more to increase conflicts.

4.2 Heterogeneous Effects: Perennial Tree Crops

One of the key elements that drive the results of the Dal Bó & Dal Bó (2011) theory is the differential degree of appropriability of the capital- and labor-intensive sectors. In this context, capital-intensive goods such as oil and minerals are more easily taxed than labor-intensive commodities such as cowpeas and groundnuts. However, some labor-intensive products such as cocoa, coffee, and palm oil are easier to tax. Perennial tree crops require a significant initial capital investment; usually, they have a high market value, and, because of their perennial characteristic, they are easily inspected, becoming targets for taxation (Bazzi & Blattman, 2014). If perennial tree crops are a non-negligible government's income source, they could contribute to the state as prize mechanism. Therefore, an increase in their price could raise conflicts, going in the opposite direction of the baseline results.

TABLE 4: CONFLICT INCIDENCE, AND PERENNIAL TREE CROPS

	Conflict Incidence							
	All Africa				Sub-Saharan Africa			
	Baseline	Including Perennial	Excluding Cassava	Excluding Cote d'Ivoire	Baseline	Including Perennial	Excluding Cassava	Excluding Cote d'Ivoire
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mine × ln Mineral price	0.076***	0.078***	0.068***	0.077***	0.091***	0.092***	0.084***	0.092***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.021)	(0.021)	(0.022)	(0.021)
Main crop × ln Crop price w	-0.010	-0.020**	-0.022*	-0.019*	-0.016*	-0.026***	-0.033 ***	-0.026***
	(0.009)	(0.010)	(0.013)	(0.010)	(0.009)	(0.009)	(0.012)	(0.010)
× Perennial tree crops		0.079***	0.083***	0.066**		0.084***	0.091***	0.070***
		(0.024)	(0.025)	(0.027)		(0.024)	(0.025)	(0.027)
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115666	115666	99804	114182	93350	93350	77488	91866

Notes: Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for 25 year serial correlation. Mine is a dummy variable that takes the value of one when the mine is open the entire period. ln Mineral price shows the cell's main mineral international real price in logarithms. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. Perennial tree crops is a dummy variable that takes the value of one if the main crop is cocoa, coffee or palm oil.

Table 4 shows the presence of heterogeneous effects of perennial tree crops in the agricultural shock. The triple interaction ($Main\ crop \times \ln Crop\ price\ w \times Perennial\ tree\ crops$) shows a statistically significant positive coefficient, which reveals that the coefficient of the agricultural shock has differential effects for different crops. Column 2 shows that in the case of Africa, the magnitude of crop prices changes from -0.01 to -0.02, and it becomes statistically significant at the 5% significance level. Similarly, for sub-Saharan Africa, the coefficient in column 6 shows that, on average, a 10% increase in the crop prices decreases conflict likelihood by 0.26 p.p. instead of the initial result of 0.16 p.p.

Regarding the effect magnitude of perennial tree crops on conflict likelihood, columns 2 and 6 show that the coefficient is similar to the one estimated for the capital-intensive commodity. Considering the entire continent (left-hand side panel), on average, a 10% increase in the weighted crop price increases conflict likelihood differently for perennial tree crop areas in 0.79 p.p. relative to the cell's long term mean. This magnitude reaches 0.84 p.p. in the case of sub-Saharan Africa. However, it is essential to note that mineral prices increased substantially more than crop prices during the period of study. Therefore, the detrimental effects on conflicts of the commodity price boom are much higher for minerals compared with perennial tree crops.

Columns 3 and 7 show that the results are robust to the exclusion of cassava, whose production is closely related to the presence of conflicts. Given that cassava is a tuber hard to tax, it could be driving the negative relationship between agricultural prices and conflicts. However, the results show that the relationship found is robust to this change.

Finally, columns 4 and 8 contain the results obtained when Cote d'Ivoire, the largest exporter of cocoa on the continent, is excluded. Given that the first Ivorian Civil War started in 2002, it could be driving the positive relationship between perennial tree crops and conflicts. Nevertheless, both columns show that the coefficient remains stable, showing the importance of considering different degrees of appropriability in the agricultural sector.

4.3 Heterogeneous Effects: Historical African-specific Factors

A large literature studies the long-run effects of historical factors that have affected the African continent. Among these different possible historical factors, *ethnic partition*, *pre-colonial centralization*, and the *slave trade* have received particular attention.[21] This

[21] For ethnic partition see Michalopoulos & Papaioannou (2016), for pre-colonial centralization Michalopoulos & Papaioannou (2013), for slave trade Nunn (2008); Nunn & Wantchekon (2011).

section tests whether current commodity shocks affect differently along these three dimensions.

TABLE 5: CONFLICT INCIDENCE, AND HISTORICAL AFRICAN-SPECIFIC FACTORS

	Conflict Incidence									
	All Africa					Sub-Saharan Africa				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mine × ln Mineral price	0.076***	0.061***	0.088**	0.077***	0.087*	0.091***	0.079***	0.088**	0.093***	0.097*
	(0.019)	(0.020)	(0.039)	(0.020)	(0.050)	(0.021)	(0.022)	(0.039)	(0.020)	(0.054)
× Partition		0.032			0.000		0.023			-0.014
		(0.036)			(0.043)		(0.039)			(0.047)
× Centralized			-0.033		-0.032			-0.013		-0.012
			(0.047)		(0.051)			(0.048)		(0.053)
× Slave trade				-0.008	-0.001				-0.015	-0.009
				(0.009)	(0.011)				(0.009)	(0.011)
Main crop × ln Crop price w	-0.010	-0.013	-0.017	-0.013	-0.026	-0.016*	-0.020	-0.018	-0.019*	-0.027
	(0.009)	(0.013)	(0.017)	(0.011)	(0.019)	(0.009)	(0.014)	(0.017)	(0.011)	(0.020)
× Partition		0.007			0.016		0.011			0.017
		(0.014)			(0.017)		(0.014)			(0.018)
× Centralized			0.005		0.006			0.003		0.004
			(0.021)		(0.020)			(0.021)		(0.021)
× Slave trade				0.010	0.007				0.011	0.008
				(0.014)	(0.016)				(0.014)	(0.015)
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	115666	109590	69005	110472	68781	93350	91082	57679	91684	57581

Notes: Significance level: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Columns 1 and 6 contain Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for 25 years serial correlation. Columns 2-5 and 7-10 present ethnic level clustered standard errors in parentheses. ln Mineral price shows the cell's main mineral international real price in logarithms. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. Partition is a dummy variable that takes the value of one if the cell corresponds to an ethnic group where 10% or more territory belongs to two or more countries (based on Michalopoulos & Papaioannou (2016)). Centralized is a dummy variable that represent the ethnic group's pre-colonial centralization level, it takes the value of one when the Murdock's (1960) Jurisdictional Hierarchy Beyond the Local Community Level index is equal or greater than 2 (following Michalopoulos & Papaioannou (2013)). Slave trade is a continuous variable of the ratio of slaves exported over homeland extension (data comes from Nunn & Wantchekon (2011)).

Table 5 includes triple interactions of each historical African-specific factor: the Scramble for Africa *(Partition)*, pre-colonial centralization *(Centralized)*, and transatlantic and Indian Ocean slave trades *(Slave trade)*, with both the capital- and labor-intensive sectors. The left-hand side panel shows the results considering the entire sample, while the right-hand side panel contains the results for sub-Saharan Africa. All the specifications present both cell fixed effects and country × time fixed effects.

Columns 1 and 6 show the baseline results for both samples. Columns 2 and 7 include the triple interaction capturing the differential impacts for partitioned ethnic groups. According to the literature, partitioned ethnic groups are more prone to be engaged in conflicts Michalopoulos & Papaioannou (2016). In this case, the triple interaction captures the differential impacts for both partitioned and non-partitioned groups under a commodity price shock. In line with the literature, the results show a positive sign suggesting that partitioned groups are more prone to have conflicts under a commodity shock regardless of the factor intensity. However, the estimates are not statistically significant different from zero, which suggest that commodity price shocks do not affect both groups differently.

Columns 3 and 8 contain the results when including the triple interaction for pre-colonial centralized ethnic groups. In this case, the coefficients of the interaction with the capital-intensive sector are negative. The interaction with the labor-intensive sector suggests the opposite effect with a positive sign. Nevertheless, similar to the former case, the coefficients show that commodity shocks do not have a different effect on centralized and non-centralized pre-colonial ethnic groups.

When addressing differential effects for both groups that exported a higher amount of slaves relative to the size of their homeland territory and those without a slave trade legacy, I find that a commodity shock does not affect these groups differently (columns 4 and 8). Finally, columns 5 and 10 introduce all the interactions together. As with the individual interactions, none of the coefficients is significantly different from zero, suggesting the absence of differential impacts for African Historical Factors.

In a nutshell, the results suggest that none of the three historical African-specific factors –ethnic partition, pre-colonial centralization, and slave trade– present differential effects under current commodity shocks. Even though the literature shows evidence of these three variables' overall impact, the results do not reveal differential effects when addressing commodity shock impacts. These results could suggest that historical factors are important from a long-run perspective, but when groups are affected by transitory shocks such as commodity prices, other current variables drive the relationship.

4.4 Heterogeneous Effects: Quality of Institutions

Regions with better institutional quality present a weaker relationship between natural resources and conflicts than regions with weak institutions (Adhvaryu et al., 2018; Fetzer et al., 2018). The underlying theory states that regions with a strong institutional framework are better at managing resource revenues, and therefore they have less resource-driven conflicts (Besley & Persson, 2010, 2011). Given that the governments' main revenues come from high-value capital-intensive commodities, this section tests for the existence of heterogeneous effects of a commodity shock in the mining sector.

Table 6 show the results of including a triple interaction that captures the differential effects of a capital-intensive commodity shock for regions with strong institutions. Following Berman et al. (2017), I consider pre-sample indexes of institutional quality (levels in 1996). Next, I construct a dummy variable for each measure if the index is greater than its percentile 75 value. The first index is the International Country Risk Guide (ICRG), which contains a measure of country risk considering both political and economic risks. The second set of indexes includes three indexes from the Worldwide Governance Indicators. These are: *government effectiveness*, *control of corruption* and *rule of law*. The last specification contains the democracy variable *Polity*. As before, I regress these different specifications for both samples all Africa and sub-Saharan Africa.

TABLE 6: CONFLICT INCIDENCE, AND QUALITY OF INSTITUTIONS

	Conflict Incidence					
	(1)	(2)	(3)	(4)	(5)	(6)
Variable Z		ICRG	Control of Corruption	Government Effectiveness	Rule of Law	Polity
Panel A. All Africa						
Mine × ln Mineral price	0.076***	0.068**	0.085***	0.089***	0.088***	0.080***
	(0.019)	(0.028)	(0.027)	(0.031)	(0.027)	(0.027)
× Variable Z		0.022	-0.028	-0.030	-0.038	-0.014
		(0.040)	(0.031)	(0.034)	(0.031)	(0.028)
Main crop × ln Crop price w	-0.010	-0.012	-0.010	-0.010	-0.010	-0.010
	(0.009)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)
Observations	115666	102408	115624	115568	115624	115624
Panel B. Sub-Saharan Africa						
Mine × ln Mineral price	0.091***	0.082**	0.100***	0.105***	0.101***	0.103***
	(0.021)	(0.032)	(0.029)	(0.031)	(0.028)	(0.028)
× Variable Z		0.024	-0.029	-0.033	-0.032	-0.037
		(0.043)	(0.029)	(0.034)	(0.029)	(0.029)
Main crop × ln Crop price w	-0.016*	-0.018	-0.016	-0.016	-0.016	-0.016
	(0.009)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)
Observations	93350	80148	93308	93308	93308	93308
Controls (for all panels)						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Significance level: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Column 1 contain Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for 25 year serial correlation. Columns 2-6 present country level clustered standard errors in parentheses. ln Mineral price shows the cell's main mineral international real price in logarithms. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. ICRG stands for International Country Risk Guide, index of country risk evaluating political and economic risks. Rule of Law, Government Effectiveness, Control Corruption are part of the World Governance Indicators of the World Bank. Polity, measure authority characteristics of the countries.

For the first variable of institutional quality ICRG, the triple interaction coefficient shows an unexpected positive sign for both Panel A and B; however, these coefficients are not statistically significant different from zero. Contrary, columns 3-6 show a negative sign for the triple interaction of control of corruption, government effectiveness, the rule of law, and the polity index, suggesting that regions with better institutional quality are less prone to being engaged in resource-related conflicts; nevertheless, as in the first case, the coefficients lack significance.

Overall the results suggest that regions with better institutional frameworks do not react differently from regions with weak institutions under a commodity shock in the capital-intensive sector. However, the lack of significance in most cases could reflect that the country $\times$ time fixed effects are capturing the quality of institutions making heterogeneous effects hard to detect.

4.5 Shocks and Types of Conflicts

The literature documents that natural resources are a possible source of income that fuels violence and increases rent-seeking behavior. Therefore, it is important to address how commodity price shocks affect conflict incidence disaggregating for the type of conflict. This section presents the results of considering three types of conflicts: battles, riots and protests, and violence against civilians.

Table 7 shows the disaggregation of the baseline results by type of event. Panel A shows the results for the entire sample, while Panel B contains the results for sub-Saharan Africa. All the models include cell and country $\times$ time fixed effects and control for perennial tree crops.

According to the results in columns 1-3, an increase in mineral prices raises the probability that the cell presents battles. Under the first alternative of measuring mines, the effect is statistically significant. However, column 2 shows that regions that have ever had mines do not present an increase in the probability of having a battle. This behavior shows that capital-intensive commodity price shocks only increase the probability of having an armed conflict in cells with mines operating permanently, which can reflect that rebels want to take control of the producing centers.

Regarding the agricultural sector, columns 1 and 2 in Panel A show that the coefficient is not statistically significant. These coefficients become significant in the sub-Saharan sample, denoting a decrease in battle incidence when crop prices increase. Column 3 shows that climate conditions are contemporaneously related to battle incidence. This result could be capturing not only the opportunity cost channel in production but also the effects of climate conditions on armed conflict. For example, more rain implies moody conditions that reduce armed violence episodes committed by rebels, militias and government forces. Interestingly, the capital-intensive coefficient loses significance, which provides more evidence of the importance of climate conditions for armed conflicts.

Columns 4-6 contain the regressions with riots and protests as the dependent variable. In this case, a positive commodity shock in the capital-intensive sector increases the like-

TABLE 7: CONFLICT INCIDENCE, CAPITAL- AND LABOR-INTENSIVE COMMODITY SHOCKS BY TYPE OF EVENT

	Type of Event								
	Battles			Riots and Protests			Violence against Civilians		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. All Africa									
Mine × Mineral price	0.018**		0.013	0.049***		0.050***	0.037***		0.037***
	(0.008)		(0.008)	(0.016)		(0.017)	(0.013)		(0.012)
Main crop × ln Crop price w	-0.013	-0.013		0.005	0.004		-0.026 ***	-0.027***	
	(0.009)	(0.009)		(0.004)	(0.004)		(0.007)	(0.007)	
Mine ever × Mineral price		0.004			0.042***			0.032***	
		(0.007)			(0.012)			(0.011)	
SPEI crop			-0.015**			0.008**			0.004
			(0.006)			(0.004)			(0.006)
SPEI crop,$_{t-1}$			-0.005			-0.006			-0.001
			(0.007)			(0.004)			(0.006)
SPEI crop,$_{t-2}$			-0.009			-0.008**			-0.017***
			(0.006)			(0.004)			(0.006)
Perennial tree crops	0.050**	0.042**		0.018	0.017		0.068***	0.068***	
	(0.021)	(0.021)		(0.017)	(0.017)		(0.021)	(0.021)	
Observations	115666	116620	81198	115666	116620	81198	115666	116620	81198
R^2	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.000
Panel B. Sub-Saharan Africa									
Mine × Mineral price	0.021**		0.016*	0.056***		0.050***	0.050***		0.045***
	(0.008)		(0.008)	(0.018)		(0.019)	(0.014)		(0.013)
Main crop × ln Crop price w	-0.025***	-0.024***		0.006	0.005		-0.023 ***	-0.024***	
	(0.008)	(0.008)		(0.004)	(0.004)		(0.007)	(0.007)	
Perennial tree crops	0.058***	0.050**		0.017	0.016		0.066***	0.066***	
	(0.020)	(0.021)		(0.017)	(0.017)		(0.021)	(0.021)	
Mine ever × Mineral price		0.005			0.048***			0.040***	
		(0.008)			(0.014)			(0.012)	
SPEI crop			-0.017***			0.006			0.001
			(0.007)			(0.004)			(0.007)
SPEI crop,$_{t-1}$			-0.004			-0.006			-0.002
			(0.007)			(0.004)			(0.006)
SPEI crop,$_{t-2}$			-0.007			-0.008*			-0.016**
			(0.006)			(0.004)			(0.006)
Observations	93350	94220	74286	93350	94220	74286	93350	94220	74286
R^2	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.000

Notes: Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for 25 year serial correlation. Mine is a dummy variable that takes the value of one when the mine is open the entire period. ln Mineral price shows the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. SPEI crop is a drought index, higher values indicate better harvest conditions.

lihood of a riot or protests regardless of the measure used. Given that both alternative mine measures are significant and similar in magnitude, the increase in riots and protests could reflect a rent-seeking behavior. The rent-seeking behavior explanation is supported by the fact that an increase in the value of the high appropriability commodity generates non-armed conflicts even in places that could have non-operating mines. For the labor-intensive sector commodity shock, the coefficient that explains riots and protests loses significance and changes its sign. This result could reflect that this type of conflict presents a lower opportunity cost for agriculture producers relative to being engaged in armed conflicts. Finally, in the case of Africa, the drought index impacts offset each other having no effect overall; while in sub-Saharan Africa, there is a small negative effect that takes two periods to materialize.

Finally, the coefficients explaining violence against civilians are close to the baseline results. A commodity shock in the capital-intensive sector increases the likelihood of violence against civilians. This result coincides with the premise that natural resources could be fueling conflicts by becoming an income source for rebels. On the other hand, an income shock in the labor-intensive sector decreases violence against civilians, which goes in line with the opportunity cost theory. This result coincides with the drought index, which shows a two-period lag in materialize, implying that the effect is related to agricultural production.

5 CONCLUSIONS

This study addresses the impacts of commodity price shocks on conflicts considering different factor intensity commodities. Using sub-national cells covering the African continent for the period 1997-2010, this paper exploits exogenous commodity price variations to evaluate their impact on conflict incidence. Using a high-dimensional fixed-effect panel data model with spatial error correction, this study test whether a capital-intensive commodity (mining) and a labor-intensive commodity (agriculture) have different effects on conflict incidence. The findings suggest that commodity shocks have opposite effects on conflicts depending on their factor intensity. A rise in international prices of capital-intensive commodities leads to an increase in conflict likelihood. In contrast, an increase in labor-intensive commodity prices leads to a reduction in conflicts. The opposite effects of the same phenomenon shed light on the importance of factor intensity when looking at the effects of positive commodity shocks.

When assessing the different possible heterogeneous effects, I found differential effects on high-value perennial tree crops. Unlike the overall effect of an increase in agricultural prices, the effects on perennial tree crops coincide with those derived from a commodity price shock in the capital-intensive commodity sector. Perennial tree crops producers' different behavior shows that the opportunity cost and the state as prize mechanisms are closely related to the degree of commodity appropriability. I also test for heterogeneous effects in regions affected by African historical events related to conflicts. The estimates suggest that ethnic partition, pre-colonial centralization, and the slave trade do not play a significant role in conflict incidence due to commodity price shocks. In the same vein, the estimates do not show different dynamics in the commodity price shocks for different levels of institutional quality. Finally, I find that capital-intensive commodity shocks are positively related to different types of violent events such as battles, riots and protests, and violence against civilians. Meanwhile, labor-intensive commodity price shocks are negatively related to battles and violence against civilians, whereas riots and protests are not affected by crop price shocks.

This study has relevant policy implications. First, it shows that commodity booms, which are seen as an opportunity for economic development in primary goods producer economies, could have detrimental impacts on society by driving social unrest. Therefore, policy-makers should design focused-policies to avoid resource-driven conflict, particularly when the international prices of capital-intensive commodities rise. Second, given that increases in the price of labor-intensive commodities reduce conflict likelihood, policies that increase harvest productivity and reduce agricultural production risks can help to reduce conflicts. Finally, since perennial tree crops present the same behavior as capital-intensive commodities, policy interventions in monitoring and preventing leakages on state revenues from these commodities could decrease corruption and avoid these resources fueling conflicts.

This research sheds light on the causal relationship between commodity price shocks and conflict incidence. Future research is needed to identify the mechanisms underlying this relationship in the case of Africa. Future work should also consider the different degrees of appropriability among agricultural products and their possible links to conflicts.

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APPENDIX

TABLE A1: COUNTRIES CONSIDERED IN THE SAMPLE

Algeria	Cote d'Ivoire	Liberia	Sao Tome and Principe
Angola	Djibouti	Libya	Senegal
Benin	Egypt	Madagascar	Sierra Leone
Botswana	Equatorial Guinea	Malawi	Somalia
Burkina Faso	Eritrea	Mali	South Africa
Burundi	Ethiopia	Mauritania	Sudan
Cameroon	Gabon	Mauritius	Swaziland
Cape Verde	Gambia	Morocco	Tanzania
Central African Republic	Ghana	Mozambique	Togo
Chad	Guinea	Namibia	Tunisia
Comoros	Guinea-Bissau	Niger	Uganda
Congo, Rep.	Kenya	Nigeria	Zambia
Democratic Republic of Congo	Lesotho	Rwanda	Zimbabwe

Notes: The number of countries in the regressions depends on their data availability. The baseline regressions exclude Mauritius because of agricultural missing data.

TABLE A2: ROBUSTNESS CHECK AGRICULTURE AND MINES

	Conflict Incidence					
	Baseline		Excluding Cassava and Sesame		Including Diamond and Tantalum	
	(1)	(2)	(3)	(4)	(5)	(6)
Mine × Mineral price	0.076***	0.091***	0.069***	0.087***	0.069***	0.082***
	(0.019)	(0.021)	(0.019)	(0.022)	(0.019)	(0.021)
Main Crop × ln Crop price w	-0.010	-0.016*	0.003	-0.010	-0.010	-0.015*
	(0.009)	(0.009)	(0.016)	(0.015)	(0.009)	(0.009)
Controls						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Africa	SS. Africa	Africa	SS. Africa	Africa	SS. Africa
Observations	115666	93350	88926	66680	115946	93630
Within R^2	0.000	0.001	0.000	0.001	0.000	0.000

Notes: Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for infinite serial correlation following Berman et al. (2017). Mine is a dummy variable that takes the value of one when the mine is open the entire period. Mineral price show the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if the there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). Ln Crop price denotes the cell's main crop international real price in logarithms.

TABLE A3: CONFLICT INCIDENCE, QUALITY OF INSTITUTIONS AVERAGE 1985-1997

	Conflict Incidence					
	(1)	(2)	(3)	(4)	(5)	(6)
Variable Z		ICRG	Control of Corruption	Government Effectiveness	Rule of Law	Polity
Panel A. All Africa						
Mine × Mineral price	0.076***	0.057*	0.085***	0.089***	0.088***	0.082***
	(0.019)	(0.030)	(0.027)	(0.031)	(0.027)	(0.027)
× Variable Z (1985-1997)		0.043	-0.028	-0.030	-0.038	-0.020
		(0.039)	(0.031)	(0.034)	(0.031)	(0.028)
Main crop × ln Crop price w	-0.010	-0.012	-0.010	-0.010	-0.010	-0.010
	(0.009)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)
Observations	115666	102408	115624	115568	115624	115624
R^2 (Within R^2)	(0.000)	0.426	0.431	0.431	0.431	0.431
Panel B. Sub-Saharan Africa						
Mine × Mineral price	0.091***	0.086**	0.100***	0.105***	0.101***	0.106***
	(0.021)	(0.038)	(0.029)	(0.031)	(0.028)	(0.028)
× Variable Z (1985-1997)		0.015	-0.029	-0.033	-0.032	-0.043
		(0.046)	(0.029)	(0.034)	(0.029)	(0.029)
Main crop × ln Crop price w	-0.016*	-0.018	-0.016	-0.016	-0.016	-0.016
	(0.009)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)
Observations	93350	80148	93308	93308	93308	93308
R^2 (Within R^2)	(0.001)	0.416	0.423	0.423	0.423	0.423
Controls (for all panels)						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Significance level: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Column 1 contain Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for 25 year serial correlation. Columns 2-6 present country level clustered standard errors in parentheses. ln Mineral price show the cell's main mineral international real price in logarithms. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. ICRG stands for International Country Risk Guide, index of country risk evaluating political and economic risks. Rule of Law, Government Effectiveness, Control Corruption are part of the World Governance Indicators of the World Bank. Polity, measure authority characteristics of the countries. All quality of institution measures show an average of period 1985-1997 when data is available.

TABLE A4: CONFLICT INCIDENCE, QUALITY OF INSTITUTIONS AVERAGE 1997-2010

	Conflict Incidence					
	(1)	(2)	(3)	(4)	(5)	(6)
Variable Z		ICRG	Control of Corruption	Government Effectiveness	Rule of Law	Polity
Panel A. All Africa						
Mine × ln Mineral price	0.076***	0.096***	0.088***	0.100***	0.091***	0.075***
	(0.019)	(0.029)	(0.028)	(0.030)	(0.028)	(0.028)
× Variable Z (1997-2010)		-0.047	-0.035	-0.053	-0.041	0.006
		(0.033)	(0.031)	(0.033)	(0.032)	(0.033)
Main crop × ln Crop price w	-0.010	-0.012	-0.010	-0.010	-0.010	-0.010
	(0.009)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)
Observations	115666	102408	115624	115624	115624	115624
R^2 (Within R^2)	(0.000)	0.426	0.431	0.431	0.431	0.431
Panel B. Sub-Saharan Africa						
Mine × ln Mineral price	0.091***	0.108***	0.106***	0.113***	0.106***	0.096***
	(0.021)	(0.029)	(0.029)	(0.030)	(0.029)	(0.029)
× Variable Z (1997-2010)		-0.038	-0.040	-0.052	-0.040	-0.016
		(0.030)	(0.030)	(0.031)	(0.030)	(0.034)
Main crop × ln Crop price w	-0.016*	-0.018	-0.016	-0.016	-0.016	-0.016
	(0.009)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)
Observations	93350	80148	93308	93308	93308	93308
R^2 (Within R^2)	(0.001)	0.416	0.423	0.423	0.423	0.423
Controls (for all panels)						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Significance level: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Columns 1 and 5 contain Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for 25 year serial correlation. Columns 2-4 and 6-8 present country level clustered standard errors in parentheses. Mine (A/B) denote the two different alternatives of measure the mining sector (A. mine open the entire period, B. mine ever open). Ln Mineral price show the cell's main mineral international real price in logarithms. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). Ln Crop price w denotes the cell's main international real crop price weighted by the cell's main crop in logarithms. ICRG stands for International Country Risk Guide, index of country risk evaluating political and economic risks. Rule of Law, Government Effectiveness, Control Corruption are part of the World Governance Indicators of the World Bank. Polity, measure authority characteristics of the countries.

TABLE A5: ROBUSTNESS CHECK CROPS EXOGENEITY LARGE AFRICAN PRODUCERS

	Conflict Incidence							
	Baseline		Excluding crops top 5 producers		Excluding crops top 5 producers, cassava and sesame		Exluding countries top 5 producers	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mine × ln Mineral price	0.076***	0.091***	0.069***	0.091***	0.068***	0 .087***	0.080***	0.098***
	(0.019)	(0.021)	(0.020)	(0.021)	(0.020)	(0.023)	(0.020)	(0.023)
Main Crop × ln Crop price w	-0.010	-0.016*	-0.013	-0.020**	-0.002	-0.022	-0.010	-0.019
	(0.009)	(0.009)	(0.010)	(0.010)	(0.020)	(0.017)	(0.013)	(0.012)
Controls								
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Africa	SS. Africa	Africa	SS. Africa	Africa	SS. Africa	Africa	SS. Africa
Observations	115666	93350	111060	88464	84040	61794	95478	73162
Within R^2	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001

Notes: Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for infinite serial correlation following Berman et al. (2017). Mine is a dummy variable that takes the value of one when the mine is open the entire period. Mineral price show the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if the there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). Ln Crop price denotes the cell's main crop international real price in logarithms.

TABLE A6: ROBUSTNESS CHECK CROP PRICES EXOGENEITY

	Conflict Incidence									
	International prices		Including cassava and sesame		IV 1 world production excl. African top5 producers		IV 2 world production excl. Africa		IV 3 world production excl. Africa (all crops)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Second Stage.										
Mine × Mineral price	0.071***	0.089***	0.078***	0.092***	0.076***	0 .091***	0.076***	0.091***	0.074***	0.091***
	(0.019)	(0.022)	(0.018)	(0.020)	(0.020)	(0.022)	(0.020)	(0.022)	(0.020)	(0.022)
Main Crop × ln Crop Price w	-0.024	-0.051***	-0.020**	-0.026***	0.016	0.005	0.012	-0.002	0.055	0.016
	(0.020)	(0.017)	(0.010)	(0.009)	(0.021)	(0.023)	(0.022)	(0.026)	(0.053)	(0.057)
× Perennial tree crops	0.086***	0.107***	0.079***	0.084***	0.081***	0.086***	0.087***	0.095***	0.160***	0.165***
	(0.028)	(0.027)	(0.023)	(0.023)	(0.028)	(0.028)	(0.030)	(0.031)	(0.034)	(0.034)
Sample	Africa	SS. Africa	Africa	SS. Africa	Africa	SS. Africa	Africa	SS. Africa	Africa	SS. Africa
Observations	88926	66680	115666	93350	115624	93308	115624	93308	115624	93308
Within R^2	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.000	0.001
First Stage. Dependent Variable is ln Main Crop Price										
W.P. Excluding African top 5 producers					0.612 ***	0.565 ***				
					(0.010)	(0.011)				
W.P. Excluding African countries (selected crops)							0.568***	0.515***		
							(0.011)	(0.012)		
W.P. Excluding African countries (all crops)									0.248***	0.234***
									(0.012)	(0.012)
F-stat					3791.99	2778.74	2557.44	1834.45	429.84	385.20

Notes: Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for spatial correlation of 500km radius and for infinite serial correlation following Berman et al. (2017). Mine is a dummy variable that takes the value of one when the mine is open the entire period. Mineral price show the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if the there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). Ln Crop price denotes the cell's main crop international real price in logarithms.

TABLE A7: ROBUSTNESS CHECK HAC STANDARD ERRORS

	Conflict Incidence					
	(1)	(2)	(3)	(4)	(5)	(6)
Mine × ln Mineral price	0.076		0.071		0.093	
baseline	(0.019)		(0.019)		(0.023)	
distance: 100, time: 25	(0.019)		(0.019)		(0.020)	
distance: 1000, time: 25	(0.019)		(0.019)		(0.023)	
distance: 500, time: 1	(0.016)		(0.016)		(0.021)	
distance: 500, time: 5	(0.016)		(0.016)		(0.021)	
Main crop × ln Crop price	-0.010	-0.012			0.008	0.007
baseline	(0.009)	(0.009)			(0.010)	(0.010)
distance: 100, time: 25	(0.008)	(0.008)			(0.006)	(0.007)
distance: 1000, time: 25	(0.010)	(0.010)			(0.012)	(0.012)
distance: 500, time: 1	(0.009)	(0.009)			(0.010)	(0.010)
distance: 500, time: 5	(0.009)	(0.009)			(0.010)	(0.010)
Mine ever × ln Mineral price		0.044		0.048		0.057
baseline		(0.015)		(0.014)		(0.020)
distance: 100, time: 25		(0.015)		(0.014)		(0.017)
distance: 1000, time: 25		(0.015)		(0.014)		(0.021)
distance: 500, time: 1		(0.013)		(0.012)		(0.018)
distance: 500, time: 5		(0.013)		(0.012)		(0.018)
SPEI crop			-0.007	-0.007		
baseline			(0.008)	(0.008)		
distance: 100, time: 25			(0.007)	(0.007)		
distance: 1000, time: 25			(0.008)	(0.008)		
distance: 500, time: 1			(0.008)	(0.008)		
distance: 500, time: 5			(0.007)	(0.007)		
SPEI crop,$_{t-1}$			-0.003	-0.003		
baseline			(0.008)	(0.008)		
distance: 100, time: 25			(0.007)	(0.007)		
distance: 1000, time: 100000			(0.009)	(0.009)		
distance: 500, time: 1			(0.008)	(0.008)		
distance: 500, time: 5			(0.008)	(0.008)		
SPEI crop,$_{t-2}$			-0.021	-0.022		
baseline			(0.008)	(0.008)		
distance: 100, time: 25			(0.007)	(0.007)		
distance: 1000, time: 25			(0.008)	(0.008)		
distance: 500, time: 1			(0.008)	(0.008)		
distance: 500, time: 5			(0.008)	(0.008)		
Observations	115666	116620	81198	82161	115666	116620
R^2	0.000	0.000	0.000	0.000	0.001	0.000
Controls						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	No	No
Time Fixed Effects	No	No	No	No	Yes	Yes

Notes: Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for different levels of spatial correlation and different levels of serial correlation. Mine is a dummy variable that takes the value of one when the mine is open the entire period. Mineral price show the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if the there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). Ln Crop price denotes the cell's main crop international real price in logarithms.

TABLE A8: ROBUSTNESS CHECK DIFFERENT LEVELS OF STANDARD ERRORS CLUSTERING

	Conflict Incidence					
	(1)	(2)	(3)	(4)	(5)	(6)
Mine × ln Mineral price	0.076		0.071		0.093	
baseline Conley HAC	(0.019)		(0.019)		(0.023)	
cluster cell level	(0.019)		(0.020)		(0.021)	
cluster country level	(0.020)		(0.019)		(0.027)	
Main crop × ln Crop price w	-0.010	-0.012			0.008	0.007
baseline Conley HAC	(0.009)	(0.009)			(0.010)	(0.010)
cluster cell level	(0.008)	(0.008)			(0.006)	(0.006)
cluster country level	(0.015)	(0.014)			(0.012)	(0.012)
Mine ever × ln Mineral price		0.044		0.048		0.057
baseline Conley HAC		(0.015)		(0.014)		(0.020)
cluster cell level		(0.016)		(0.016)		(0.017)
cluster country level		(0.014)		(0.011)		(0.024)
SPEI crop			-0.007	-0.007		
baseline Conley HAC			(0.008)	(0.008)		
cluster cell level			(0.007)	(0.007)		
cluster country level			(0.009)	(0.010)		
SPEI crop,$_{t-1}$			-0.003	-0.003		
baseline Conley HAC			(0.008)	(0.008)		
cluster cell level			(0.007)	(0.007)		
cluster country level			(0.012)	(0.011)		
SPEI crop,$_{t-2}$			-0.021	-0.022		
baseline Conley HAC			(0.008)	(0.008)		
cluster cell level			(0.007)	(0.007)		
cluster country level			(0.013)	(0.013)		
Observations	115666	116620	81198	82161	115666	116620
R^2	0.000	0.000	0.000	0.000	0.001	0.000
Controls						
Cell Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × Time Fixed Effects	Yes	Yes	Yes	Yes	No	No
Time Fixed Effects	No	No	No	No	Yes	Yes

Notes: Linear Probability Model estimation. Conley (1999) type standard errors in parentheses, adjusted for different levels of spatial correlation and different levels of serial correlation. Mine is a dummy variable that takes the value of one when the mine is open the entire period. Mineral price show the cell's main mineral international real price in logarithms. Mine ever is a dummy variable taking the value of one if the there is at least one mine in the cell that produced during the period of study. Main crop denotes the cell's main crop produced near the year 2000 (Monfreda et al., 2008). Ln Crop price denotes the cell's main crop international real price in logarithms.

FIGURE A1: Spatial Distribution Fraction of Conflicts, 1997 - 2010

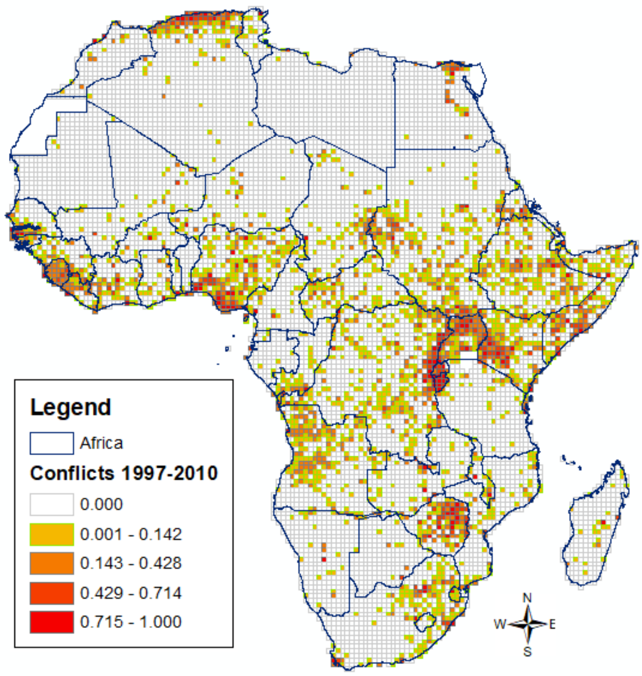

FIGURE A2: Main crop year 2000

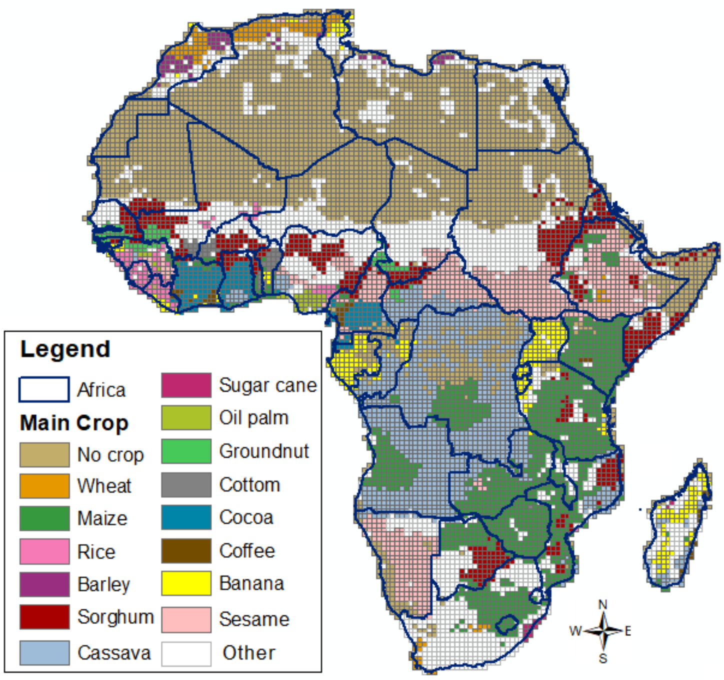

FIGURE A3: Spatial Distribution Mines Ever Open 1997-2010

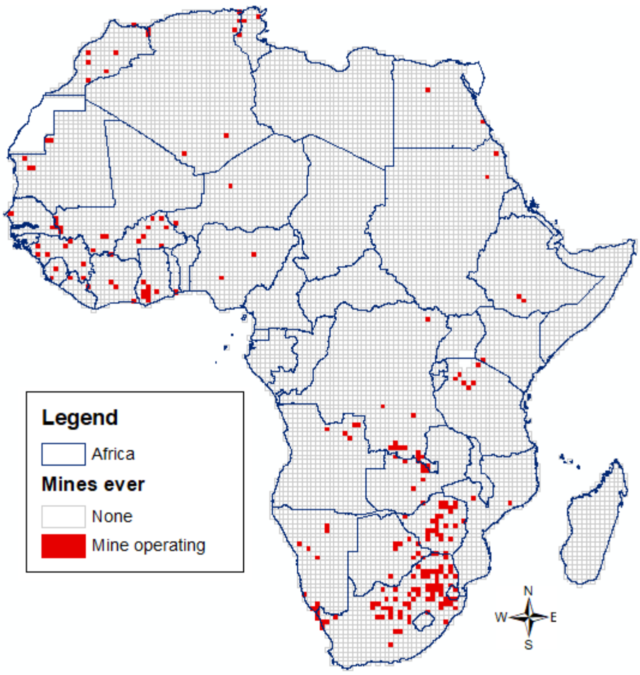

FIGURE A4: Spatial Distribution Mines Always Open 1997-2010

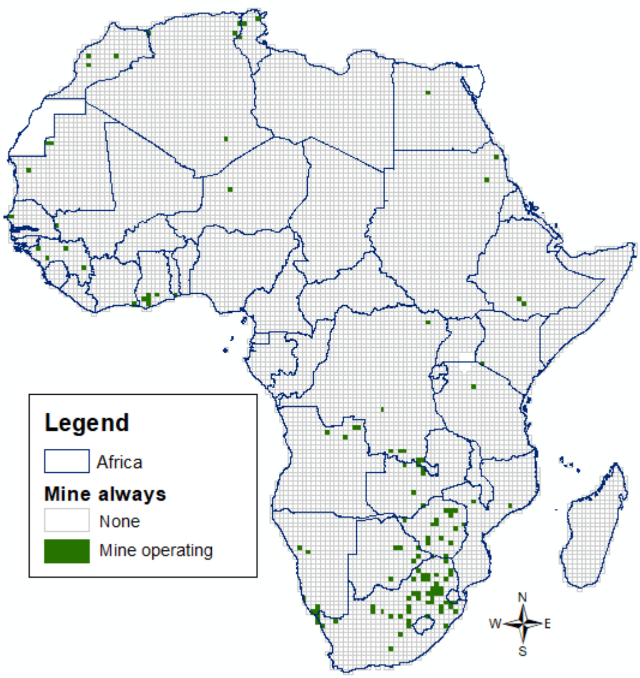

FIGURE A5: Spatial Distribution SPEI Crop, average 1997-2010

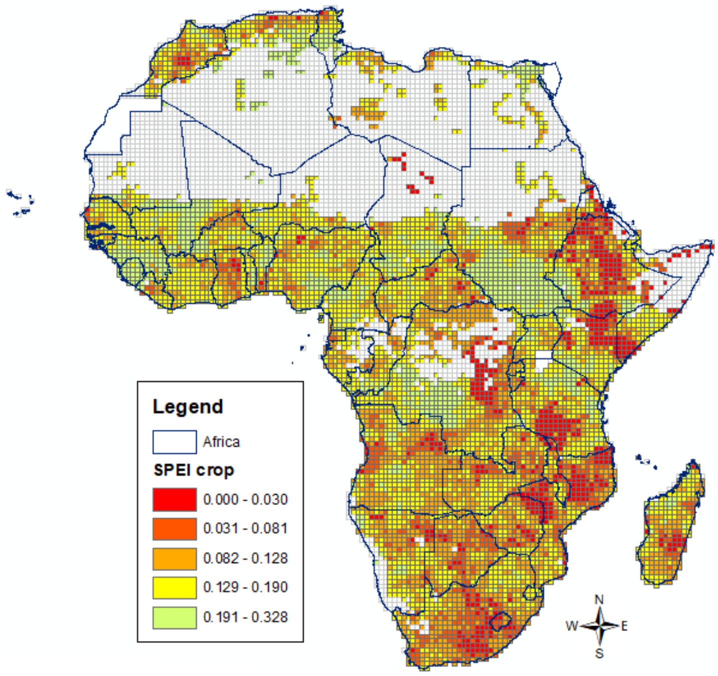

FIGURE A6: Spatial Distribution Partitioned Ethnic Groups

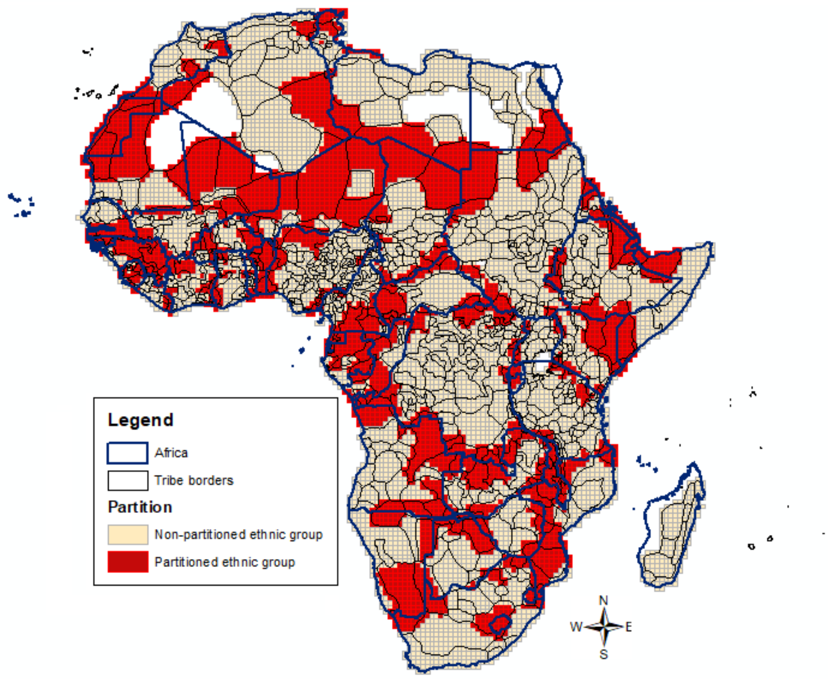

FIGURE A7: Spatial Distribution pre-colonial Centralized Ethnic Groups

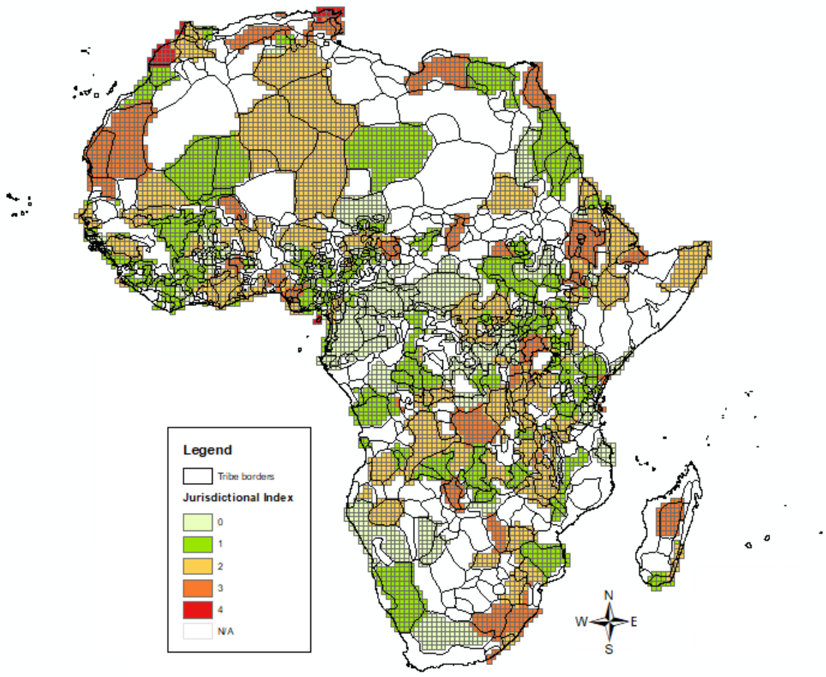

FIGURE A8: Spatial Distribution transatlantic and Ocean Sea Slave Trade

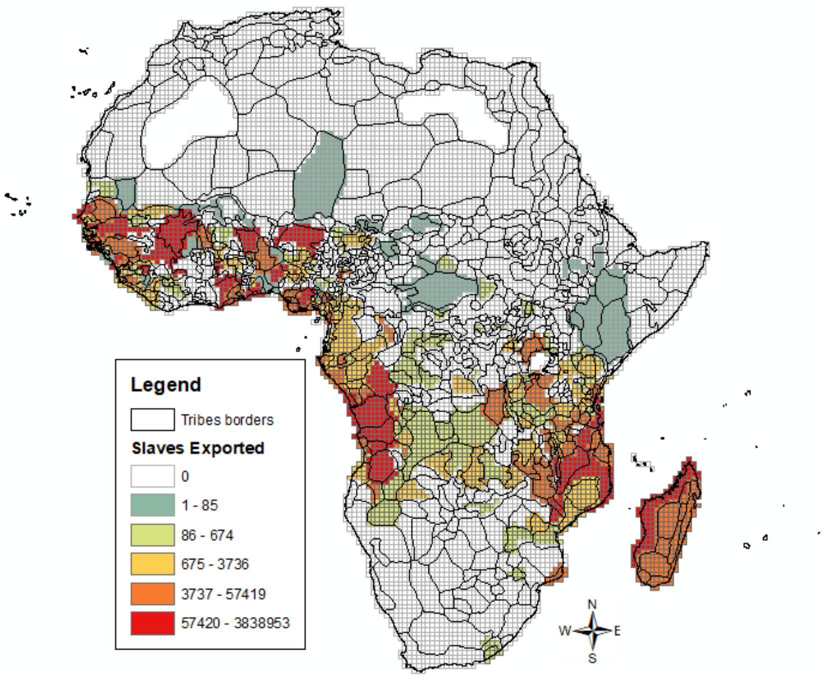

FIGURE A9: Spatial Distribution Main Crop Without Cassava and Sesame