How does Conflict Spread?

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Introduction

- In 2014, over half of the worlds violent conflict incidents took place in Africa, despite having only 16% of the global population (Cilliers 2015)
- Start off as small, localized events but then spread to neighbouring regions and across borders
- Vast literature on what leads to spatial clustering and conflict contagion in Africa (Harari & La Ferrara, 2018, Berman et al., 2017, Hsiang et al., 2017, Deryugina & Hsiang, 2014, Hsiang & Jina, 2014, Ciccone, 2011, Blattman and Miguel, 2010, Collier and Hoeffler, 2004)
- Mostly concerned with exploiting exogenous variation in factors that **increase** the likelihood of conflict
- What about factors that **decrease** conflict in a given area?
    - policy relevance

Introduction

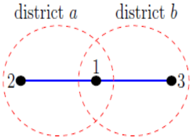
Economic Shock	Greed	Opp. Cost
+	Berman et al. (2017)	McGuirk & Burke (2018)
−		Harari & LaFerrara (2018)

Introduction

- This paper
  - Constructs a theoretical model on the local and spillover effects of exogenous events that **decrease** the likelihood of conflict
  - Empirically tests the model by exploiting the **exogenous** variation in natural disasters as shocks that locally increase the costs and decreases the benefits of fighting
  - Using a novel panel data set at a fine degree of spatial and temporal resolution i.e. **district-month** level for
    - 5,944 African districts (ADM2 units)
    - over the years 1989-2015

Summary of the Model

- A set of players (1,2,3) are involved in battles in different districts, which are linked through a network



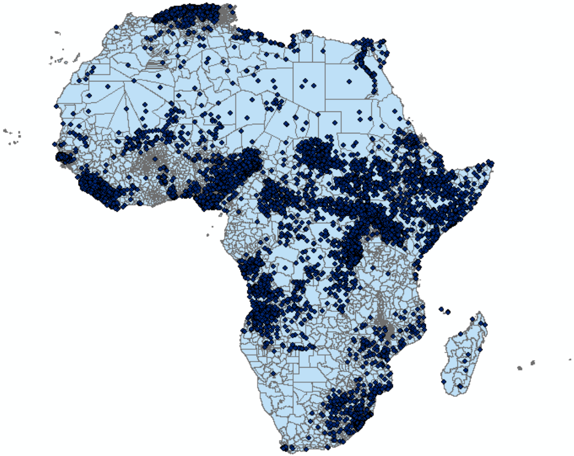
- Each player has to decide how much effort, x, to exert in each battle. Higher the effort, higher the chance of winning the battle (standard Tullock contest success function)
- Value of battle (the economic gains of winning a battle) is v
- Negative shock on district a reduces the value of battle in district a, i.e. v^a
- Model Propositions:
  - the total battle in district a goes down
  - the total battle in district b goes up

Data

- Unit of observation
  - Subnational administrative unit (ADM2 "districts") level
  - 5,944 districts from 53 African countries
  - Monthly observations over the period 1989-2015
  - 324 monthly observations per district, approx. 2 million observations for all 5,944 districts
- Dependent variable: Battles
  - Uppsala Conflict Data Program's (UCDP) Georeferenced Event Dataset
  - Geo-coded down to the level of individual villages, temporally disaggregated to individudal days
  - Use of GIS to geo-locate each battle to the districts
  - *Battle* is a binary variable $= 1$ if a battle leading to at least one death occurred in district i in time t, and 0 otherwise

Data

Dispersion of battles across Africa

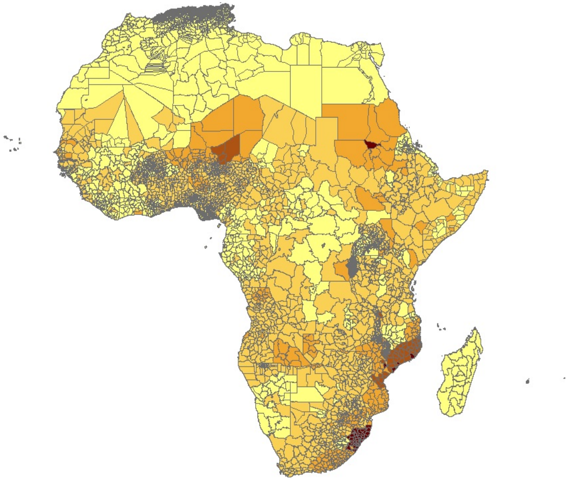


Data

- Independent variable: Natural disasters
  - Emergency Events Database (EM-DAT)
  - **Challenge**: Data available at the country level, but the analysis is at the subnational level. Only uncategorized location info available
  - **Response**: manual geo-coding of 1,016 natural disasters that occurred in Africa over the period
  - Detailed investigation of location column of each natural disaster entry
    - Where the exact ADM2 districts were identified, mapped to themselves (precision score 4)
    - Individual villages were mapped to the ADM2 district it belongs to (precision score 4)
    - Where a province was identified, mapped to all districts within the province (precision score 3)
    - Where only a state/country was identified, mapped to all districts within the state/country (precision score 2 and 1) *only 5% of mapped locations - excluded*
  - Final output is a geo-coded dataset of **exogenous** local shocks at a very fine *spatial* and *temporal* resolution
  - *Disaster* is a binary variable = 1 if a natural disaster occurred in district i in time t, and 0 otherwise

Data

Dispersion of natural disasters across Africa



Data

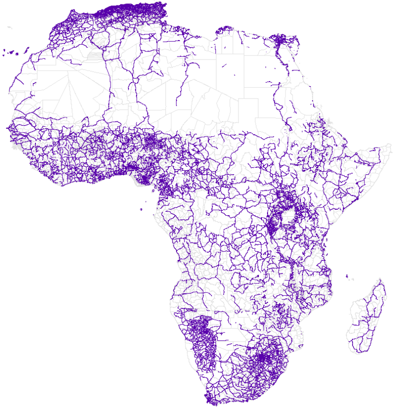
- Mechanisms - time-invariant indicators of district characteristics
  - Nighttime light (as a proxy for economic activity) - NOAA
    - $Light$=1 if initial nighttime light>10, and 0 otherwise
  - Agricultural suitability - Global Land Cover Characteristics Data Base Version2.0
    - $Agri$=1 if more than 50% of the district's area is agriculturally suitable, and 0 otherwise
  - Mining activity - SNL Minings & Metals database
    - $Mine_i$=1 if the district had at least one active mine over the sample period, and 0 otherwise

Connectivity Matrices

- Geographic Connectivity
  - Inverse geodesic distance between districts
  - Altitude-adjusted
  - Truncated at different distance cutoffs
- Road Connectivity
  - OpenStreetMap (https://openstreetmap.org)
  - (Inverse of the) shortest path between districts based on primary and secondary roads

Connectivity Matrices

Primary and secondary road network in Africa



Empirical Strategy - Local Effects

Natural Disasters and battles at the **district-month** level

$$Battle_{iym} = \beta_1 Disaster_{iym} + \beta_2 Disaster_{iym-1} + \gamma Battle_{iym-1} + \mathbf{FE_m} + \mathbf{FE_{iy}} + \epsilon_{iym} \quad (1)$$

- $Disaster_{iy}$ is a binary indicator $=1$ if a natural disaster event occurred in district i in year y, and 0 otherwise
- $Battle_{iy}$ is a binary indicator $=1$ if a battle leading to at least one death occurred in district i in year y, and 0 otherwise
- $\mathbf{FE_m}$ are month fixed effects
- $\mathbf{FE_{iy}}$ are district-year fixed effects
  - account for all district-specific time-invariant characteristics
  - as well as year-specific time-varying characteristics (including those affecting a particular country)
- ϵ_{iym} is the error term
- Model prediction: negative β_1 and β_2

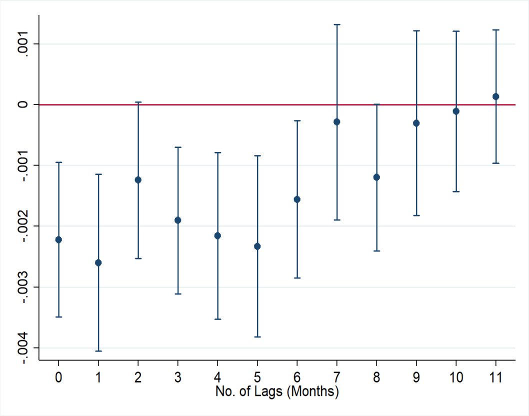
Results - Local Effects

	(1) $Battle_{iym}$	(2) $Battle_{iym}$	(3) $Battle_{iym}$	(4) $Battle_{iym}$
$Disaster_{iym}$	-0.0026***	-0.0026***	-0.0014**	-0.0015**
	(0.0007)	(0.0007)	(0.0006)	(0.0007)
$Disaster_{iym-1}$		-0.0021***		-0.0018**
		(0.0007)		(0.0007)
Observations	1,919,912	1,913,968	1,919,912	1,913,968
Number of Districts	5,944	5,944	5,944	5,944
District-FE	YES	YES	NO	NO
Month FE	YES	YES	YES	YES
Year FE	YES	YES	NO	NO
District $\times$ Year FE	NO	NO	YES	YES

Notes: *Battle* and *Disaster* are binary variables indicating the presence (=1) or absence (=0) of a battle resulting in at least one death, and a natural disaster event, respectively, in district i in month m of year y. Disasters exclude droughts. Additional controls include $Battle_{iym-1}$. Standard errors, clustered at the *country* $\times$ *year* level in parenthesis.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

District-year level here.

Results: Persistence of Local Effects



Notes: Dependent variable is $Battle_{iym}$. Dots show the coefficients of *Disaster* when applying up to 11 monthly lags. The vertical lines show the 90% confidence interval based on standard errors clustered at the country × year level. *Battle* and *Disaster* are binary variables indicating the presence (=1) or absence (=0) of a battle resulting in at least one death, and a natural disaster event, respectively, in district *i* in month *m* of year *y*. Disasters exclude droughts. Additional controls include $Battle_{iym-1}$, $\mathbf{FE_m}$ and $\mathbf{FE_{iy}}$.

Results: Local Effects - Mechanisms

	(1) $Battle_{iym}$	(2) $Battle_{iym}$	(3) $Battle_{iym}$	(4) $Battle_{iym}$
$Disaster_{iym}$	-0.0015**	-0.0013*	-0.0015**	-0.0010
	(0.0006)	(0.0008)	(0.0007)	(0.0008)
$Disaster_{iym-1}$	-0.0013*	-0.0013	-0.0018**	-0.0006
	(0.0007)	(0.0009)	(0.0007)	(0.0008)
$Disaster_{iym} \times Light_i$	-0.0011			-0.0014
	(0.0026)			(0.0025)
$Disaster_{iym-1} \times Light_i$	-0.0065**			-0.0071***
	(0.0025)			(0.0019)
$Disaster_{iym} \times Agri_i$		-0.0011		-0.0012
		(0.0011)		(0.0010)
$Disaster_{iym-1} \times Agri_i$		-0.0018		-0.0024**
		(0.0012)		(0.0011)
$Disaster_{iym} \times Mine_i$			-0.0013	-0.0013
			(0.0021)	(0.0024)
$Disaster_{iym-1} \times Mine_i$			0.0003	0.0004
			(0.0016)	(0.0016)
Observations	1,913,968	1,913,968	1,913,968	1,913,968
Number of Districts	5,944	5,944	5,944	5,944
Month FE	YES	YES	YES	YES
District × Year FE	YES	YES	YES	YES

Battle and *Disaster* are binary variables indicating the presence (=1) or absence (=0) of a battle resulting in at least one death, and natural disaster event, respectively, in district *i* in month *m* of year *y*. Disasters exclude droughts. *Light*=1 if average nighttime light in 1992 (i.e. initial light) >10 (on a scale of 0-63), and 0 otherwise. *Agri*=1 if the fraction of land suitable for agriculture in district *i* is above 50%, and 0 otherwise. *Mine* = 1 if the district hosted at least one active mining project over the sample period, and 0 otherwise. Standard errors, clustered at the *country* × *year* level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Specification here

Spillover Effects

- We do not observe any statistically significant spillover effects at the district-month level (i.e. in the short run)
- However, we do observe spillover effects at the district-year level (i.e. medium to long term)
- This suggests that spillovers may take longer to materialize, as opposed to local effects which are almost instantaneous

Spillovers at the district-month level here.

Empirical Strategy: Spillover Effects

Natural disasters' effect on battle spillovers at the **district-year** level

$$\begin{aligned} Battle_{iy} = \beta_1 Disaster_{iy} + \beta_2 Disaster_{iy-1} + \delta_1 NeighbDisaster_{iy} + \delta_2 NeighbDisaster_{iy-1} \\ + \gamma_1 Battle_{iy-1} + \gamma_2 NeighbBattle_{iy} + \mathbf{FE_i} + \mathbf{FE_{cy}} + \epsilon_{iy} \end{aligned} \quad (2)$$

where

$$NeighbDisaster_{iy}=1 \text{ if } \textstyle\sum_{j=1}^{J} \omega_{ij} Disaster_{jy} \geqslant 0$$
$$NeighbDisaster_{iy}=0 \text{ if } \textstyle\sum_{j=1}^{J} \omega_{ij} Disaster_{jy} = 0$$

- Neighbourhood is defined by the connectivity matrix $\mathbf{\Omega} = (\omega_{ij})$
- Two forms of connectivity: geographic $\mathbf{\Omega_1}$ and road $\mathbf{\Omega_2}$
- Truncated at different distance cutoffs
- δ_1 and δ_2 capture the *spatial* and *spatial*$\times$*temporal* spillover effects
- Model prediction: positive δ_1 and δ_2

Results: Spillover Effects

	(1) $Battle_{iy}$	(2) $Battle_{iy}$	(3) $Battle_{iy}$
Inverse Geodesic Distance			
$Neighb\ Disaster_{iy}$	0.0042		0.0034
	(0.0030)		(0.0029)
$Neighb\ Disaster_{iy-1}$	0.0118***		0.0108***
	(0.0036)		(0.0033)
Inverse Road Distance			
$Neighb\ Disaster_{iy}$		0.0048**	0.0042*
		(0.0023)	(0.0023)
$Neighb\ Disaster_{iy-1}$		0.0037	0.0016
		(0.0023)	(0.0022)
$Disaster_{iy}$	-0.0022	-0.0027	-0.0028
	(0.0030)	(0.0029)	(0.0029)
$Disaster_{iy-1}$	-0.0048*	-0.0055**	-0.0053*
	(0.0028)	(0.0028)	(0.0028)
Observations	154,544	154,544	154,544
Number of Districts	5,944	5,944	5,944
Distance Cut-off	500km	500km	500km
District FE	YES	YES	YES
Country× Year FE	YES	YES	YES

Battle and *Disaster* are binary variables indicating the presence (=1) or absence (=0) of a battle resulting in at least one death, and natural disaster event, respectively, in the given district in the given time period. *NeighbDisaster* (*NeighbBattle*) is a binary variable indicating the presence (=1) or absence (=0) of a natural disaster event (battle), in any one of the district's neighbours. Neighbourhood is based on the altitude-adjusted inverse distance matrix and the inverse road distance matrix, truncated 500km. Disasters exclude droughts. Standard errors, clustered at the *country* × *year* level, in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

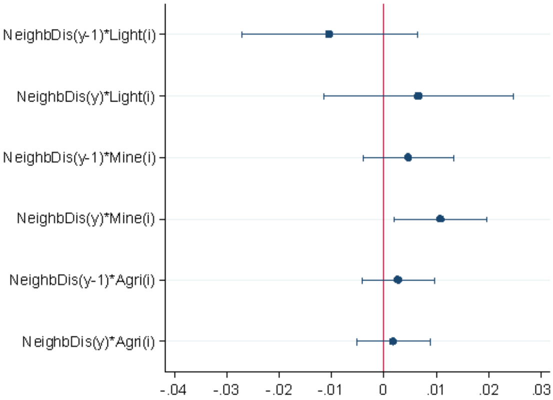
Empirical Strategy: Spillover Mechanisms

- Target vs Source District
  - $NeighbDisaster_{iy} \times Z_i$ - Features of district i, which is the target/recipient of the battle spillovers following its neighbours' natural disaster shock (target district)
  - $NeighbDisaster_{iy} \times Z_j$ - Features of the neighboring district j where the natural disaster occurs (source district)
  - Z as defined before, i.e. *Light*, *Mine* or *Agri*
- No statistically significant effects of mechanisms observed under the Inverse Geodesic Distance Network

Specification here.
Results for Inverse Geodesic Distance Network here.

Results: Spillover Mechanisms

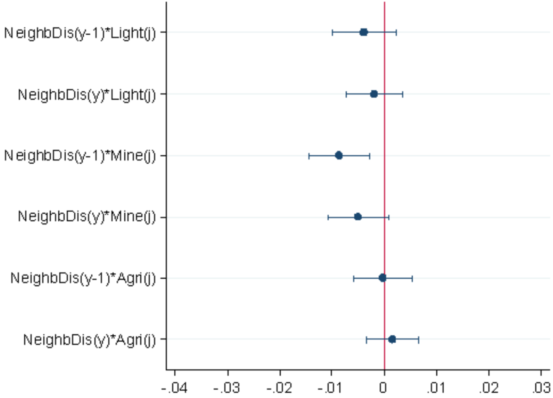
Mechanisms of Battle Diffusion - Target District's Features (Road Network)



Notes: Dependent variable is $Battle_{iy}$. Dots show the estimated coefficients on $NeighbDisaster_{iy} \times Z_i$ and $NeighbDisaster_{iy-1} \times Z_i$, where Z_i is a time-invariant feature of district i as classified by the variables $Light_i$, $Mine_i$ and $Agri_i$. Neighbourhood is defined by the inverse road distance matrix. Horizontal lines show the 90% confidence interval based on standard errors clustered at the country×year level.

Results: Spillover Mechanisms

Mechanisms of Battle Diffusion - Source District's Features (Road Network)



Notes: Dependent variable is $Battle_{iy}$. Dots show the estimated coefficients on $NeighbDisaster_{iy} \times Z_j$ and $NeighbDisaster_{iy-1} \times Z_j$, where Z_j is a time-invariant feature of district i as classified by the variables $Light_j$, $Mine_j$ and $Agri_j$. Neighbourhood is defined by the inverse road distance matrix. Horizontal lines show the 90% confidence interval based on standard errors clustered at the country$\times$year level.

Conclusion

- Develop a theoretical model to understand how players engaged in battles in districts linked through a network react in response to a negative shock on the potential gains from battles
- Empirically test the model propositions on local and spillover effects of negative economic shocks, using natural disasters as a proxy
- Construct a novel panel data set of natural disasters at a fine spatial and temporal dimension
- Local natural disaster events systematically decrease the likelihood of battles in the short run. This effect is persistent over time
- Mitigating effect more pronounced in developed districts as well as agricultural districts
- Battle spillovers observed in the medium to long run, between districts linked through the inverse geodesic network and road network
- Spillover effects observed particularly for mining districts, particularly those linked through the road network

Thank You

Empirical Strategy - Local Effects

Natural Disasters and battles at the **district-year** level

$$Battle_{iy} = \beta_1 Disaster_{iy} + \beta_2 Disaster_{iy-1} + \gamma Battle_{iy-1} + \mathbf{FE_i} + \mathbf{FE_{cy}} + \epsilon_{iy} \quad (3)$$

- $Disaster_{iy}$ is a binary indicator =1 if a natural disaster event occurred in district i in year y, and 0 otherwise.
- $Battle_{iy}$ is a binary indicator =1 if a battle leading to at least one death occurred in district i in year y, and 0 otherwise.
- $\mathbf{FE_i}$ are district fixed effects
- $\mathbf{FE_{cy}}$ are country-year fixed effects
- ϵ_{iy} is the error term
- Model Prediction: negative β_1

Results - Local Effects

	(1) $Battle_{iy}$	(2) $Battle_{iy}$	(3) $Battle_{iy}$	(4) $Battle_{iy}$
$Disaster_{iy}$	-0.0024	-0.0028	-0.0021	-0.0021
	(0.0033)	(0.0033)	(0.0030)	(0.0030)
$Disaster_{iy-1}$		-0.0050		-0.0045
		(0.0032)		(0.0028)
Observations	160,488	154,544	154,544	154,544
Number of Districts	5,944	5,944	5,944	5,944
District FE	YES	YES	YES	YES
Country $\times$ Year	YES	YES	YES	YES

Battle and *Disaster* are binary variables indicating the presence (=1) or absence (=0) of a battle resulting in at least one death, and a natural disaster event, respectively, in district i in year y. *Disaster* excludes droughts. Standard errors, clustered at the *country* $\times$ *year* level, in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Empirical Strategy: Local Effects - Mechanisms

$$\begin{aligned} Battle_{iym} = {} & \beta_1 Disaster_{iym} + \beta_2 Disaster_{iym-1} + \theta_1(Disaster_{iym} \times Z_i) + \theta_2(Disaster_{iym-1} \times Z_i) \\ & + \gamma Battle_{iym-1} + \mathbf{FE_{iy}} + \mathbf{FE_m} + \epsilon_{iym} \end{aligned} \tag{4}$$

- Z_i is a time-invariant variable that contains information about different characteristics of district i
- We use $Light_i$, $Mine_i$ and $Agri_i$
  - $Light_i$=1 if initial nighttime light>10, and 0 otherwise
  - $Agri_i$=1 if more than 50% of the district's area is agriculturally suitable, and 0 otherwise
  - $Mine_i$=1 if the district had at least one active mine over the sample period, and 0 otherwise

Empirical Strategy: Spillover Effects

Natural Disasters' effect on battle spillovers at the **district-month** level

$$Battle_{iym} = \beta_1 Disaster_{iym} + \beta_2 Disaster_{iym-1} \delta_1 NeighbDisaster_{iym} + \delta_2 NeighbDisaster_{iym-1} + \gamma_1 Battle_{iym-1} + \gamma_2 NeighbBattle_{iym} + \mathbf{FE_{iy}} + \mathbf{FE_m} + \epsilon_{iym} \quad (5)$$

where

$$NeighbDisaster_{iym} = 1 \text{ if } \sum_{j=1}^{J} \omega_{ij} Disaster_{jym} \geqslant 0$$
$$NeighbDisaster_{iym} = 0 \text{ if } \sum_{j=1}^{J} \omega_{ij} Disaster_{jym} = 0$$

- Neighbourhood is defined by the connectivity matrix $\mathbf{\Omega} = (\omega_{ij})$
- Two forms of connectivity: Geographic distance $\mathbf{\Omega_1}$ and road distance $\mathbf{\Omega_2}$
- δ_1 and δ_2 capture the *spatial* and *spatial* $\times$ *temporal* spillover effects
- Model prediction: positive δ_1 and δ_2

Results: Spillover Effects

	(1) $Battle_{iym}$	(2) $Battle_{iym}$	(3) $Battle_{iym}$
Inverse Geodesic Distance			
$Neighb\ Disaster_{iym}$	-0.0002		-0.0005
	(0.0003)		(0.0004)
$Neighb\ Disaster_{iym-1}$	-0.0003		-0.0006
	(0.0003)		(0.0004)
Inverse Road Distance			
$Neighb\ Disaster_{iym}$		0.0003	0.0007
		(0.0005)	(0.0005)
$Neighb\ Disaster_{iym-1}$		0.0003	0.0008
		(0.0005)	(0.0006)
$Disaster_{iym}$	-0.0012	-0.0017**	-0.0016*
	(0.0008)	(0.0008)	(0.0008)
$Disaster_{iym-1}$	-0.0014*	-0.0018**	-0.0017**
	(0.0008)	(0.0009)	(0.0009)
Observations	1,919,912	1,919,912	1,919,912
Number of Districts	5,944	5,944	5,944
Distance Cut-off	500km	500km	500km
Month FE	YES	YES	YES
District × Year FE	YES	YES	YES

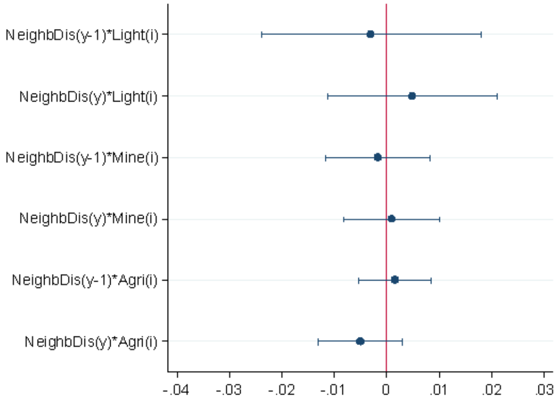
Battle and *Disaster* are binary variables indicating the presence (=1) or absence (=0) of a battle resulting in at least one death, and natural disaster event, respectively, in the given district in the given time period. *NeighbDisaster* (*NeighbBattle*) is a binary variable indicating the presence (=1) or absence (=0) of a natural disaster event (battle), in any one of the district's neighbours, within the given time period. Neighbourhood is based on the altitude-adjusted inverse distance matrix and the inverse road distance matrix, truncated at 500km. Disasters exclude droughts. Standard errors, clustered at the *country* × *year* level, in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Empirical Strategy: Spillover Mechanisms

$$\begin{aligned} Battle_{iy} = {} & \beta_1 Disaster_{iy} + \beta_2 Disaster_{iy-1} + \delta_1 NeighbDisaster_{iy} + \delta_2 NeighbDisaster_{iy-1} \\ & + \rho_1 NeighbDisaster_{iy} \times Z_i + \rho_2 NeighbDisaster_{iy-1} \times Z_i \\ & + \lambda_1 NeighbDisaster_{iy} \times Z_j + \lambda_2 NeighbDisaster_{iy-1} \times Z_j \\ & + \gamma_1 Battle_{iy-1} + \gamma_2 NeighbBattle_{iy} + \mathbf{FE_i} + \mathbf{FE_{cy}} + \epsilon_{iy} \end{aligned} \tag{6}$$

Results: Spillover Mechanisms

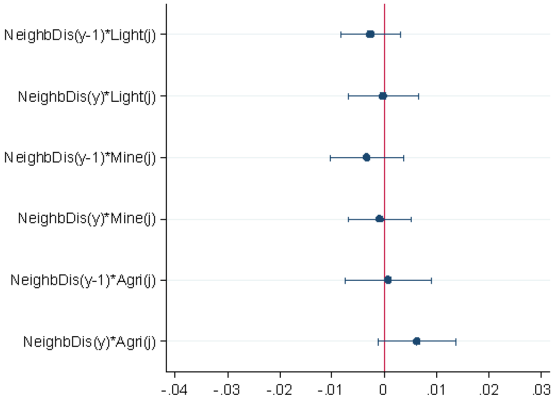
Mechanisms of Battle Diffusion - Target District's Features (Inverse Geodesic Distance Network)



Notes: Dependent variable is $Battle_{iy}$. Dots show the estimated coefficients on $NeighbDisaster_{iy} \times Z_i$ and $NeighbDisaster_{iy-1} \times Z_i$, where Z_i is a time-invariant feature of district i as classified by the variables $Light_i$, $Mine_i$ and $Agri_i$. Neighbourhood is defined by the inverse geodesic distance matrix. Horizontal lines show the 90% confidence interval based on standard errors clustered at the country$\times$year level.

Results: Spillover Mechanisms

Mechanisms of Battle Diffusion - Source District's Features (Inverse Geodesic Distance Network)



Notes: Dependent variable is $Battle_{iy}$. Dots show the estimated coefficients on $NeighbDisaster_{iy} \times Z_j$ and $NeighbDisaster_{iy-1} \times Z_j$, where Z_j is a time-invariant feature of district i as classified by the variables $Light_j$, $Mine_j$ and $Agri_j$. Neighbourhood is defined by the inverse geodesic distance matrix. Horizontal lines show the 90% confidence interval based on standard errors clustered at the country×year level.