

# Mining for Peace

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# Motivation

- ▶ Raising global demand for minerals (green energy transition).
- ▶ Demand is increasingly met by industrial mining in (diverse) developing countries.
- ▶ But natural resource rents and ethnic diversity are key drivers of conflict at the country and the local level.
  - ▶ The drivers may reinforce one another (Hodler 2006, Morelli and Rohner 2015, Berman et al. 2017, Amarasinghe et al. 2020, Adhvaryu et al. 2021).
- ▶ Risk of a new wave of resource-fuelled ethnic conflicts.
- ▶ Important to understand how to mitigate such conflict risks.

# Our objectives

- ▶ To offer a conflict model that allows for local and national determinants of local and national conflict:
  - ▶ local mining rents and local ethnic diversity,
  - ▶ a country's mining geography and its ethnic geography.
- ▶ To show that new mines in the right locations *can* reduce the aggregate propensity to conflict.

# Our mindset

- ▶ Systemic (i.e., country-wide) forces shape local conflict risks.
- ▶ Focus on bargaining failure (e.g., Fearon 1995, Jackson and Morelli 2011, Blattman 2022) that results from possible intra-ethnic coalitions at local and national levels.
- ▶ Draw more realistic picture of ethnic conflicts by endogenizing grievances and the mobilization of ethnic groups.
- ▶ Key role of ethnic groups in resource-rich locations that feel politically excluded and economically deprived of local rents (Berman et al. 2023).

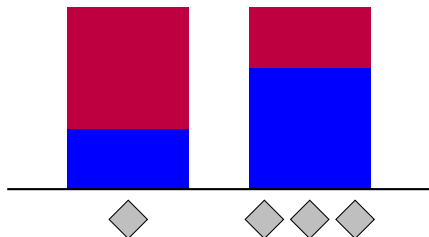
# Steps of analysis

1. Theoretical model (exciting)
2. Empirical validation of theoretical concepts (state of the art)
3. Counterfactual analysis and policy implications (exciting)

# Flavor of Theory: Model

- ▶ General distributions of ethnic groups and resource rents across locations.
- ▶ Ethnic groups can contest resource rents at two levels:
  - ▶ Local conflicts: Local group members fight for local rents
  - ▶ National conflict: All group members fight for aggregate rents
  - ▶ Conflict is costly, and conflict costs are private information
  - ▶ Winning probabilities are proportional to group sizes
- ▶ Planner can transfer rents across groups and locations.
  - ▶ Metaphorically, planner can represent the outcome of efficient bargaining between ethnic groups in the shadow of conflict.
- ▶ Planner's objective is:
  1. To guarantee peace at the national level
  2. To maximize the weighted number of locations with peace (where weights could represent ethno-regional favoritism)

## Flavor of Theory: Problem (or why peace fails)



- ▶ Any group may start a national conflict unless they get a rent share proportional to their size.
- ▶ Planner transfers rents to **groups over-represented in resource-poor locations** to ensure national peace.
- ▶ **Groups over-represented in resource-rich locations** experience “discord” between high local resource rents and comparatively low post-transfer incomes and may thus start local conflicts.

# Flavor of Theory: Results

1. Impossibility to guarantee peace everywhere in presence of ethnic segregation and spatial resource inequality.
  - ▶ *Peace deficit*: hypothetical monetary amount necessary to guarantee peace everywhere (i.e., to pacify **discordant groups** in all locations).
  - ▶ It's our empirical measure for the aggregate propensity to conflict.
2. Implementation of peace via truthful revelation of private conflict costs is also impossible in presence of ethnic segregation and spatial resource inequality.



# Flavor of Theory: Results

## 3. Characterization of second-best transfer scheme and the resulting spatial distribution of conflict risks:

- ▶ *Local conflict exposure:*

$$e_l(\mathbf{t}_l, \mathbf{s}_l, r_l) := (r_l/r) \left[ \prod_{g \in G^*} (s_l^g / s^g) \right]^{1/|G^*|}$$

- ▶ It's our empirical measure for the local propensity to conflict.
- ▶ Intuition: Costs for “buying” local peace increase in
  - ▶ (relative) local resource rents,
  - ▶ local ethnic diversity among discordant groups  $G^*$ , which tends to be high if discordant groups are manifold and locally over-represented.

# Empirical setting



# Empirical setting and sample

## Sierra Leone:

- ▶ Civil war 1991–2002: 70,000 casualties
- ▶ Ethnicity is salient, but only one of several factors in the war.
- ▶ Industrial mining important since 2003: 65% of export revenues, large share of government revenues.

## Sample:

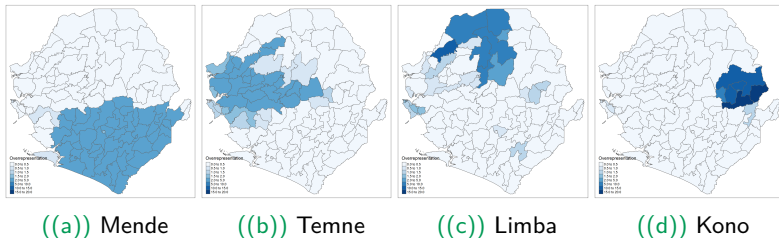
- ▶ Units: 107 wards in Sierra Leone.
  - ▶ Typically one or more historical chiefdoms.
  - ▶ Average area 670 km<sup>2</sup> ( $< 1/4$  of  $0.5 \times 0.5$  DD grid cells).
- ▶ Sample period: 1997–2018.

# Data: Ethnic geography

Data on population and ethnicity:

- ▶ Source: 2004 Housing and Population Census of Sierra Leone; 10% of all households; ward-level.
- ▶ Ethnic groups: Mende (33%), Temne (32%), Limba (8%), Kono (5%), plus 8 smaller, less important groups.

Figure: Local over-representation ( $s_l^g/s^g$ ) of largest ethnic groups

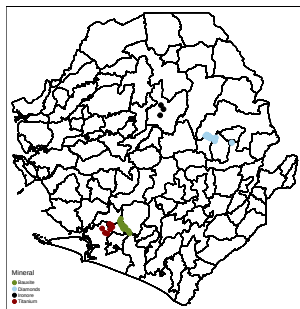
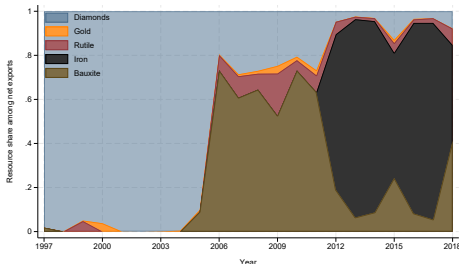


# Data: Mining geography

Data on mining and minerals:

- ▶ Source for net exports: UN Comtrade
- ▶ Source for mines: Raw Material Data (RMD) plus polygons by Maus et al. (2020).
- ▶ Interesting variation:

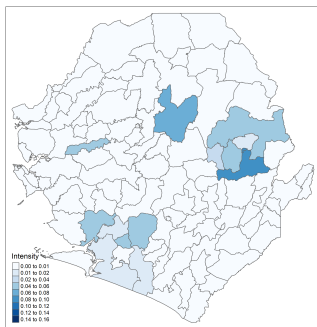
Figure: Net exports shares and mine distribution



## Data: Mining geography

- ▶ Assumption: Local resource rents  $r_l$  increase in
  - ▶ size of nearby mines,
  - ▶ inverse distance to these mines, and
  - ▶ importance of the corresponding mineral in a given year.

Figure: Time-averaged relative local resource rents  $r_l/r$

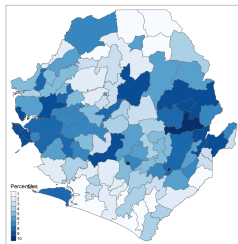


## Data: Conflict

Observed local conflict exposure:

- ▶ Source: Armed Conflict Location and Event Data (ACLED)
- ▶ Events included: Battles, riots, violence against civilians (Eberle et al. 2020).
- ▶ Assumption: Observed local conflict exposure increases in
  - ▶ the number of nearby conflict events and
  - ▶ the inverse distance to these conflict events.

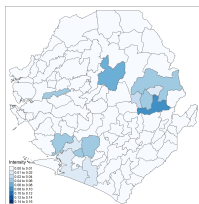
**Figure:** Time-averaged observed local conflict exposure



# Empirical validation: Predicted local conflict exposure

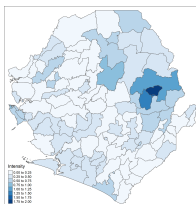
Computation of predicted local conflict exposure:

1. Determine (country-level) set of discordant groups.
  - ▶ Example: Mende, who are over-represented in iron-mining area, are a discordant group in the iron period only.
2. Compute ethnic diversity among discordant groups in each ward.
3. Compute predicted conflict exposure in each ward:



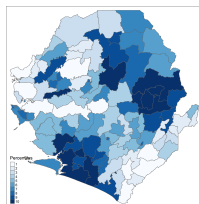
((a)) Relative resource rents

×



((b)) Diversity discordant groups

=

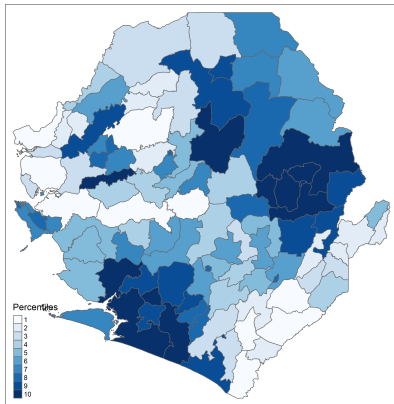


((c)) Predicted conflict exposure

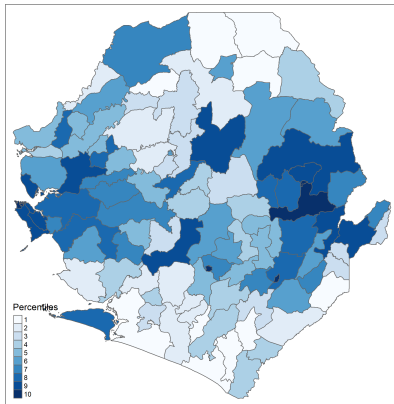


# Empirical validation: Visual econometrics

Figure: Time-averaged predicted vs observed local conflict exposures



((a)) Predicted conflict exposure



((b)) Observed conflict exposure

► Comparisons by period

# Empirical validation: Cross-sectional OLS evidence

|                                 | <i>Dependent variable: Log observed conflict exposure</i> |                     |                     |                    |
|---------------------------------|-----------------------------------------------------------|---------------------|---------------------|--------------------|
|                                 | (1)                                                       | (2)                 | (3)                 | (4)                |
| <i>Panel A: Full period</i>     |                                                           |                     |                     |                    |
| Log predicted conflict exposure | 0.140***<br>(0.044)                                       | 0.120***<br>(0.041) | 0.055**<br>(0.024)  | 0.053*<br>(0.028)  |
| R2                              | 0.0648                                                    | 0.245               | 0.773               | 0.833              |
| <i>Panel B: Diamond period</i>  |                                                           |                     |                     |                    |
| Log predicted conflict exposure | 0.097***<br>(0.023)                                       | 0.085***<br>(0.016) | 0.068**<br>(0.030)  | 0.089**<br>(0.035) |
| R2                              | 0.0967                                                    | 0.238               | 0.537               | 0.684              |
| <i>Panel C: Bauxite period</i>  |                                                           |                     |                     |                    |
| Log predicted conflict exposure | 0.105**<br>(0.048)                                        | 0.117***<br>(0.044) | 0.065**<br>(0.027)  | -0.021<br>(0.032)  |
| R2                              | 0.0649                                                    | 0.245               | 0.736               | 0.794              |
| <i>Panel D: Iron period</i>     |                                                           |                     |                     |                    |
| Log predicted conflict exposure | 0.174*<br>(0.096)                                         | 0.127*<br>(0.074)   | 0.091***<br>(0.031) | 0.071**<br>(0.028) |
| R2                              | 0.0695                                                    | 0.218               | 0.762               | 0.832              |
| Population control              | —                                                         | ✓                   | ✓                   | ✓                  |
| Area control                    | —                                                         | —                   | ✓                   | ✓                  |
| Province-fixed effects          | —                                                         | —                   | —                   | ✓                  |
| Observations                    | 107                                                       | 107                 | 107                 | 107                |

*Notes:* Standard errors are spatially clustered with a distance cutoff of 100km.

# Empirical validation: Panel and IV evidence

- ▶ Exploit intertemporal variation in two-way fixed effects regressions.
- ▶ Endogeneity concern: Conflict reduces mining activities and, thereby, local resource rents and predicted conflict exposure.
- ▶ Common practice: Use variation in global mineral prices.
- ▶ Strategy: Use shift-share instruments for identification via exogenous (global price) shocks (Borusyak et al. 2022).
- ▶ First stage:  $\ln(\text{Predicted conflict exposure}_{lt}) =$

$$\sum_{j=B,D,I} \delta_j [\ln(\text{proximity}_l^j) \times \ln(\text{price}_t^j)] + FE_l + FE_t + \nu_{lt},$$

where  $B$ ,  $D$  and  $I$  stand for bauxite, diamonds, and iron.

# Empirical validation: Panel and IV evidence

|                                                                                          | <i>Dependent var.: Log observed conflict exposure</i> |                      |                     |                      |
|------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------------|---------------------|----------------------|
|                                                                                          | (1)                                                   | (2)                  | (3)                 | (4)                  |
| <i>Panel A: OLS</i>                                                                      |                                                       |                      |                     |                      |
| Log predicted conflict exposure                                                          | 0.064***<br>(0.020)                                   | 0.047***<br>(0.017)  | 0.041**<br>(0.018)  | 0.041**<br>(0.020)   |
| R2                                                                                       | 0.516                                                 | 0.560                | 0.567               | 0.583                |
| <i>Panel B: 2SLS (second stage)</i>                                                      |                                                       |                      |                     |                      |
| Log predicted conflict exposure                                                          | 0.189***<br>(0.066)                                   | 0.171**<br>(0.069)   | 0.165**<br>(0.069)  | 0.161***<br>(0.059)  |
| R2                                                                                       | 0.496                                                 | 0.543                | 0.552               | 0.570                |
| <i>Panel C: 2SLS (first stage) – Dependent variable: Log predicted conflict exposure</i> |                                                       |                      |                     |                      |
| Bauxite proximity-price interaction                                                      | 2.643***<br>(0.460)                                   | 2.882***<br>(0.434)  | 3.102***<br>(0.448) | 3.286***<br>(0.407)  |
| Diamond proximity-price interaction                                                      | -2.924***<br>(0.331)                                  | -1.583***<br>(0.359) | -0.668*<br>(0.362)  | -0.650<br>(0.426)    |
| Iron proximity-price interaction                                                         | 0.311***<br>(0.112)                                   | 0.157<br>(0.113)     | -0.014<br>(0.119)   | -0.439***<br>(0.157) |
| First-stage F-stat                                                                       | 43.42                                                 | 22.34                | 19.18               | 25.12                |
| Ward-fixed effects                                                                       | ✓                                                     | ✓                    | ✓                   | ✓                    |
| Year-fixed effects                                                                       | ✓                                                     | ✓                    | ✓                   | ✓                    |
| Province trends                                                                          | –                                                     | ✓                    | –                   | –                    |
| District trends                                                                          | –                                                     | –                    | ✓                   | –                    |
| Ward trends                                                                              | –                                                     | –                    | –                   | ✓                    |
| Observations                                                                             | 2354                                                  | 2354                 | 2354                | 2354                 |

Notes: Standard errors are spatially clustered with a distance cutoff of 100km.

# Empirical validation: Robustness and external validity

## Robustness:

► Figures and tables

- All or different types of conflict events included
- Alternative computation of local resource rents
- Different distance decays and spatial clustering
- Restriction to four largest ethnic groups
- Controlling for local resource rents and Berman et al. (2017) interaction term

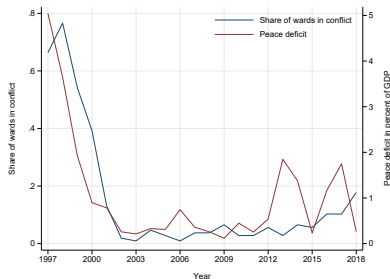
## External validity:

► Figures and tables

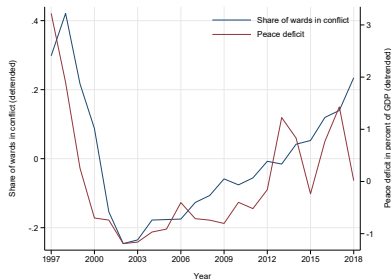
- Similar cross-sectional results in a sample of 8 West African countries with less granular spatial data.

# Empirical validation: Peace deficit

**Figure:** Peace deficit in percent of GDP (red lines) vs share of wards with conflict events (blue lines)



((a)) Standard time series



((b)) Detrended time series

# Counterfactual analysis

Idea:

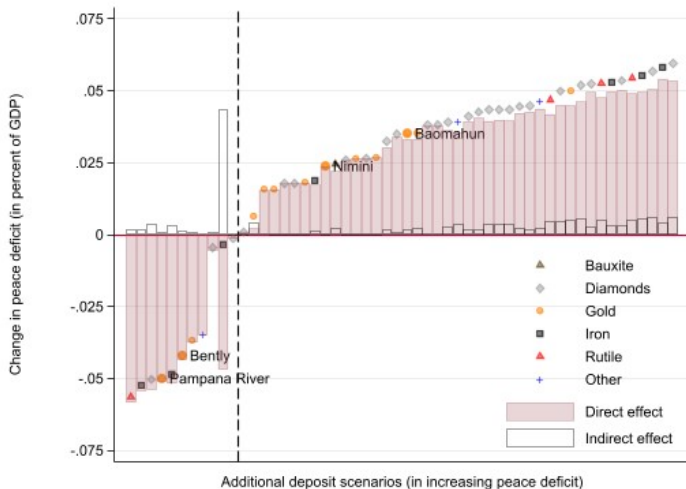
- ▶ Predict conflict externalities of the hypothetical development of known mineral deposits in Sierra Leone.
- ▶ Use changes in peace deficit to predict effects on aggregate propensity for conflict.
- ▶ Use changes in local conflict exposure to predict relative effects across locations.

Assumptions (easy to modify):

- ▶ Revenues of existing mines are unchanged.
- ▶ Revenues of new mines equal 10% of total revenues of existing mines.

# Counterfactual analysis

Figure: Aggregate effects of new mining projects on conflict

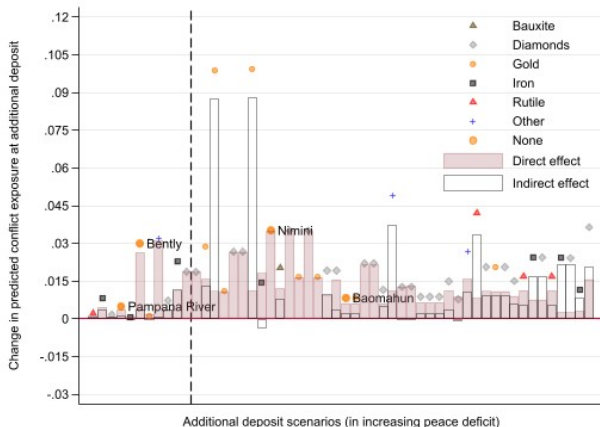


► Mining for peace is rather rare, but possible.



# Counterfactual analysis

Figure: Effects of new mining projects on local conflict at deposits



- ▶ Large variation and no clear correlation with aggregate effects.
  - ▶ Large variation also for local effects in other wards, e.g., those with currently active mines.
- ▶ Figure

# Counterfactual analysis

Intuition: Pampana River deposit

- ▶ Location: Close to the center (slightly towards the west).
- ▶ Reasons for negative aggregate conflict externalities:
  - ▶ Reduction in spatial resource inequality, as no active mine is nearby.
  - ▶ Reduction in ethnic diversity among discordant groups in some resource-rich locations as the Kono are no longer discordant.
    - ▶ Kono live in the diamond-mining area in the East.
- ▶ Reasons for very low local conflict externality:
  - ▶ Low ethnic diversity among discordant groups, as they are all locally under-represented.
  - ▶ However, this would change if local revenues were even higher and the Temne, who are locally over-represented, became a discordant group.

# Conclusions and policy implications

- ▶ Our theoretical model shows that the effects of a new mine on conflict depend on:
  - ▶ Location of the new mine
  - ▶ Country's existing mining geography
  - ▶ Country's ethnic geography
- ▶ Empirical analyses validate our theoretical concepts: local conflict exposure and peace deficit.
- ▶ Counterfactual analyses highlight the existence of mining projects that would lower the aggregate propensity to conflict.

# Conclusions and policy implications

- ▶ Our concepts and simulations can be useful for governments, international mining companies, and other stakeholders.
  - ▶ Governments can influence the set of active mines.
  - ▶ Governments can use the peace deficit to price mining licences or design royalty schemes.
  - ▶ International mining companies can use our concepts because conflict can increase their production and transportation costs or undermine their social license to operate.

# Theory: Setup

- ▶ Country with ethnic groups  $g = 1 \dots G$  and locations  $l = 1 \dots L$ .
- ▶ Each location has a resource rent  $r_l > 0$ , with  $r = \sum_l r_l$ .
- ▶ Resource rents can be contended in **local** or **national** conflicts.
- ▶ Group  $g$  (in location  $l$ ) believes that the share of the rents preserved in a **local**/**national** conflict is  $v_l^g \in [0, 1]$ / $v^g \in [0, 1]$ .
- ▶ Group  $g$  (in location  $l$ ) wins the share  $s_l^g \in [0, 1]$ / $s^g \in [0, 1]$  of the preserved rents in a **local**/**national** conflict.
  - ▶ These shares may depend on a group's local and national population  $m_l^g$  and  $m^g$ , e.g., ratio forms  $s_l^g = m_l^g / m_l$  and  $s^g = m^g / m$ .
- ▶ Group  $g$ 's payoff from **local**/**national** conflict is  $r_l v_l s_l^g / r v s^g$ .

# Theory: Setup

- ▶ A central planner can redistribute resource rents.
- ▶ A transfer system  $\mathbf{t}$  is a  $|G| \times |L|$  dimensional matrix with  $t_l^g$  as typical element.
- ▶ A transfer system is *budget feasible* iff  $\sum_g t_g \leq r$ .
- ▶ Group  $g$ 's payoff from peace is  $t_l^g / t^g$  at the local/national level, where  $t^g = \sum_l t_l^g$ .
- ▶ The planner's objective is to (i) guarantee peace the national level and (ii) maximize the number of locations with peace.
  - ▶ Benevolent political leaders are rare, but even non-benevolent leaders care about security and stability.
  - ▶ Other objectives (e.g., ethnic or regional favoritism) would imply a tightening of the budget constraint, making ours a best-case scenario.

# Theory: Peace guaranteeing transfers

Main result:

- **Proposition 1:** There exists a transfer system that is budget feasible and implements peace everywhere if and only if

$$1 = \sum_l (r_l/r)(s_l^g/s^g) \text{ for each } g. \quad (1)$$

- Assuming ratio forms, peace condition (1) holds only in very special cases:
  - No spatial resource inequality, i.e.,  $r_l/m_l = r/m$  for all  $l$ .
  - No ethnic segregation, i.e.,  $m_l^g/m_l = m^g/m$  for all  $l$  and  $g$ .

# Theory: Peace guaranteeing transfers

Intuition:

- ▶ A transfer system implements peace everywhere for all  $v^g$  and  $v_l^g$  if and only if  $t^g \geq s^g r$  and  $t_l^g \geq s_l^g r_l$  for all  $g$  and  $l$ .
- ▶ First, each group gets  $t^g = s^g r$  to guarantee national peace.
- ▶ Groups over-represented in resource-rich locations are then short of (local) transfers from this national-level constraint:

$$rs^g = t^g = \sum_{l \in L} t_l^g < \sum_{l \in L} r_l s_l^g$$

- ▶ Formally, the set of these groups is

$$G^* = \{g \in G : 1 < \sum_{l \in L} (r_l/r)(s_l^g/s^g)\}$$

- ▶ These groups feel deprived of the resource rents accruing in the locations where they predominately live.
- ▶ They may start local conflicts (unlike other groups).



# Theory: Peace guaranteeing transfers

Remark:

- Bargaining failure follows from the presence of multiple threat points.

Useful measure:

- We define the peace deficit as the amount of extra funds that would allow the planner to guarantee peace everywhere:

$$D := \sum_{g \in G^*} \left( \sum_{l \in L} r_l s_l^g - r s^g \right)$$

- It measures the general tendency to conflict in a country.

“Extension:”

- **Proposition 2:** There exists a mechanism that is peace maximizing and incentive compatible if and only if peace condition (1) holds.

## Theory: Second-best transfers

- ▶ Government minimizes aggregate probability of local conflict subject to ensuring peace at the national level:

$$\min_t \sum_l p_l(t_l, \dots) \text{ s.t. } t^g = s^g r \text{ for each } g.$$

- ▶ Deprived groups  $g \in G^*$  are again conflict initiators.
- ▶ Assumption: Groups' signals of preserved shares are iid with power-form CDF  $\Phi(x) = x^\alpha$  with  $\alpha$  sufficiently small.
- ▶ **Proposition 3:** Given the optimal system of transfers, the probability of conflict at each location  $l \in L$  is increasing in the conflict exposure index

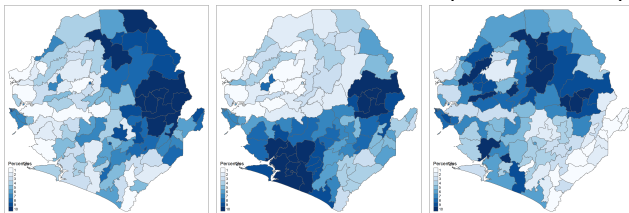
$$e_l(\mathbf{t}_l, \mathbf{s}_l, r_l) := (r_l/r) \left[ \prod_{g \in G^*} (s_l^g / s^g) \right]^{1/|G^*|}.$$

## Data: Summary statistics

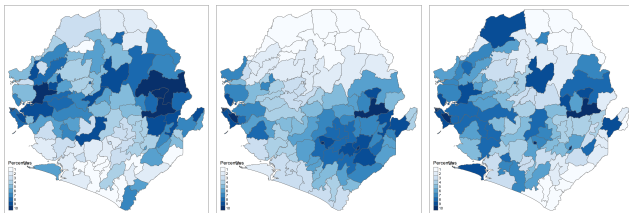
| Variable                                         | Mean   | SD   | Min    | Max    | N     |
|--------------------------------------------------|--------|------|--------|--------|-------|
| <i>Panel A: Cross-sectional sample</i>           |        |      |        |        |       |
| Relative resource rents                          | 0.01   | 0.02 | 0.00   | 0.10   | 107   |
| Diversity among discordant groups                | 0.34   | 0.30 | 0.04   | 1.76   | 107   |
| Log observed conflict exposure                   | -5.51  | 0.65 | -6.33  | -3.00  | 107   |
| Log predicted conflict exposure                  | -7.04  | 1.18 | -9.13  | -2.63  | 107   |
| Log population (2004)                            | 10.57  | 0.50 | 9.53   | 12.67  | 107   |
| Log area                                         | 5.93   | 1.61 | -0.23  | 7.97   | 107   |
| <i>Panel B: Panel sample</i>                     |        |      |        |        |       |
| Log observed conflict exposure                   | -5.51  | 1.04 | -7.43  | -0.81  | 2,354 |
| Log predicted conflict exposure                  | -7.04  | 1.68 | -11.24 | -0.16  | 2,354 |
| Log bauxite proximity $\times$ log bauxite price | -41.58 | 6.24 | -50.90 | -10.82 | 2,354 |
| Log diamond proximity $\times$ log diamond price | -24.96 | 4.25 | -30.48 | -7.91  | 2,354 |
| Log iron proximity $\times$ log iron price       | -20.74 | 5.07 | -32.06 | -3.34  | 2,354 |
| <i>Panel C: Time-series sample</i>               |        |      |        |        |       |
| Share of wards in conflict                       | 0.15   | 0.22 | 0.01   | 0.77   | 22    |
| Peace deficit in percent of GDP                  | 1.03   | 1.23 | 0.12   | 5.05   | 22    |

# Empirical validation: Visual econometrics

Figure: Predicted vs observed local conflict exposures across periods



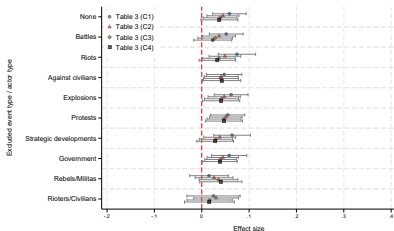
((a)) Predicted DP ((b)) Predicted BP ((c)) Predicted IP



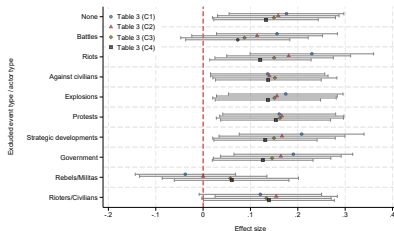
((d)) Observed DP ((e)) Observed BP ((f)) Observed IP

# Robustness

Figure: Robustness: Alternative outcome variables



((a)) OLS panel



((b)) 2SLS panel (second stage)

**Notes:** Top row includes all ACELD event types. Rows 2–7 exclude a single event type: battles, riots, violence against civilians, explosions, protests, and strategic developments. Rows 8–10 exclude events for distinctive actor types: State forces, rebels/militias, and civilians/protesters and rioters. Different colors and shapes refer to different specifications in the main tables. Confidence intervals are based on spatially clustered Conley standard errors with a 100km distance cutoff.

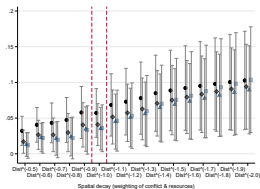
# Robustness

**Table:** Robustness: Alternative computation of resource rents

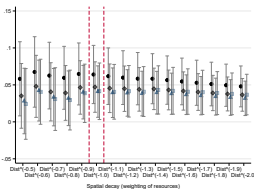
|                                           | <i>Dependent variables: Log conflict exposure</i>   |                     |                    |                    |                                     |                     |                    |                    |
|-------------------------------------------|-----------------------------------------------------|---------------------|--------------------|--------------------|-------------------------------------|---------------------|--------------------|--------------------|
|                                           | <i>Difference in computation of resource rents:</i> |                     |                    |                    |                                     |                     |                    |                    |
|                                           | <i>Light-weighted industrial mines</i>              |                     |                    |                    | <i>Inclusion of artisanal mines</i> |                     |                    |                    |
|                                           | (1)                                                 | (2)                 | (3)                | (4)                | (5)                                 | (6)                 | (7)                | (8)                |
| <i>Panel A: OLS cross-section</i>         |                                                     |                     |                    |                    |                                     |                     |                    |                    |
| Log predicted conflict exp.               | 0.133***<br>(0.039)                                 | 0.117***<br>(0.036) | 0.049*<br>(0.026)  | 0.047<br>(0.031)   | 0.125***<br>(0.034)                 | 0.105***<br>(0.033) | 0.044*<br>(0.025)  | 0.046<br>(0.028)   |
| Population control                        | ✓                                                   | ✓                   | ✓                  | ✓                  | ✓                                   | ✓                   | ✓                  | ✓                  |
| Area control                              | –                                                   | ✓                   | ✓                  | ✓                  | –                                   | ✓                   | ✓                  | ✓                  |
| Province-fixed effects                    | –                                                   | –                   | –                  | ✓                  | –                                   | –                   | –                  | ✓                  |
| Obs.                                      | 107                                                 | 107                 | 107                | 107                | 107                                 | 107                 | 107                | 107                |
| <i>Panel B: OLS panel</i>                 |                                                     |                     |                    |                    |                                     |                     |                    |                    |
| Log predicted conflict exp.               | 0.066***<br>(0.021)                                 | 0.051***<br>(0.019) | 0.048**<br>(0.019) | 0.048**<br>(0.021) | 0.066***<br>(0.021)                 | 0.051***<br>(0.019) | 0.048**<br>(0.019) | 0.048**<br>(0.021) |
| <i>Panel C: 2SLS panel (second stage)</i> |                                                     |                     |                    |                    |                                     |                     |                    |                    |
| Log predicted conflict exp.               | 0.184***<br>(0.058)                                 | 0.167***<br>(0.064) | 0.154**<br>(0.068) | 0.134**<br>(0.058) | 0.184***<br>(0.058)                 | 0.167***<br>(0.064) | 0.154**<br>(0.068) | 0.134**<br>(0.058) |
| First-stage F-stat                        | 22.61                                               | 12.57               | 11.08              | 14.82              | 22.61                               | 12.57               | 11.08              | 14.82              |
| Ward-fixed effects                        | ✓                                                   | ✓                   | ✓                  | ✓                  | ✓                                   | ✓                   | ✓                  | ✓                  |
| Year-fixed effects                        | ✓                                                   | ✓                   | ✓                  | ✓                  | ✓                                   | ✓                   | ✓                  | ✓                  |
| Province trends                           | –                                                   | ✓                   | –                  | –                  | –                                   | ✓                   | –                  | –                  |
| District trends                           | –                                                   | –                   | ✓                  | –                  | –                                   | –                   | ✓                  | –                  |
| Ward trends                               | –                                                   | –                   | –                  | ✓                  | –                                   | –                   | –                  | ✓                  |
| Obs.                                      | 2354                                                | 2354                | 2354               | 2354               | 2354                                | 2354                | 2354               | 2354               |

# Robustness

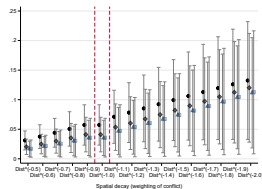
Figure: Robustness: Alternative distance decays



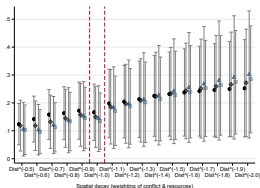
((a)) OLS panel (both)



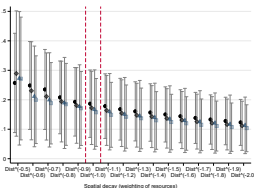
((b)) OLS panel (rents)



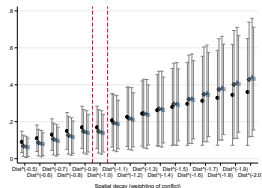
((c)) OLS panel (conflict)



((d)) 2SLS panel (both)



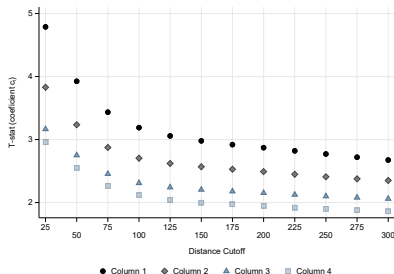
((e)) 2SLS panel (rents)



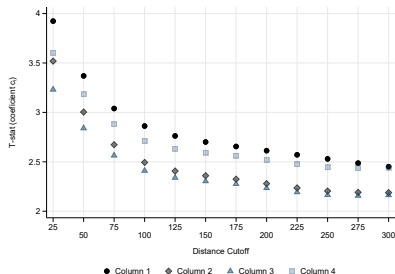
((f)) 2SLS panel (confl.)

# Robustness

Figure: Robustness: Alternative distance cutoffs for spatially clustered standard errors



((a)) OLS panel



((b)) 2SLS panel



**Table:** Robustness: Large ethnic groups only

|                                           | <i>Dependent variable:</i><br><i>Log observed conflict exposure</i> |                     |                     |                     |
|-------------------------------------------|---------------------------------------------------------------------|---------------------|---------------------|---------------------|
|                                           | (1)                                                                 | (2)                 | (3)                 | (4)                 |
| <i>Panel A: OLS cross-section</i>         |                                                                     |                     |                     |                     |
| Log predicted conflict exposure           | 0.089**<br>(0.038)                                                  | 0.076**<br>(0.034)  | 0.031*<br>(0.018)   | 0.023<br>(0.022)    |
| Population control                        | –                                                                   | ✓                   | ✓                   | ✓                   |
| Area control                              | –                                                                   | –                   | ✓                   | ✓                   |
| Province-fixed effects                    | –                                                                   | –                   | –                   | ✓                   |
| Obs.                                      | 107                                                                 | 107                 | 107                 | 107                 |
| <i>Panel B: OLS panel</i>                 |                                                                     |                     |                     |                     |
| Log predicted conflict exposure           | 0.055***<br>(0.017)                                                 | 0.047***<br>(0.016) | 0.046***<br>(0.015) | 0.050***<br>(0.019) |
| <i>Panel C: 2SLS panel (second stage)</i> |                                                                     |                     |                     |                     |
| Log predicted conflict exposure           | 0.156***<br>(0.055)                                                 | 0.161***<br>(0.059) | 0.152**<br>(0.064)  | 0.149***<br>(0.056) |
| First-stage F-stat                        | 34.25                                                               | 23.59               | 17.56               | 23.72               |
| Ward-fixed effects                        | ✓                                                                   | ✓                   | ✓                   | ✓                   |
| Year-fixed effects                        | ✓                                                                   | ✓                   | ✓                   | ✓                   |
| Province trends                           | –                                                                   | ✓                   | –                   | –                   |
| District trends                           | –                                                                   | –                   | ✓                   | –                   |
| Ward trends                               | –                                                                   | –                   | –                   | ✓                   |
| Obs.                                      | 2354                                                                | 2354                | 2354                | 2354                |

# Robustness

**Table:** Robustness: Controlling for (absolute) local resource rents  $r_l$

|                                           | Dependent variable:<br>Log observed conflict exposure |                     |                    |                     |
|-------------------------------------------|-------------------------------------------------------|---------------------|--------------------|---------------------|
|                                           | (1)                                                   | (2)                 | (3)                | (4)                 |
| <i>Panel A: OLS cross-section</i>         |                                                       |                     |                    |                     |
| Log predicted conflict exposure           | 0.331**<br>(0.139)                                    | 0.075**<br>(0.030)  | 0.075**<br>(0.030) | -0.006<br>(0.032)   |
| Log resource rents                        | -0.549*<br>(0.332)                                    | -0.048<br>(0.059)   | -0.048<br>(0.059)  | 0.143***<br>(0.053) |
| Population control                        | —                                                     | ✓                   | ✓                  | ✓                   |
| Area control                              | —                                                     | —                   | ✓                  | ✓                   |
| Province-fixed effects                    | —                                                     | —                   | —                  | ✓                   |
| Obs.                                      | 107                                                   | 107                 | 107                | 107                 |
| <i>Panel B: OLS panel</i>                 |                                                       |                     |                    |                     |
| Log predicted conflict exposure           | 0.065***<br>(0.019)                                   | 0.047***<br>(0.017) | 0.041**<br>(0.018) | 0.042**<br>(0.020)  |
| Log resource rents                        | -0.082<br>(0.171)                                     | 0.053<br>(0.180)    | 0.064<br>(0.190)   | 0.218<br>(0.283)    |
| <i>Panel C: 2SLS panel (second stage)</i> |                                                       |                     |                    |                     |
| Log predicted conflict exposure           | 0.183***<br>(0.055)                                   | 0.151***<br>(0.058) | 0.156**<br>(0.065) | 0.166***<br>(0.062) |
| Log resource rents                        | -0.167<br>(0.189)                                     | 0.077<br>(0.189)    | 0.088<br>(0.196)   | 0.282<br>(0.291)    |
| First-stage F-stat                        | 66.76                                                 | 38.83               | 27.94              | 25.17               |
| Ward-fixed effects                        | ✓                                                     | ✓                   | ✓                  | ✓                   |
| Year-fixed effects                        | ✓                                                     | ✓                   | ✓                  | ✓                   |
| Province trends                           | —                                                     | ✓                   | —                  | —                   |
| District trends                           | —                                                     | —                   | ✓                  | —                   |
| Ward trends                               | —                                                     | —                   | —                  | ✓                   |
| Obs.                                      | 2354                                                  | 2354                | 2354               | 2354                |

# Robustness

**Table:** Robustness: Controlling for relative local resource rents  $r_l/r$

|                                   | Dependent variable:<br>Log observed conflict exposure |                     |                     |                     |
|-----------------------------------|-------------------------------------------------------|---------------------|---------------------|---------------------|
|                                   | (1)                                                   | (2)                 | (3)                 | (4)                 |
| <i>Panel A: OLS cross-section</i> |                                                       |                     |                     |                     |
| Log predicted conflict exposure   | 0.375**<br>(0.168)                                    | 0.331**<br>(0.139)  | 0.075**<br>(0.030)  | -0.006<br>(0.032)   |
| Log relative resource rents       | -0.619<br>(0.406)                                     | -0.549*<br>(0.332)  | -0.048<br>(0.059)   | 0.143***<br>(0.053) |
| Population control                | —                                                     | ✓                   | ✓                   | ✓                   |
| Area control                      | —                                                     | —                   | ✓                   | ✓                   |
| Province-fixed effects            | —                                                     | —                   | —                   | ✓                   |
| Obs.                              | 107                                                   | 107                 | 107                 | 107                 |
| <i>Panel B: OLS panel</i>         |                                                       |                     |                     |                     |
| Log predicted conflict exposure   | 0.053**<br>(0.027)                                    | 0.065***<br>(0.024) | 0.076***<br>(0.024) | 0.083***<br>(0.032) |
| Log relative resource rents       | 0.032<br>(0.079)                                      | -0.056<br>(0.067)   | -0.113*<br>(0.068)  | -0.142<br>(0.107)   |
| Ward-fixed effects                | ✓                                                     | ✓                   | ✓                   | ✓                   |
| Year-fixed effects                | ✓                                                     | ✓                   | ✓                   | ✓                   |
| Province trends                   | —                                                     | ✓                   | —                   | —                   |
| District trends                   | —                                                     | —                   | ✓                   | —                   |
| Ward trends                       | —                                                     | —                   | —                   | ✓                   |
| Obs.                              | 2354                                                  | 2354                | 2354                | 2354                |

Notes: 2SLS panel is not feasible, as log of relative local resource rents absorbs the instrument power.

# Robustness

**Table:** Robustness: Controlling for the Berman et al. (2017) interaction

|                                           | <i>Dependent variable:<br/>Log observed conflict exposure</i> |                      |                      |                     |
|-------------------------------------------|---------------------------------------------------------------|----------------------|----------------------|---------------------|
|                                           | (1)                                                           | (2)                  | (3)                  | (4)                 |
| <i>Panel A: OLS panel</i>                 |                                                               |                      |                      |                     |
| Log predicted conflict exposure           | 0.067***<br>(0.020)                                           | 0.049***<br>(0.018)  | 0.043**<br>(0.018)   | 0.041**<br>(0.019)  |
| Mine ward $\times$ log mineral price      | -1.463***<br>(0.441)                                          | -0.819***<br>(0.308) | -0.738***<br>(0.213) | -1.100*<br>(0.664)  |
| <i>Panel B: 2SLS panel (second stage)</i> |                                                               |                      |                      |                     |
| Log predicted conflict exposure           | 0.201***<br>(0.066)                                           | 0.186***<br>(0.070)  | 0.179***<br>(0.066)  | 0.158***<br>(0.058) |
| Mine ward $\times$ log mineral price      | -1.857***<br>(0.431)                                          | -1.236***<br>(0.337) | -1.190***<br>(0.335) | -0.838<br>(0.852)   |
| First-stage F-stat                        | 28.57                                                         | 24.02                | 34.69                | 32.47               |
| Ward-fixed effects                        | ✓                                                             | ✓                    | ✓                    | ✓                   |
| Year-fixed effects                        | ✓                                                             | ✓                    | ✓                    | ✓                   |
| Province trends                           | —                                                             | ✓                    | —                    | —                   |
| District trends                           | —                                                             | —                    | ✓                    | —                   |
| Ward trends                               | —                                                             | —                    | —                    | ✓                   |
| Obs.                                      | 2354                                                          | 2354                 | 2354                 | 2354                |

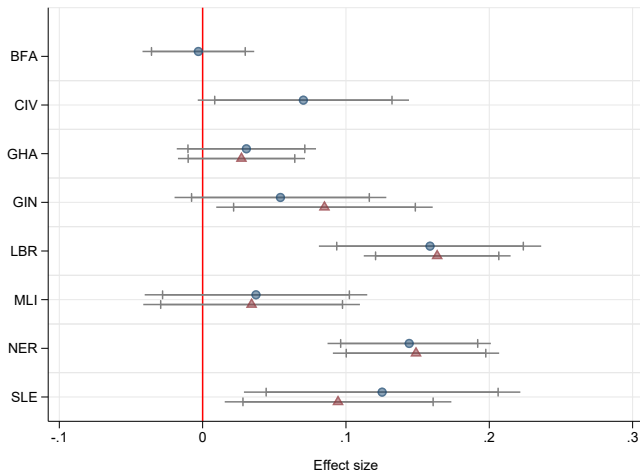
# External validity

Table: External validity

|                                                    | <i>Dependent variable:<br/>Log observed conflict exposure</i> |                     |                     |                     |
|----------------------------------------------------|---------------------------------------------------------------|---------------------|---------------------|---------------------|
|                                                    | <i>Sierra Leone</i>                                           |                     | <i>West Africa</i>  |                     |
|                                                    | (1)                                                           | (2)                 | (3)                 | (4)                 |
| <i>Panel A: All ethnic groups</i>                  |                                                               |                     |                     |                     |
| Log predicted conflict exposure                    | 0.121**<br>(0.059)                                            | 0.150***<br>(0.053) | 0.074***<br>(0.015) | 0.061***<br>(0.013) |
| Obs.                                               | 39                                                            | 39                  | 1534                | 1534                |
| <i>Panel B: Politically relevant ethnic groups</i> |                                                               |                     |                     |                     |
| Log predicted conflict exposure                    | 0.103**<br>(0.040)                                            | 0.117***<br>(0.040) | 0.090***<br>(0.015) | 0.090***<br>(0.015) |
| Obs.                                               | 39                                                            | 39                  | 1275                | 1275                |
| Population and area controls                       | —                                                             | ✓                   | —                   | ✓                   |
| Country-fixed effects                              | ✓                                                             | ✓                   | ✓                   | ✓                   |

# External validity

Figure: External validity: Single-country estimates



# Counterfactual analysis

**Figure:** Predicted effects of hypothetical mining projects on conflict around two currently active iron mines

