Chapter	18
Title	On the Logistics of Violence
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Abstract	This chapter explores how logistical costs shape the quantity and quality of violence against civilians. I distinguish between two types of supply systems: a reliance on local resources obtained from within a conflict zone, and external resources shipped from outside. All else equal, the intensity of violence against civilians should be greater where external resources are available at relative low cost. As the costs of obtaining external resources rise – due to poor infrastructure or sabotage – violence against civilians should decline. I evaluate the empirical evidence for these claims using disaggregated data on 58 low-intensity conflicts since 1997, and archival data on Stalin's Great Terror and killings of civilians by Nazi Germany in World War II.
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ON THE LOGISTICS OF VIOLENCE

Logistics make organized violence possible. One cannot kill without the means to reach a target. Without transport and open lines of communication, combatants cannot easily deploy their forces, reload their weapons, refuel their vehicles, repair their equipment, feed their troops, evacuate their wounded, or send detainees to camps. The same logistical constraints that apply to warfare extend to violence against civilians – whether intentional or a result of collateral damage. As this chapter illustrates through micro-level data from historical and contemporary cases, disruptions to military logistics forces combatants to slow their tempo, and divert resources away from fighting. As logistical challenges mount, a combatant loses the capacity to repress, kill and destroy on a massive scale.

Research on genocide and violence against civilians regularly cites the importance of logistics, but only infrequently studies them directly. In contrast to the dedicated treatment the topic has received in military theory (Jomini, 1862), doctrine (Joint Publication 4-0, 2013), history (Van Creveld, 2004; Guerlac, 1986), policy analysis (Eccles, 1991; Foxton, 1994; Owen and Mueller, 2007) and operations research (Kress, 2000, 2002; Baker et al., 2002), social scientists have treated logistics mostly as an ancillary factor in civil conflict rather than a phenomenon of primary theoretical interest.

Recent empirical conflict research has examined the impact of road density on violence (Murshed and Gates, 2005; Buhaug and Rod, 2006; Bellows and Miguel, 2006; Raleigh and Hegre, 2009), the use of roadside bombs by insurgents (McFate, 2005; Townsley, Johnson and Ratcliffe, 2008), the diffusion of violence through transportation networks (Zhukov, 2012) and government efforts to isolate centers of rebel activity (Toft and Zhukov, 2012). With few exceptions, this literature has avoided probing the conditions under which logistics might affect

violence against civilians, and how logistical considerations relate to the pursuit of local popular support.

If logistical constraints indeed make violence against civilians more costly, research on this topic should be of great value in predicting the location, timing and scale of atrocities. Recent evidence suggests that these constraints apply to great powers and local militias, and that the importance of logistics has not declined over time. Zhukov (2015*a*) shows, with archival data, that attacks against railroad networks made German forces kill fewer civilians in World War II. Using evidence from a more recent case, Rogall (2014) employs an interaction of transportation infrastructure and rainfall as an instrumental variable for mobilization during the Rwandan genocide. Such studies offer a dark contrast to recent work on the positive economic effects of low transport costs (Banerjee, Duflo and Qian, 2012; Donaldson, 2010). The same roads that lead to prosperity, this new research suggests, can also lead to a much darker place.

This chapter offers a more direct look at the logistics of political violence, with an emphasis on violence against civilians during intrastate conflict.[1] In the first section, I distinguish between two types of supply systems – a reliance on *local* resources obtained from within a conflict zone, and *external* resources shipped from outside – and the relative prevalence of these systems in government and rebel armed forces. In the second section, I consider the implications of external resources for the quality and quantity of violence, particularly the use of force against civilians. I argue that more extreme forms of violence call for a greater reliance on external resources, but also create vulnerabilities that opponents can exploit. In the third section, I examine how disruptions to logistics affect the behavior of armed groups. The fourth

[1]A conflict is "intrastate" if the parties to the dispute are state and non-state actors competing for sovereignty (i.e. supreme, independent authority over a body politic) in a common geographical area. Violence in such conflicts is "political" if it is part of an organized campaign to compel loyalty or deter opposition to those perpetrating it. This definition includes most violence in civil wars, revolutions, armed rebellions, as well as one-sided mass killings and state terror. It excludes unorganized violence like riots and looting, political non-violence like protests, and non-political violence due to criminal activity.

section considers the empirical basis for these claims. Using data on contemporary and historical conflicts in Eastern Europe, Africa and Asia, I show that where logistical costs are high – due to infrastructure or sabotage – we should see less violence overall, and less violence against civilians in particular.

1. The Art of the Logistically Feasible

In his *Precis de l'Art de la Guerre*, the French general and military theorist Antoine-Henri Jomini defined logistics as the "practical art of moving armies" (Jomini, 1862, 15). If strategy "decides where to act," then logistics "bring the troops to this point" (Jomini, 1862, 51). Core tasks include moving and sustaining forces, managing their inventory of fuel, food, medicine, clothing, construction materials, ammunition and spare parts, organizing the supply chain, protecting roads, bridges and waterways, and ensuring that field equipment is in serviceable condition (Joint Publication 4-0, 2013, II-1-6). Logistics determine the scope of what is feasible, and can have profound implications for both strategy and tactics, shaping the amount and type of violence that we observe.

1.1. **Local and External Resources.**

The effect of logistics on the production of violence depends on the type of supply system an armed group uses – one that relies mostly on locally-obtained resources or those shipped from outside (Leites and Wolff, Jr. 1970, 76, Kress 2002, 29).

In the first case, the army recruits its personnel and procures its supplies from the immediate geographical area in which it is deployed. This requires a local resource base with sufficient carrying capacity to support the force, as well as the cooperation or acquiescence of the local population.

In the second case, an army supports its operations through a logistical network, which connects supply depots with distribution centers, and home bases with forward-deployed units. The external option requires, first and foremost, open and protected lines of communication.

The greater one's reliance on external resources, the greater the logistical burden.

Most combatants rely on some bundle of local and external resources. The balance depends on static factors like infrastructure and resource endowments, as well as dynamic factors like popular support and the actions of adversaries. A reliance on local support emerges where there is little infrastructure to receive outside supplies, or where use of this infrastructure is prohibitively expensive. A reliance on external support is likely where the local population is uncooperative, or where key materiel cannot be locally obtained.

1.2. **Government logistics.** In confrontations between governments and their non-state opponents, the incumbent generally has the heavier logistical tail. Because rebel armies typically organize their forces into small light infantry units, many of the basic resources needed to produce violence – recruits, food, water, clothing – can be locally acquired, through voluntary donations, taxation and various forms of coercion (Mao, 1966, 111). Even firearms, body armor and explosives can sometimes be locally purchased or looted from police stations, prisons, commercial and industrial enterprises, and private individuals.

For regular armies and state security forces, requisitions from the immediate neighborhood are too insufficient and uncertain to keep soldiers well-fed and stocked. As field armies grew in size in early modern Europe, mass foraging and plunder quickly exhausted local supplies, making it difficult to occupy any one piece of territory for a significant period of time. To ensure that provisions kept flowing, militaries developed sophisticated networks of supply convoys, garrisons and magazines (Van Creveld, 2004, 16, 41-42). Government supply needs expanded in the twentieth century, as armies became mechanized, their fleets of vehicles requiring massive quantities of fuel to remain mobile.

1.3. **Rebel logistics.** Although rebels generally rely on local support more than governments do, this reliance is not absolute. Some groups can insulate themselves from the whims of popular support by extracting revenue from lootable natural resources, like diamonds (Bellows

and Miguel, 2009). Yet the insulation is only partial, as extraction often requires local labor (Weinstein, 2007, 173). Alternatively, groups may solicit support from external patrons, like foreign governments, ethnic diasporas, charities and volunteers (Saideman, 2002; Salehyan, Gleditsch and Cunningham, 2011*a*; Bakke, 2014).

Few groups are fully self-sufficient, but some receive more external support than others. Cross-national evidence has shown that groups with linkages to an ethnic diaspora are more likely to attract foreign support (Saideman, 2002; Gleditsch, 2007). Other studies have pointed to a more complex set of explanations of external support, like initial rebel strength and the existence of an transnational constituency (Salehyan, Gleditsch and Cunningham, 2011*b*), or simple cost savings (Salehyan, 2010).

An emerging consensus in cross-national literature on civil conflict is that rebel groups with greater access to external support are more indiscriminate in their use of force (Weinstein, 2005, 2007; Wood, 2010, 2014; Salehyan, Siroky and Wood, 2014). Where rebels receive external support, they are less reliant on the local population, less likely to seek cooperative bargains with local civilians, and less vulnerable to local backlash (Beardsley and McQuinn, 2009). Recent evidence has shown that groups reliant on external support are able to operate even where it is very costly for the local population to support them (Toft and Zhukov, Forthcoming). Not surprisingly, external support for rebels tends to make civil wars longer (Balch-Lindsay and Enterline, 2000; Cunningham, 2006; Fearon and Laitin, 2007).

As rebels receive more support from outside, their logistical requirements increase. Much like governments, rebels become dependent on the efficient delivery of supplies through logistical networks (Galula 1964, 40, Buhaug and Gates 2002). In South Vietnam, the Viet Cong created a complex system of roads, rivers, fuel pipelines and porters – collectively known as the Ho Chi Minh Trail – to transport manpower and supplies from the north. In Gaza, Palestinian militant groups have used underground tunnels to smuggle arms, food and money from Egypt, and to smuggle fighters and weapons into Israel (Piven, 2014).

Recent research on the Caucasus and Afghanistan has shown that rebel violence can spread through road networks (Zhukov, 2012), and tends to cluster around major lines of communication (O'Loughlin and Witmer, 2011; O'Loughlin et al., 2010).

1.4. **Sources of logistical costs.** The costs of utilizing external resources depend on what is being transported and how. Among the most significant drivers of costs is physical distance (Boulding, 1962; Sprout and Sprout, 1965; Starr, 1978; Schutte, Forthcoming). As distances increase between logistical bases and conflict zones, armies divert more resources to noncombat duties like escort and supply chain management (Cederman, Buhaug and Rod, 2009, 503), and more investment becomes necessary to keep fighting.

Costs also depend on cargo type and means of transportation. Fuel and ammunition weigh more than food and spare parts, and are also in greater demand. Trains are cheaper to operate than trucks. Almosy every means of transport is cheaper than air. Railways and highways have a greater capacity than unpaved roads, where truck breakdowns are common and movement is slow (Dunnigan, 2003, 499-500). The most basic mode of transportation – by foot – is least efficient, since porters and packhorses move slowly, carry little, and require regular food and rest.

2. Logistics and the scale of violence

Where the costs of acquiring external resources are low – due to robust infrastructure, short distances or a lack of enemy sabotage – violence can be more intense and often more indiscriminate. To a greater extent than other types of violence, mass killings and arrests are difficult to sustain through local resources alone. The scale and type of such violence is therefore highly sensitive to disruptions in the logistics network.

Logistical cost and complexity increase with an operation's scale. An individual detention requires little more than two or three armed

personnel, a transport vehicle, and jail cell. To detain multiple individuals from a single neighborhood requires a cordon team to regulate entry and exit to the area, a search team to conduct reconnaissance, check documents, interrogate suspects, and make arrests, and a third team to transport and process the prisoners. Such operations cannot easily reach a "massive" scale – ensnaring hundreds and thousands of people in a short period of time – without a surge in logistics, as reinforcements arrive to assist the local personnel, as additional detention facilities become necessary to hold the prisoners, and as the number people requiring transportation, food and medicine grows.

Air strikes and artillery shelling present different sorts of logistical problems. While these forms of violence do not require the direct insertion of personnel into the location of the fighting – and as such, they are attractive when ground transportation options are limited – airfields and firing positions still require significant supplies and open lines of communication. A single sortie – one flight by one aircraft on one mission – requires hundreds of hours of labor and dozens of tons of supplies to launch. A single artillery piece may fire up to five hundred shells in a single day, consuming some twenty tons of ammunition – or two to six times the carrying capacity of a typical military truck (Dunnigan, 2003, 107-108, 509).

2.1. **Implications for violence against civilians.** The economies of scale needed for a systematic campaign of mass violence requires extensive coordination and logistical infrastructure. It is difficult if not impossible to incarcerate, enslave or kill tens of thousands of people – much less the tens of millions ensnared by Soviet, German and Chinese "democides" (Rummel, 1994) – without resource mobilization and sustainment on a colossal scale.

To scale the violence and sustain it for an extended period of time, a heavily armed and mechanized combatant needs access to potentially thousands of tons of fuel, munitions and spare parts each day. Even combatants reliant on small arms and edged weapons – like militias in many parts of the developing world – need to ensure that personnel are

present in sufficient numbers, and are adequately fed and equipped to keep fighting. If the violence is expected to last more than a month, unit rotations will be necessary to relieve tired troops and maintain morale.

There is yet another reason why large-scale violence places heavier demands on external resources: local personnel can be reluctant to use force against their neighbors and co-villagers, particularly where doing so puts their families at risk of retaliation. To suppress a local uprising, governments often rely on military and police units from other parts of their country (Hassan, 2015) – further increasing the logistical burden.

3. Disruptions to Logistics

If large-scale violence requires large-scale resources, can disruptions to a combatant's supply network reduce such violence? Armed groups can seek to interrupt their opponents' local or external sources of support. Local disruptions include mass killings, population resettlement and other efforts to reduce or eliminate a combatant's civilian base of support. External disruptions include interdictions, sieges, blockades, ambushes and various forms of sabotage aimed at raising the costs of outside support.

3.1. **Disruption of local support.** Attacks on local sources of support come in two varieties. First is the use of coercion to compel local residents to either not cooperate with the opponent (Kalyvas, 2006) or leave the area (Steele, 2009). As members of the local population defect or flee in large numbers, a combatant gradually becomes unable to extract significant resources from his local support base.

A second category of local actions includes brute force campaigns of mass killing (Valentino, Huth and Balch-Lindsay, 2004) and population resettlement (Zhukov, 2015*b*) – which operate by physically eliminating local civilians or relocating them somewhere else. If the logic of the first category is one of deterrence – raising the costs of "bad" behavior through threats, intimidation and selective force – the second adopts the logic of resource denial – a combatant cannot extract much support

from someone who is either dead or in a concentration camp.

Efforts to disrupt local resources, somewhat ironically, often require significant external resources to implement. The deterrence, physical elimination and detention of local civilians are all tasks that require personnel, weapons and supplies.

The types of tactics combatants employ against civilians depend on what resources are readily available. If there are no means to transport heavy artillery within range of the targeted locality, artillery shelling will not be part of a combatant's tactical choice set. If it is prohibitively costly to transport prisoners to a detention facility far away, the prisoners are less likely to be exiled, relative to other options. The more logistically costly a given technology of violence becomes, the less likely combatants are to use it.

3.2. **Disruption of external support.** Attacks on external supply networks can constrain a combatant's behavior through several mechanisms. First is the direct disruption of vital supplies like fuel and ammunition, which can gradually render a force immobile and ill-equipped. A combatant can forestall this outcome by rerouting traffic, stockpiling supplies and reducing daily consumption to overcome short-term shortages, but such countermeasures are not without costs of their own.

Second, supply disruptions divert military resources away from offensive operations, and toward emergency management, engineering and defense. Units committed to rebuilding bridges, tunnels and railroads, escorting convoys, and monitoring ambush points are ones which cannot be simultaneously used for patrols, sweeps and other efforts to find and kill the enemy.

Third, sufficiently frequent disruptions can change the structure and capacity of a support network, forcing traffic to use expensive detours, creating choke points and congestion, and exposing the supply chain to a new set of vulnerabilities. If fewer people and materiel can move from point A to point B in a set interval of time, the tempo of operations will inevitably decline.

In all three cases, attacks on supply lines make it more costly for the opponent to operate and force him to make some unpleasant choices.

Examples of external supply disruptions abound on both the government and rebel sides. The Russian Army employed siege warfare extensively during the Caucasus Wars of 1816-1864, to contain Imam Shamil's forces in fortified mountain settlements, where supplies of food and water would grow increasingly scarce (Baddeley, 1908/2005, 323). A century later, government forces in Malaya used an extensive system of checkpoints and rail and road traffic inspections to enforce a "food denial" policy aimed against the guerrillas' supply chain (Komer, 1972, 59-60). In Algeria in the 1950s, French forces devoted great resources to seal the border from Tunisia and Morocco, in a campaign so disruptive that the Front de Libération Nationale (FLN) eventually buried most of their automatic weapons for lack of ammunition (Galula, 1964, 30).

These practices continue in contemporary conflicts. In the Syrian city of Homs, government troops cut off supply routes – along with electricity, telecommunications and water – to the rebel-controlled neighborhoods of Old City and Khalidiya. As one activist described it, "The only thing they haven't blocked is the air we breathe" (Barnard, 2013). Similar efforts could be observed during the Serb siege of Dubrovnik, the Croat siege of Bihac, and the Serbian blockade of Sarajevo (Waxman, 1998; Andreas, 2011). To take a more recent example, the primary military objective of Israel's 2014 ground incursion into Gaza was to close and destroy Hamas' network of 500 underground tunnels (Piven, 2014).

Efforts to disrupt an opponent's supply chain can cause widespread devastation. During Major General William T. Sherman's "March to the Sea" in the U.S. Civil War, Union forces heavily bombarded, evacuated and razed Atlanta, to eliminate what was then a major Confederate manufacturing center and railway hub (Waxman, 1998, 376-377). A century later, some 500,000 civilians died of starvation during Nigeria's blockade of Biafra in 1967-1970 (de St. Jorre, 1972, 412).

Not surprisingly, rebels have also sought to exploit the vulnerabilities that the government's heavy logistical tail creates. T.E. Lawrence observed that Turks' long supply lines exposed them to ambushes and blockades by Faisal's irregular forces during the Arab Revolt of 1916-1918 (Lawrence, 1920, 1). In subsequent decades, Chinese communists blockaded Suchow in 1948, the Viet Cong conducted a siege of Khe Sahn during the 1968 Tet Offensive in Vietnam, and in 1975 the Khmer Rouge laid siege to Phnom Penh. More recently, the Forces démocratiques de libération du Rwanda (FDLR) have used road blockades to isolate areas of North and South Kivu.

4. Empirical evidence

The following section compares the claims made in this chapter against the empirical record, using disaggregated data on contemporary and historical civil conflicts. To evaluate the claim that violence against civilians is decreasing in logistical costs, I use district-level data from 58 contemporary civil conflicts in Africa and South Asia. To assess the claim that logistical costs shape tactical choices in violence against civilians, I use archival data on Stalin's Great Terror. To show that logistical sabotage reduces the intensity of violence against civilians, I use data on Soviet partisan efforts to disrupt German supply lines during World War II.

4.1. **Violence against civilians in contemporary civil wars.**

Although the mechanization of warfare has expanded the technologies of violence available to combatants, most mass killings today are still carried out with small arms and melee weapons.[2] Unlike the resource-intensive armored formations and field artillery units that dominated conventional warfare in the twentieth century, today's lightly-equipped death squads and militias have a much lighter logistical burden, and rely on foraging at least as much as on hauling fuel, food and ammunition from elsewhere. Contemporary civil conflicts in Sub-Saharan Africa and South Asia should then pose a hard test for the proposition

[2]The author is indebted to an anonymous reviewer for this observation.

that higher logistical costs reduce the intensity of violence.

If logistical constraints can be shown to reduce violence against civilians in areas where logistics should matter the least – irregular conflicts like Rwanda and the Democratic Republic of Congo – we can have greater confidence that similar patterns obtain in less extreme circumstances. The Armed Conflict Location and Event Data (ACLED) project catalogs the violent activities of governments, opposition groups, political parties, and militias in Africa, Asia and the Balkans, from 1997 to 2010 (Raleigh et al., 2010). ACLED includes data on over 80,000 events from 58 conflicts in 57 countries, disaggregated between violence directed against armed political actors and violence against civilians.[3]

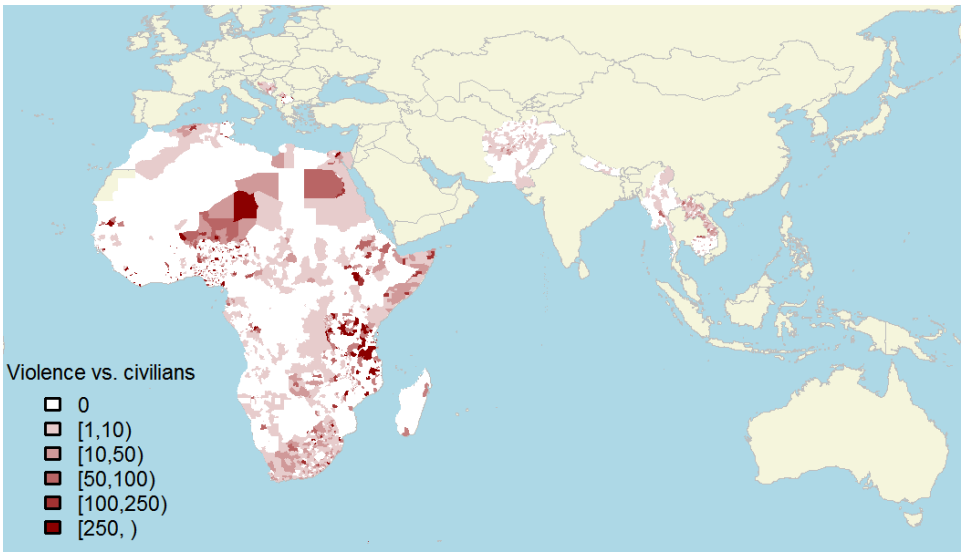
For each event, I classified its initiators into government and rebel categories, and extracted the subset of actions classified by ACLED as "violence against civilians."[4] To aggregate these individual incidents of violence into consistent units of space and time, I used the district-week as a level of analysis. Districts are second-order administrative divisions, lower than a province or governorate, but above a village or town. They are politically relevant as centers of local government

[3]The conflict zones include Afghanistan, Algeria, Angola, Benin, Bosnia and Herzegovina, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Republic of Congo, Djibouti, Democratic Republic of the Congo (First and Second Congo Wars), Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Haiti, Côte d'Ivoire, Kenya, Kosovo, Laos, Lesotho, Liberia, Libya, Macedonia, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Myanmar, Namibia, Nepal, Niger, Nigeria, Pakistan, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

[4]The government group includes the military, police, intelligence agencies and other federal, regional and municipal security services subordinate to the executive branch, as well as militias and paramilitary forces affiliated with the government or ruling party. The rebel category includes any armed opposition group seeking to challenge the government's monopoly on the use of force – locally, regionally, or nation-wide – including organized insurgencies and terrorist organizations, revolutionary movements, paramilitary wings of opposition parties, secessionist groups, local "self-defense units" and ethnic militias outside the government's control. Because each country, conflict and time period featured specific constellations of combatants, I created a custom actor dictionary for each conflict, which supplemented (or supplanted) these general classes of actors with the names of specific organizations and individuals.

power. Figure 1 shows the spatial distribution of the resulting event counts, pooled across all actors.

FIGURE 1. **Violence against civilians, 1997-2010**. District-level event counts from ACLED data. Government and rebel-initiated actions included.



As previously discussed, I expect violence against civilians – by either side – to be more intense where logistical costs are low. I capture these logistical costs with two covariates: road density, or kilometers of primary and secondary paved roads per square kilometer of area (Defense Mapping Agency, 1992), and the physical distance from each district center to the national capital. I expect the violence against civilians to be increasing in road density for both groups, and violence by government forces to be decreasing in distance from the hub of a country's political and military power. I also include standard control variables for ethnic diversity, land cover, rough terrain, urbanization and population density.[5]

A quick analysis of the data suggests that violence by both government and rebel forces is more intense where logistical costs are low.

[5]I acquired data on the the number of distinct ethnic groups within each district from the Georeferencing of Ethnic Groups data – a digital version of the Soviet *Atlas Narodov Mira* (Weidmann, Rød and Cederman, 2010). I used USGS's Global Land Cover Characteristics database to calculate the proportion of a district's land

Table 1 shows the results of quasi-Poisson regressions at the district-week level, with conflict and year fixed effects. The number of attacks against civilians is significantly higher in districts with high local road density. This intensity is also higher closer to the capital, but only for government troops.

Figure 2 shows a simulation of this result. In districts with just 3 meters of road per square kilometer of area (1st percentile), the models predict an average of .44 (95% confidence interval: .34, .57) incidents of government violence against civilians and .08 (.05, .13) incidents of rebel violence per week. In a district with the same population, terrain and other characteristics, but much higher road density (430 m/km^2, or 99th percentile), the predicted levels of violence increase more than three-fold for the government, to 1.87 (1.16, 3.05), and five-fold for rebels, to .45 (.20, 1.03). The government's ability generate violence against civilians also decreases at longer distances from the capital city. For the rebels, many of whom do not depend on resources from the capital, this distance has no effect on violence.

These results offer two important insights on the general relationship between logistics and anti-civilian violence. First, both governments and rebels rely on access to transportation infrastructure to generate and scale violence against civilians. Although rebels generally have a lighter military footprint and lower level of mechanization than modern state armies, they are just as vulnerable to traditional logistical constraints. Second, these constraints have a powerful impact on violence even in low-intensity African civil conflicts, where one might expect a relatively limited use of tanks and armored vehicles to minimize the importance of conventional military logistics.

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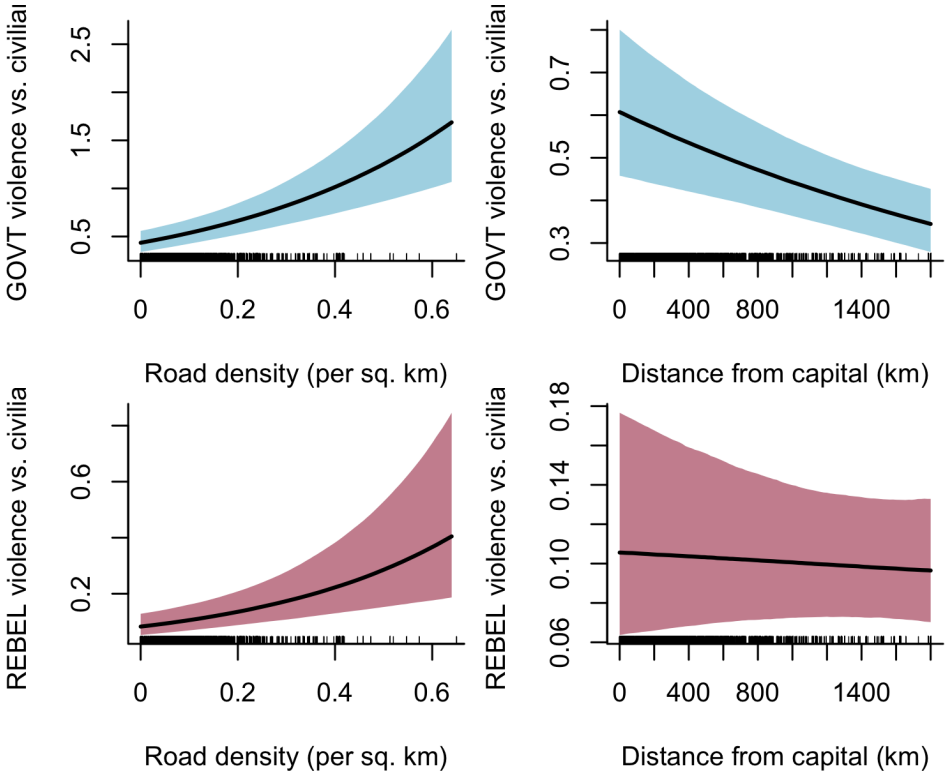
covered by open terrain (Loveland et al., 2000). I used the U.S. National Oceanographic and Atmospheric Administration' ETOPO5 5-minute gridded digital elevation model to calculate the standard deviation of elevation in each district (NOAA, 1988). I used the USGS Global GIS database to calculate the number of unique built-up areas within each district (Hearn et al., 2005), and used the Gridded Population of the World raster dataset to calculate average local population density in 1990, 1995, or 2000, depending on the start year of each conflict. Finally, include a time-lagged row-normalized spatial lag of violence against civilians, using a queen's case border contiguity matrix.

TABLE 1. **Determinants of violence against civilians.** Quasi-poisson regression with conflict and year fixed effects.

	Dependent variable:					
	Gov't violence vs. civilians			Rebel violence vs. civilians		
	(1)	(2)	(3)	(4)	(5)	(6)
Road density	2.030^{***}	3.380^{***}	3.269^{***}	5.106^{***}	3.957^{***}	3.500^{***}
(per sq. km)	(0.540)	(0.610)	(0.612)	(0.757)	(1.025)	(1.026)
Distance to capital	-1.213^{***}	-0.567^{***}	-0.678^{***}	-0.895^{***}	-0.096	-0.213
(km)	(0.123)	(0.147)	(0.148)	(0.186)	(0.263)	(0.264)
Population density	-0.596	0.542	0.559	2.609^{***}	3.453^{***}	3.360^{***}
	(0.417)	(0.405)	(0.397)	(0.413)	(0.562)	(0.559)
Built-up areas	1.378^{***}	0.573^{***}	0.623^{***}	-0.074	-0.504	-0.441
	(0.161)	(0.186)	(0.186)	(0.431)	(0.447)	(0.436)
SD(elevation)	-2.437^{***}	0.745^{**}	0.672^{**}	0.420^{*}	-0.713^{**}	-0.754^{***}
	(0.208)	(0.309)	(0.307)	(0.215)	(0.295)	(0.290)
Open terrain	-0.622^{***}	0.081	0.057	0.352^{**}	0.046	0.011
	(0.076)	(0.095)	(0.094)	(0.145)	(0.194)	(0.189)
Number of languages	0.435^{**}	0.125	0.096	1.745^{***}	1.053^{***}	1.118^{***}
	(0.171)	(0.193)	(0.195)	(0.227)	(0.238)	(0.232)
W·Gov't violence	0.319^{***}	0.074^{**}	0.068^{**}			
vs. civilians $(t-1)$	(0.025)	(0.031)	(0.032)			
Gov't violence	0.095^{***}	0.061^{***}	0.057^{***}			
vs. civilians $(t-1)$	(0.005)	(0.005)	(0.005)			
W·Rebel violence				0.443^{***}	0.269^{***}	0.221^{**}
vs. civilians $(t-1)$				(0.093)	(0.089)	(0.088)
Rebel violence				0.447^{***}	0.401^{***}	0.373^{***}
vs. civilians $(t-1)$				(0.017)	(0.017)	(0.018)
Constant	-0.154^{**}	-2.106^{***}	-1.880^{***}	-2.972^{***}	-2.497^{***}	-2.402^{***}
	(0.065)	(0.137)	(0.174)	(0.129)	(0.204)	(0.327)
Conflict fixed effects	N	Y	Y	N	Y	Y
Year fixed effects	N	N	Y	N	N	Y
Observations	11,046	11,046	11,046	11,046	11,046	11,046
AIC	35,445.02	30,826.01	30,648.80	28,522.49	27,773.41	27,609.14

Note: *p<0.1; **p<0.05; ***p<0.01

FIGURE 2. **Predicted levels of violence against civilians**. Parameter values from Model 2 used for government violence, Model 5 for rebel violence. All other variables held constant at median values.



4.2. **Stalin's mass resettlements.** Among the other claims made in this chapter is that logistical costs – all else equal – should explain variation in tactics. One of the most extreme and common forms of violence used by modern governments against civilians is population resettlement (Dobby 1952, 163-164, Galula 1964, 82). Governments have forcibly uprooted and relocated civilian populations in almost a third of all counterinsurgency campaigns since the Napoleonic era, including over two dozen cases since the end of the Cold War (Zhukov, 2015*b*). In three decades of Joseph Stalin's rule in the Soviet Union, authorities forcibly resettled 12 million people. These operations generally revolved around one overarching goal: to undermine the local popular support base of the regime's political opponents – real or imagined.

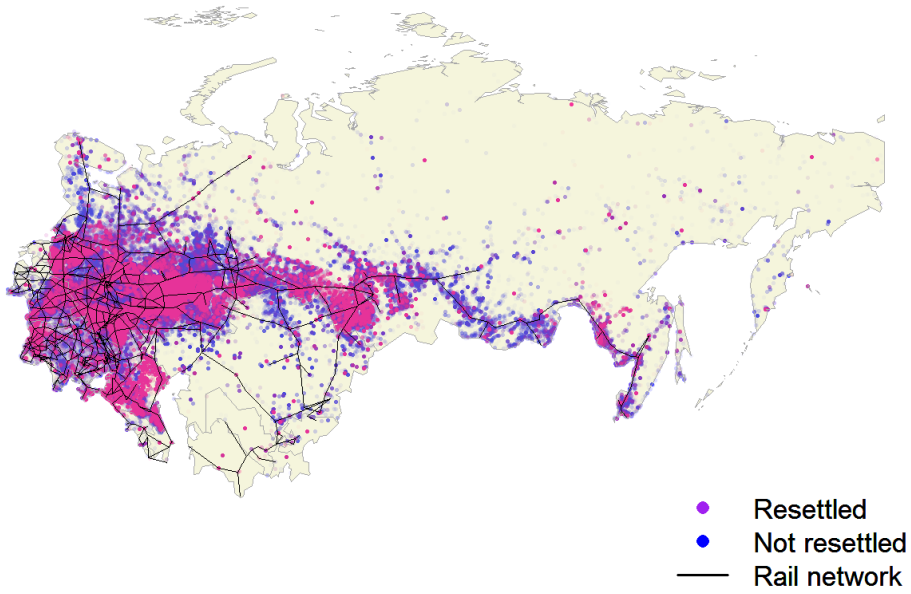
Why did the Soviets rely heavily on resettlement in some areas, but used other forms of mass repression elsewhere? Due to the wealth of archival data currently available on the actions of the Soviet secret police, Stalin's resettlement policy offers an opportune test of tactical substitution.

The Soviet resettlement campaign ranks among the most logistically taxing enterprises ever mounted by any government against its citizens. To relocate 21,000 households during a single resettlement operation in 1941, the Soviet Union required 10,000 police to round up the families, 636 freight cars to transport them, and another 194 passenger cars to carry the 1,300 enlisted personnel, 195 officers and 260 medics accompanying the human cargo to its destination.[6] Despite its impressive scale, this operation accounted for less than one percent of all Soviet citizens forcibly resettled by Stalin's regime (Pobol' and Polyan, 2005).

To evaluate whether low logistical costs made resettlement more likely, I use data on 2.65 million arrest records from 1917-1959, collected from Russian and other post-Soviet archives (Memorial, 2014), along with origin-destination distances between 618 major Soviet rail junctions from a georeferenced Soviet military map (Military-Topographical

[6]State Archive of the Russian Federation (GARF), Fond 9479, Opis 1, Delo 62, List 72-73

FIGURE 3. **Soviet rail network and mass resettlement**. Points represent 2.3 million arrests by Soviet secret police. Event data from Memorial (2014), batch geocoded with Yandex.Maps and Google Maps APIs. Rail network data from the Military-Topographical Directorate of the General Staff of the Red Army (1945).



Directorate of the General Staff of the Red Army, 1945). Figure 3 shows the geographic distribution of the arrest records, the sentences issued (resettlement of no resettlement), and the railroad network used to transport resettled arrestees to their destination.[7] 33.6 percent of the arrestees received a sentence of forcible resettlement. The remainder received sentences including local incarceration (15.6 percent), execution

[7]Of the arrest records in Memorial (2014)'s "Victims of Political Terror in the USSR" project, I was able to geocode 2.3 million (87 percent) to the municipal or district level, using Google Maps API and Yandex.Maps API. At the republican level, 81.3 percent of the arrests occurred in Russia, 5.6 percent in Ukraine, 5.1 percent in Belarus, 4.6 percent in Kazakhstan, and less than 1 percent in each of – from most to least – Kyrgyzstan, Moldova, Lithuania, Latvia, Uzbekistan, Azerbaijan, Georgia, Estonia, Armenia, Turkmenistan and Tajikistan.

(3.7 percent), property confiscation (1.6 percent), compulsory medical treatment (0.2 percent), or travel bans (less than 0.1 percent).[8]

To measure the logistical costs of resettlement, I use the locations of 618 major Soviet railroad junctions from 1945, and the travel distances between them.[9] I matched arrests and junctions by minimum geographic distance, such that each arrest is matched to its nearest rail junction, and each junction is matched with the set of arrests to which it is most proximate. In so doing, I calculated aggregated arrest statistics at the junction level, and appended nearest-junction attributes to the arrest data. Table 2 reports summary statistics at both levels of analysis.

These data suggest that the scale and nature of Stalin's mass resettlement depended strongly on railroad infrastructure. Table 3 reports the results of four regression models. Models 7 and 8, at the junction level, are Poisson event count models regressing – respectively – the number of people arrested or resettled on the travel distance, by rail, to the nearest Gulag, the centrality of the junction in the network, and local demographic and economic characteristics. Models 9 and 10, at the arrest level, are logit regressions of individual resettlement – a dummy variable – on the distance to the nearest rail junction, the distance from that junction to the nearest Gulag camp, the centrality of that junction, the arrestee's demographic and economic attributes,

[8]The arrestees' most common professions were in agriculture (13.9 percent), heavy industry (1.6 percent), service sector (1.3 percent) and forestry (1.2 percent). The most frequently arrested ethnic groups were Russian (24 percent), Polish (3.5 percent), Belarusian (3 percent), Ukrainian (2.3 percent), German (2 percent), Jewish (1.7 percent) and Tatar (1.2 percent).

[9]Based on the structure of the rail network, I calculated centrality scores for each junction, using betweenness centrality as the measure:

$$\text{Betweenness centrality}(i) = \sum_{i \neq j \neq k} \frac{\nu_{jk}(i)}{\nu_{jk}}$$

where ν_{jk} is the total number of shortest paths from junction j to junction k and $\nu_{jk}(i)$ is the number of those paths that pass through i. This statistic can be interpreted as the number of times a rail junction acts as a bridge along the shortest path between two other junctions. I rescaled this measure by $(N-1)(N-2)/2$ to ensure that it is bounded between 0 and 1, where $N = 618$ is the total number of junctions in the network.

TABLE 2. **Summary statistics**. Soviet mass terror data.

Junction-level ($N = 618$)	Range	Median	Mean	Std. Dev.
Total arrests	[0, 69374]	1581.5	3730.411	6354.176
Resettled (sum)	[0, 52835]	271	1259.941	3511.323
Resettled (mean)	[0, 0.976]	0.209	0.27	0.217
Rail distance to nearest Gulag (km)	[0.402, 1839.74]	149.628	204.798	218.556
Proportion ethnic Russian	[0, 0.783]	0.182	0.224	0.173
Proportion farm workers	[0, 0.633]	0.108	0.135	0.115
Betweenness centrality	[0, 89518.253]	5101.877	10164.023	12999.301
Betweenness centrality (rescaled)	[0, 0.014]	0.001	0.002	0.002
Arrest-level ($N = 2{,}305{,}394$)	Range	Median	Mean	Std. Dev.
Resettled	[0, 1]	0	0.336	0.472
Distance to nearest rail junction (km)	[0, 22347.139]	53.072	110.137	299.129
Rail distance to nearest Gulag (km)	[0.803, 22562.83]	185.143	254.7	357.52
Ethnic Russian	[0, 1]	0	0.241	0.428
Farm worker	[0, 1]	0	0.139	0.346
Betweenness centrality	[0, 89518.253]	9358.826	16295.475	18215.274
Betweenness centrality (rescaled)	[0, 0.014]	0.001	0.003	0.003

and regional dummies.

In each model, the intensity and probability of resettlement is decreasing in distance from the rail network and Gulags, and increasing in centrality. All else equal, a person living 10 km from a rail station was 6.8 percent (6.6, 6.9) more likely to receive a sentence of resettlement – to a Gulag labor camp or a special settlement – than someone living 100 km away. The probability of resettlement was higher still if the rail junction occupied a central position in the Soviet long-distance rail network, or if the railway distance to the nearest Gulag camp was relatively short. Victims of repression who lived in less logistically accessible areas were more likely to receive other types of sentences, including local incarceration and confiscation of property.

In contrast to the common view of Stalin's regime as an omnipotent Leviathan that sent its enemies to Siberia on a whim, the quantity and quality of Soviet repression was highly dependent on logistical costs. Archival data on mass arrests in the Soviet Union show that the scale of repression – and the likelihood of population resettlement – was higher in locations relatively accessible by rail, and proximate to preexisting labor camps and "special settlements." Logistics, it seems, were among the very few constraints on Stalin's totalitarian power.

TABLE 3. **Regression results for Soviet mass terror data**. Right-hand side variables rescaled between 0 and 1.

	Level of analysis:			
	Junction		Arrest	
	Dependent variable:			
	Arrested (count)	Resettled (count)	Resettled (dummy)	Resettled (dummy)
	Poisson		*Logit*	
	Model 7	Model 8	Model 9	Model 10
Distance to nearest junction			-23.17^{***} (0.30)	
Rail distance to nearest Gulag	-2.42^{***} (0.01)	-2.64^{***} (0.02)		-17.74^{***} (0.21)
Centrality	1.35^{***} (0.003)	1.47^{***} (0.01)	0.40^{***} (0.01)	0.33^{***} (0.01)
Ethnic Russian	-0.39^{***} (0.003)	-2.13^{***} (0.01)	-1.59^{***} (0.005)	-1.60^{***} (0.005)
Farm worker	-1.00^{***} (0.004)	-2.46^{***} (0.01)	-0.72^{***} (0.01)	-0.70^{***} (0.01)
Regional dummies	Y	Y	Y	Y
Time trend	N	N	Y	Y
Observations	611	611	1,835,584	1,834,322
Log Likelihood	−1,209,711.00	−681,719.60	−984,478.50	−983,578.80
Akaike Inf. Crit.	2,419,460.00	1,363,477.00	1,968,997.00	1,967,198.00
Note:				*p<0.1; **p<0.05; ***p<0.01

4.3. **Railroad sabotage in World War II.** A third claim in need of some empirical validation is that efforts to disrupt a combatant's logistics should decrease violence against civilians. One of the most extensive campaigns of this type was the 'Rail War' waged by Soviet partisans in German-occupied Belarus. Between 1941 and 1944, Belarusian partisans derailed over 11,128 trains carrying German personnel and supplies to the Eastern Front (Bryukhanov, 1980, 251). In response, German forces conducted mass reprisals against the local population, razing over 9,000 villages and summarily executing the civilians who lived there (State Archives of the Republic of Belarus, 2014). In part due to the brutality of these reprisals, Belarus lost a larger share of its

population – 25 percent – than any other country in World War II.

Western historians have attributed much of the blame for this devastation to the partisans themselves. As Snyder (2011) writes, 'the Germans shot so many civilians in part because Soviet partisans deliberately provoked reprisals.' Recent research in political science has challenged this assertion (Zhukov, 2015*a*).

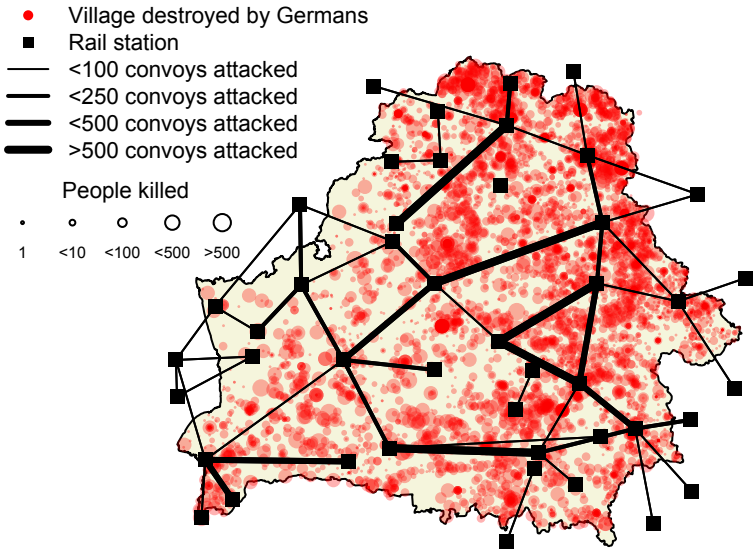
To see if railroad sabotage inflamed or suppressed German reprisal killings, I use archival data from the State Archives of the Republic of Belarus (2014), and a series of historical maps from Gamov et al. (2013). The data include 8,526 Belarusian villages destroyed by German forces in 1941-1944, along with statistics on dates, numbers of civilians killed, houses destroyed, and prewar population numbers.[10] The data also include information on 33 major World War II-era railroad junctions in Belarus, and the number of partisan-caused derailments on the routes connecting them (Figure 4).[11] I matched villages and junctions by minimum geographic distance, such that each village is associated with the nearest rail junction, and each junction with the set of villages to which it is closest. Summary statistics at both levels of analysis are shown in Table 4.

Despite the popular perception of Soviet partisans as purposefully provoking German retaliation against civilians, archival evidence suggests that their sabotage of railways had the opposite effect. Table 5 reports the results of several regression models. Models 11-13, at the junction level, are Poisson event count models regressing the number of destroyed villages – and elsewhere, the total number of civilians killed and houses destroyed – in the vicinity of the junction, on the number of trains derailed by partisans and the betweenness centrality of the junction. Models 14 and 15 are also Poisson models regressing the

[10]Of these villages, I was able to geocode 7,967 (93 percent) to the district or municipal level, using Google Maps API and Yandex.Maps API. At the provincial level, 252 of the locations were in Baranovichi, 23 in Belostok, 330 in Brest, 718 in Gomel', 992 in Minsk, 1564 in Mogilev, 258 in Pinsk, 658 in Polessie, 533 in Vileysk and 2601 in Vitebsk voblasts.

[11]Based on the structure of the rail network, I calculated betweenness centrality scores for each junction, as defined above.

FIGURE 4. **Partisan railroad attacks and German reprisals in Belarus**. Event data from Belarusian state archives (NARB), batch geocoded with Yandex.Maps and Google Maps APIs. Date range is 1941 - 1944.



number of civilians killed per village – or, separately, houses destroyed – on the number of train derailments at the closest junction, and a set of provincial dummies. In each model, partisan train derailments have a strong, negative relationship with German reprisals.

All else equal, the Germans destroyed significantly fewer villages in areas where the partisans derailed more trains (Table 6). In the villages they did destroy, they killed a significantly smaller proportion of the population and destroyed fewer houses. A high-risk junction in the rail network (1,030 train derailments, or 90th percentile) saw 49 percent fewer nearby villages destroyed than a low-risk junction (9 derailments, 10th percentile), even after controlling for the centrality of the junction in the rail network. German-attacked villages near high-risk junctions saw 20 percent fewer civilians deaths and 17.5 percent fewer houses demolished than otherwise similar villages near a low-risk section of the network.

What explains the dampening effect of train derailments on reprisals?

TABLE 4. **Summary statistics**. Belarus data.

Junction-level Belarus data. N=33.	Range	Median	Mean	Std. Dev.
Villages destroyed by Germans	[0, 1053]	138	189.3	235.19
People killed by Germans	[0, 19242]	3447	4708.39	4673.51
Houses destroyed by Germans	[0, 33244]	5791	8301.97	9155.42
Prewar population	[0, 162083]	37187	46251.58	48526.57
Prewar number of houses	[0, 43389]	8259	11237.48	11978.64
Trains derailed by partisans	[0, 1548]	252	449.09	486.85
Rails destroyed by partisans	[0, 47729]	9632	14797.7	14472.15
Routes closed by partisans	[0, 3]	1	0.73	0.84
Betweenness centrality	[0, 559.333]	9	117.12	163.83
Betweenness centrality (rescaled)	[0, 0.137]	0	0.03	0.04
Village-level Belarus data. N=7967.	Range	Median	Mean	Std. Dev.
People killed by Germans	[0, 2060]	5	24.64	82.51
Houses destroyed by Germans	[0, 1257]	27	43	54.72
Prewar population	[0, 5500]	152	239.89	305.39
Prewar number of houses	[0, 1773]	36	58.36	73.75
Trains derailed by partisans	[0, 1548]	149	341.89	417.82
Rails destroyed by partisans	[0, 47726]	9632	12044.63	10423.92
Routes closed by partisans	[0, 2]	1	0.73	0.72
Betweenness centrality	[0, 559.333]	2	114.9	184.04
Betweenness centrality (rescaled)	[0, 0.137]	0	0.03	0.05

The overwhelming majority of cargo passing through Belarus was slated for use on the front lines against the Red Army. Units stationed within Belarus were lower on the pecking order for these supplies, and their capacity to punish the population was only indirectly affected. The larger impact of the sabotage was to divert German resources to defensive duties. In high-risk sections of the network, German forces built pillboxes, laid tripwires, created minefields, leveled forests, established permanent garrisons and conducted regular patrols. So great was the demand for German personnel to protect the supply lines, that many units were diverted from the front to these rear areas (Bryukhanov, 1980, 29-30, 49).

Although a more comprehensive look at interdiction lies beyond the scope of this brief survey (see Zhukov 2015*a*), a brief look at the data suggests that the partisans' 'Rail War' is more likely to have reduced the German's violence against local civilians, than increased it.[12] If

[12]Zhukov (2015*a*) conducts a more extensive analysis of these data and finds a heterogeneous effect in partisan actions: attacks against German garrisons increased

TABLE 5. **Regression results for Belarus data**. Right-hand side variables rescaled between 0 and 1.

	Level of analysis:				
	Junction	Junction	Junction	Village	Village
	Dependent variable:				
	Villages destroyed	People killed	Houses destroyed	People killed	Houses destroyed
	Model 11	Model 12	Model 13	Model 14	Model 15
Trains derailed	-1.02^{***}	-0.25^{***}	-0.20^{***}	-0.34^{***}	-0.29^{***}
	(0.06)	(0.01)	(0.01)	(0.01)	(0.01)
Population (prewar)		2.10^{***}		6.19^{***}	
		(0.01)		(0.01)	
Houses (prewar)	2.61^{***}		2.83^{***}		5.20^{***}
	(0.04)		(0.01)		(0.01)
Centrality	0.93^{***}	0.31^{***}	0.33^{***}		
	(0.05)	(0.01)	(0.01)		
Constant	4.28^{***}	7.62^{***}	7.88^{***}	2.77^{***}	3.73^{***}
	(0.03)	(0.01)	(0.004)	(0.01)	(0.01)
Regional dummies	N	N	N	Y	Y
Observations	33	33	33	7,967	7,967
Log Likelihood	−1,531.04	−39,698.19	−38,826.33	−233,899.50	−123,364.30
Akaike Inf. Crit.	3,070.08	79,404.37	77,660.67	467,815.10	246,744.70
Note:					*p<0.1; **p<0.05; ***p<0.01

TABLE 6. **Simulation results for Belarus data**. Counterfactual is an increase in local train derailments from 9 (10th percentile) to 1030 (90th percentile).

Model	Dependent variable	Percent Change
Model 1	Villages destroyed	-48.8 (95% CI: -52.4,-45.1)
Model 2	People killed	-15.4 (95% CI: -16.5,-14.3)
Model 3	Houses destroyed	-12.3 (95% CI: -13.1,-11.4)
Model 4	People killed	-20.1 (95% CI: -21,-19.1)
Model 5	Houses destroyed	-17.5 (95% CI: -18.2,-16.8)

violence against civilians is decreasing in logistical costs, one way to reduce such violence –as the partisans found – is to increase these costs.

reprisal killings, while attacks against the rail network reduced them – consistent with the results shown here.

5. Conclusion

Mass violence can only occur where it is logistically feasible. Cheap and uninterrupted access to external resources is of course not sufficient for governments and rebels to begin committing atrocities. But where external resources are difficult or impossible to obtain, mass violence will be difficult or impossible to produce.

The preceding discussion suggests that more systematic efforts to incorporate logistics into theoretical and empirical models of conflict may help us account for much previously unexplained variation in violence. Uninterrupted flows of external resources may help us understand why some combatants can produce high levels of violence despite a lack of local popular support. Interruptions to these flows – through border closings, ambushes or sabotage – can explain why such violence sometime fails to occur, despite compelling incentives to escalate. A group's relative reliance on local and external resources may reveal why some actors are more sensitive to these disruptions than others. Above all, logistics can help us predict how much violence a group can conceivably generate, and – by extension – whether and how that group's capacity for violence may be curtailed.

The implications of such research for the study and prevention of genocide are significant. The preceding analysis has shown that logistical costs constrain violence against civilians not only during conventional mechanized warfare in highly industrialized societies, but also in dozens of lower-intensity conflicts in Africa, Asia and the Balkans. Logistics matter for both heavy-armed governments and lightly-equipped rebels. Logistics can even shape the behavior of regimes otherwise unrestrained by institutional checks on their totalitarian power – like Hitler's Germany and Stalin's Soviet Union.

If the sabotage or interdiction of external resources indeed reduces civilian suffering, states and organizations seeking to prevent mass atrocities should focus their efforts on disrupting supply lines and starving the perpetrators of resources needed to keep killing. Because supply

routes are more vulnerable and sparsely-defended than enemy positions, a strategic focus on interdiction is also less costly for opposition groups and third parties to implement than direct military engagement. A deeper understanding of the logistics of mass killing can uncover ways to make civil conflicts less deadly.

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