Transmitting Terror: Radio and Repression in Stalin's Soviet Union

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Abstract

Mass media often persuades; it can also expand the machinery of repression. We study radio network expansion and political persecution in Stalin's Soviet Union, in the decades leading up to the 'Great Terror' of 1937-38. Greater radio coverage systematically intensified political repression: a one-standard-deviation increase in signal strength is associated with roughly 40 percent more arrests and a 20 percent rise in the execution share among those arrested, with effects that grew over time. For identification, we exploit newly digitized county-level panel data for 1920–1940 and variation in longwave radio signal strength driven by ground-conductivity differences along propagation paths. Additional repression was disproportionately misdirected. Post-Stalin rehabilitation records show that high-signal areas produced substantially more sentences later reversed. Within the security apparatus itself, stronger radio reception reduced recruitment into the NKVD. It also increased the probability that incumbent officers were purged or demoted, consistent with tighter monitoring and escalating internal risk. Mass communication was not only persuasive; it operated as an input into coercive state capacity by lowering the coordination and monitoring costs of repression.

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Radio is a formidable weapon.

– *Joseph Stalin (Stalin, 1930)*

1 INTRODUCTION

From China's Great Firewall to Goebbels' control of film, music, radio, and the arts, authoritarian regimes have sought to control the media. Standard interpretations emphasize persuasion: aligning citizens' beliefs with the regime's goals secures voluntary compliance. Media should thus reduce the need for costly surveillance and repression (Wintrobe, 1998; Gehlbach and Sonin, 2014a), offering a substitute to coercion:"When people believe that the ruler has good reasons to command them ..., force is unnecessary (Przeworski, 2020)." The persuasion mechanism can be powerful; Adena et al. (2015) show that radio boosted Nazi party support, while independent TV coverage reduced Putin's support in Russian elections (Enikolopov et al., 2011). Alternatively, mass media might also complement coercive action by encouraging denunciations, by spreading mass hysteria about 'traitors', and by aligning the outlook of local security forces. There is as yet little evidence of mass media operating as a tool for more comprehensive repression.

Distinguishing whether mass media substitutes for or complements coercion is empirically challenging for three reasons. First, the placement of media infrastructure is endogenous; regimes typically target developed or politically sensitive areas, confounding signal availability with the demand for repression. Second, in most modern settings, the effects of a specific medium are obscured by a saturated information environment where television, the internet, and social media interact, making it difficult to isolate the marginal effect of broadcast infrastructure. Third, testing theories of coercive capacity requires rare, granular data not just on the incidence of repression, but on the way it is targeted and ideally – the 'guilt' of those convicted. To understand how mass media availability interacts with state persecution, one needs to observe who is repressed, the severity of their punishment, and—crucially—whether that persecution was 'misguided' or consistent with the regime's internal logic.

In this paper, we show that mass media can act as a complement to coercive state capacity. We analyse the role of radio coverage during one of the largest waves of mass persecution in history – political repression during the first 20 years of the Soviet Union,

including the "Great Terror" (1936-39). During this wave of persecution, more than 1.7 million citizens were arrested, and more than 725,000 executed among them (International Memorial, 2023).[1] At its peak, daily executions reached 1,000. The reign of terror was rooted in Soviet repression from the early 1920s, unfolding within the context of a rapidly growing, centralized propaganda system. By the late 1930s, Soviet radio broadcast a single state-controlled program through wired loudspeakers in communal spaces across the world's largest country (Lovell, 2015). This eliminates "contamination" from competing channels or selective media exposure. We use declassified documents from secret police archives tracking millions of arrests. These records allow us to observe repression on both the extensive margin (arrests) and intensive margin (execution shares). Importantly, we can also measure the "misguidedness" of persecution through subsequent rehabilitations – more than 50 percent of those executed under Stalin were subsequently exonerated (Yakovlev et al., eds, 2004).[2]

We exploit the physics of ground-wave radio transmission to overcome identification challenges.[3] Using an engineering model of long-wave propagation based on transmitter characteristics and local ground conductivity—geophysical features, we predict signal strength for each county and year. This allows us to isolate quasi-random differences in reception across otherwise similar locations.

This well-identified variation demonstrates that radio was a potent enabler of state violence. For example, in 1937, the county of Kanskii had a predicted log signal strength of 61.6, while adjacent Krasnoyarskii—shielded by the physics of ground-wave propagation—had a score of just 35.1. Consistent with this disparity in exposure, archival records document 254 repression cases in Kanskii compared to only 64 in Krasnoyarskii despite similar population sizes (94,313 and 93,656) and distance to Moscow (approximately 3,560 km and 3,360 km, respectively). This sharp local contrast generalizes systematically across the Soviet Union. In our panel from 1921 to 1939, we find that a one-standard-deviation increase in signal strength was associated with a one-third increase in

[1] Existing estimates indicate that more than 1.3 million individuals were subjected to repression, of whom between 681,000 and 692,000 were executed (Kokurin and Petrov, eds, 2000; Zemskov, 2012). Other sources place the number of executions closer to 900,000 (Gregory, 2009).

[2] Following initiatives associated with Lavrentii Beria in 1954–1955, approximately 85,000 individuals were released from labor camps (Zemskov, 1991). By the 1980s, nearly 900,000 individuals had been formally rehabilitated (Litvin, 2019). In the post-Soviet period, an additional 500,000 rehabilitations were carried out in the Russian Federation (Petrov, 2006).

[3] This is similar in spirit to the identification strategy in Yanagizawa-Drott (2014) and Olken (2009). However, the physics of longwave signal propagation differ, with longwaves primarily diffusing as a ground wave that follows the Earth's curvature and can pass over mountains (Norton, 2006).

the number of repressions relative to the mean. Executions rose by 25 percent. The 1930s "Great Terror" was, in part, facilitated by the state's new broadcasting capacity. Our estimates imply large effects. Our estimates imply that of the 725,000 individuals executed, 150,000-200,000 reflected the effect of additional radio coverage.[4]

Our data suggest that persecution not only expanded in scale and severity. It also targeted more innocent people. In high-signal areas, *fewer* people were released at the time of sentencing, and convicted instead. Evidence from post-Stalin rehabilitation records shows that in high-coverage areas, sentences are later reversed and the accused rehabilitated. A one–decibel increase in signal strength is associated with about 38 percent fewer individuals being released at sentencing and roughly 65 percent more individuals whose sentences are subsequently cleared and reversed. If stronger radio coverage had primarily improved the targeting of "guilty" suspects, we would expect the opposite pattern, with fewer later reversals. Instead, the combination of stricter trial outcomes and more post-Stalin exonerations indicates that high-signal areas brought a larger number of ultimately innocent individuals into the net of repression, consistent with coercive overreach and an abundance of "Type I" errors, rather than more accurate screening.

How were the forces that carried out the persecution of dissidents affected by the arrival of radio? On the one hand, their task might have been easier, if locals aligned with the party line and provided more information. On the other hand, greater central control might reduce the discretion of the secret police (NKVD), making positions less attractive. It might also facilitate the persecution of officers considered subversive or too independent.

We find that in counties with strong radio reception, recruitment into the NKVD was reduced, while the probability that incumbent officers were themselves repressed or demoted increased with signal strength. A one–standard–deviation stronger reception is associated with a 30 percent decline in recruits born in that region, while at the same time being associated with a roughly 120 percent increase in the officers who were purged. Radio-enabled coercion widened the net for both civilians and the security apparatus itself.

This paper contributes to three literatures. First, we add to work on the foundations of state capacity. Classic accounts emphasize coercion as central to state formation (Tilly,

[4]This calculation is based on using the estimated semi-elasticities to the scale of executions during the Great Terror (1937–38). A one–standard–deviation increase in predicted radio signal strength—a shift comparable to the observed cross-county variation in radio exposure during the 1930s—is associated with on the order of 150,000 to 200,000 additional executions.

1990), while more recent work studies how fiscal, legal, and administrative investments expand the state's reach (Besley and Persson, 2009; Acemoglu et al., 2015). We show that communication infrastructure can expand coercive capacity itself: greater radio coverage systematically increased the scale and severity of repression. State capacity thus depends not only on fiscal or bureaucratic investments, but also on the informational environment in which coercion operates.[5]

Second, we contribute to the literature on mass media and political behavior. Existing work demonstrates that media access shapes spending, voting, and persuasion (Strömberg, 2004; Gentzkow, 2006), and can even affect mass violence (Adena et al., 2015; Yanagizawa-Drott, 2014). Theoretical models analyze why autocrats invest in media control (Besley and Prat, 2006; Egorov et al., 2009). This literature largely treats media as a device for shaping citizens' beliefs. We instead show that media access is systematically associated with expanded use of coercion, shifting attention from persuasion alone to the interaction between communication and repression.[6]

Third, we connect to the political economy of authoritarian institutions, where a central question is whether propaganda substitutes for or complements repression (Guriev and Treisman, 2019; Przeworski, 2020). Related work studies strategic information management and censorship (Lorentzen, 2014; Hollyer et al., 2015; King et al., 2013), as well as broader theoretical frameworks (Egorov and Sonin, 2024). A parallel literature examines Stalinist repression directly, including its regional patterns and long-run consequences.[7] Our evidence indicates that mass media operated as a complement to coercion, widening both the scale and severity of repression and increasing the share of cases later reversed.

[5]See also Finan et al. (2017); Przeworski (2020); Mehmood (2022); Gulzar and Khan (2025) on voluntary compliance, bureaucratic incentives, and selection within the state apparatus.

[6]For broader surveys, see Zhuravskaya et al. (2020) and references therein, as well as DellaVigna and Kaplan (2007); Gerber et al. (2009); Enikolopov et al. (2011); Gehlbach and Sonin (2014b).

[7]See Rozenas and Zhukov (2019); Rozenas et al. (2017); Zhukov and Talibova (2018); Markevich et al. (2025); Dower et al. (2021); Gregory et al. (2011); Mehmood et al. (2025).

2 Historical Background and Context

> We can and must turn radio... into our own weapon in the struggle against the enemies of the people.
>
> – *Anatoly Lunacharsky*

In this section, we briefly summarize the role of repression in Soviet rule during the interwar years, and discuss the founding and expansion of radio in the USSR.

2.1 The Soviet Union and Stalin's Rule.

The Soviet Union emerged from the 1917 Bolshevik Revolution as a one-party socialist state following a protracted and bloody civil war. The Communist regime consolidated power through the Bolshevik Party, abolished competitive elections, and nationalized major industries (Suny, 1998). Joseph Stalin consolidated power in the late 1920s. Thereafter, the regime emphasized rapid industrialization, collectivization of agriculture, and strict central planning as key policy aims. Output grew rapidly as heavy industry expanded.

The government increasingly regulated social, economic, and ideological life through centralized administrative control and extensive monitoring. Soon, the Stalinist system combined an omnipresent party structure organizing everyday life with mass indoctrination through the press and the school system (Fitzpatrick, 1999).

One of the main pillars of party rule was the state security police, reorganized several times and operating from 1934 as the NKVD (People's Commissariat for Internal Affairs). It was responsible for intelligence, policing, and internal security across the country. The Cheka of the Civil War era was transformed into the GPU and then the OGPU in the 1920s; in 1934, these security functions were absorbed into the newly created NKVD, which combined state security with the regular police (*militsiia*), border troops, and the rapidly expanding Gulag system(Hagenloh, 2009; Shearer, 2009). This bureaucratic consolidation linked intelligence collection, registration and surveillance, criminal policing, and the administration of forced labor into a single apparatus capable of identifying targets, arresting them, and processing them through either judicial or administrative channels.

The NKVD relied on dense record-keeping (workplace files, residence registration,

and passport controls), systematic surveillance, and a constant flow of denunciations from citizens and institutions, which were encouraged as a civic duty and then sifted locally into operational leads (Shearer, 2009; Hagenloh, 2009). Investigations typically aimed at producing admissions and usable narratives—confessions, named accomplices, and "plots"—that could be aggregated into wider cases. The resulting feedback loop (more arrests producing more denunciations and forced testimony, which in turn produced more suspects) made campaigns self-sustaining once launched.

Persecution was often managed via central directives specifying target categories and arrest priorities. These were frequently coupled with numerical limits or benchmarks (in practice functioning as quotas) that prescribed local patterns of persecution (Getty and Naumov, 1999; Khlevniuk, ed, 2004). Processing often bypassed ordinary courts altogether through extra-judicial or quasi-judicial bodies (notably *troiki* and other NKVD commissions), which could sentence large numbers of cases rapidly, with minimal procedural safeguards and little scope for defense.[8] Even when the judiciary was used, the system was designed to prioritize speed, uniformity, and political reliability over fairness and scrutiny of evidence.

Finally, the NKVD's repressive toolkit extended beyond arrest and execution to forms of coercion that were administratively cheaper and socially pervasive: internal exile, deportation, labor-camp sentences, and the use of employment and housing controls to discipline "unreliable" groups (Khlevniuk, ed, 2004; Hagenloh, 2009). These measures blurred the boundary between security policing and social governance. The resulting environment of chronic uncertainty—in which ordinary bureaucratic encounters (registration, workplace discipline, neighborhood scrutiny) could feed into security categorization—added an additional layer of state repression encouraging ritualistic conformity.

Persecution was therefore not only aimed at political enemies of the Soviet regime. From the 1930s onwards, following rapid industrialization and the rapid expansion of urban centres, low-level criminality and social disorder were common. Recent research has emphasized that the NKVD increasingly targeted all forms of malfeasance, using its methods honed in the fight against political 'opponents' to cleanse society of anti-social behavior, the homeless, petty criminals, and nomads. (Shearer, 2009; Hagenloh, 2009). During the Great Terror especially, NKVD persecution aimed as much at social control as at the systematic rooting out of serious political opposition; a tool for which the radio was

[8]Many cases did not go through full judicial procedure at all, and where courts were involved the process was commonly expedited and highly constrained. See Khlevniuk, ed (2004); Getty and Naumov (1999).

unique suited.

2.2 The Expansion of Soviet Radio

The Soviet regime invested heavily in propaganda and mass communication to shape beliefs and legitimize state actions. The party-state exercised extensive control over newspapers, cinema, and the arts. Radio was soon seen by the Soviet authorities as an additional means to control the minds of citizens. The 1920s saw the rollout of radio stations and regular broadcasting in most developed countries; in the Soviet Union, the 1924 *Freedom of the Air* degree established the basis for a national state broadcasting system. Panel A of Figure A1 summarizes key milestones in the expansion of Soviet radio and the major repression campaigns between 1920 and 1940. The timeline shows the launch of regular broadcasts in 1924 and the 1931 creation of the All-Union Committee for Radio Broadcasting (centralized state broadcasting authority), and highlights key political events such as the Dekulakization campaigns of 1930–1932 (mass peasant dispossession) and the Great Terror of 1936–1938 (peak Stalinist purge). Panel B plots the cumulative power of all Soviet radio transmitters between 1920 and 1940, showing minimal capacity in the early 1920s, rapid expansion after 1931, and a plateau by the late 1930s. The vertical lines in Panel B mark the same institutional turning points. Initially centered on Moscow, the transmitter network expanded rapidly, from 0 kW transmission power in 1923 to more than 1,500 by 1932, and 2,000 by 1939. By the 1930s, even the furthest corners of the Soviet Union had a good chance of radio reception, with more than 80% of the population covered (Figure 2).

Routine programming combined news, commentary, and cultural material with political content: celebration of industrial and agricultural achievements, denunciations of "class enemies" and "enemies of the people," and the adulation of Stalin's leadership (Brooks, 2000; Lovell, 2015; Roth-Ey, 2011). All messages were prepared in advance, in writing, and approved from above, then carried verbatim across the national network . Listening was rarely optional; loudspeakers were connected in offices, workshops, communal apartments, and streets to play the official broadcasts (Lovell, 2015).

This institutional setting made radio an intrusive and pervasive channel for state communication and indoctrination. Central broadcasts were used to announce policy priorities, publicize ongoing campaigns, and signal which groups were currently classified as "enemies" or potential threats. By repeatedly framing political dangers, exhorting the

public to be vigilant, and encouraging cooperation with the security services, the radio may have influenced expectations about alleged threats to the regime and the urgency of counter-measures. Radio thus served both as a source of information and as a medium for codifying the official line, reinforcing a narrative in which economic progress, national unity, and obedience to the leadership were presented as inseparable. In periods of heightened repression, broadcasts increasingly stressed vigilance against saboteurs and traitors and framed coercive campaigns as necessary defensive measures (Brooks, 2000).

Radio's importance in the Stalinist Soviet Union therefore plausibly extended beyond persuasion in a narrow sense. In a centralized political system that governed a vast and heterogeneous territory, nationwide broadcasts provided a low-marginal-cost channel for transmitting information, cues, and interpretations of events to both officials and citizens in distant localities (Lovell, 2015).

3 Data and Descriptive Statistics

We assemble a novel panel at the county (*uezd*)–year and region–year levels, covering 717 counties and 60 regions from 1920 to 1940, by merging the Memorial database of political repressions (including releases at sentencing and post–Stalin rehabilitations) with our geophysical measures of radio signal strength. Predicted longwave Radio Signal (dB) at each administrative unit is computed from station-level frequency, power, and location information extracted from early Soviet technical periodicals *Radiofront* and *Radio for All*, combined with standard engineering formulas for ground-wave propagation (Budden, 1988). We harmonize historical borders and link a set of covariates, including baseline population (1897 and 1926), distance to Moscow and Leningrad, and a time-varying distance to the nearest GULAG camp as camps open and close. For within-security-apparatus outcomes, we compile region–year NKVD personnel records (1936–1940) and construct a region–cohort measure of exposure, the mean signal from birth to age 18 in the region of birth, to study recruitment; we also compute region–year Radio Signal (dB) to analyze career outcomes such as sanctions (repression, rank demotion) and rewards (promotion, prizes). Variable definitions, sample sizes, and key construction steps are summarized in Table A1 in Online Results Appendix A. Online Results Appendix A also reports additional figures, heterogeneity analyses, and robustness checks. A separate Online Data Appendix B focuses on data construction: Appendix B1 illustrates the raw data, and Appendix B2 describes the construction, compilation, and further details on the

datasets. Details on the longwave model and the engineering formulas used to construct radio signal strength are provided in Appendix B3. Below, we describe the main variables used in our analysis.

Radio Exposure. Our main independent variable is predicted radio signal strength (dB) evaluated at the geographic center of each administrative unit. In the *uezd*-year panel we measure signal strength at the uezd centroid, and in the region-year and region-cohort panels we use the region centroid. Station characteristics are taken from Soviet radio periodicals Radio vsem (Radio for All) (1925-1930) and Radiofront (1926–1939), which report for each transmitter the first exploitation date, wave frequency, transmitter power, and location. Using a standard longwave ground-wave propagation model, we compute expected field strength from each transmitter to each centroid and adjust for terrain with a topographic attenuation index; the resulting panel captures the expansion of transmitter power and coverage over 1920 to 1940, as summarized in Figure 2. For robustness, we also construct alternative measures, including a terrain-adjusted signal and a binary audibility indicator based on a pre-specified threshold, both derived from the same engineering formulas. For the small subset of broadcasts for which transcript text survives, we present illustrative excerpts from radio broadcasts, which provide descriptive background on the tone and content of Soviet radio programming. For example, one surviving script introduces a dramatization with the line, "Comrades, you are now about to hear excerpts from The Iron Flood," and proceeds to contrast the terror inflicted by landlords, kulaks, and officers in the Northern Caucasus with the disciplined advance of Red Army infantry, cavalry, and tanks, emphasizing themes of class struggle and military mobilization. Figure B1 in Appendix B reproduces sample pages from the radio journals *Radiofront* and *Radio for All*, which form the basis of our transmitter dataset, and Figure B2 reports example excerpts from the few surviving transcripts we were able to collect, where the regime is portrayed in vivid, heroic terms, consistent with the use of radio to dramatize class conflict and legitimize coercive force (Goryaeva, 2007).

Repression Data. We construct our main outcomes from Memorial's Victims of Political Terror database, which compiles declassified archival records, regional "Memory Books," and related historical materials on Stalin-era political repression.[9] The database records repression at the arrest level, so our measure captures exposure to the coercive apparatus rather than convictions alone. Individual entries include full name, year of birth, nationality, occupation, and the date and location of arrest, as well as sentencing out-

[9]These data are publicly available at https://github.com/nextgis/memorial_data.

comes and information on release, amnesty, and post-Stalin rehabilitation. The dataset contains roughly two million individuals; we deduplicate records at the full-name-by-year-of-birth level. Our primary outcome is the number of arrests aggregated to the *uezd*–year level, based on the place and year of arrest. We also use the sentencing and post-Stalin review information to report results for the subsample of formally sentenced individuals, distinguishing those convicted under Stalin from those later declared innocent in the post-Stalin review process.

Figure A2 summarizes the temporal and spatial variation in this variable. Panel A plots annual counts of political repressions in the USSR between 1920 and 1940. The series shows sharp spikes during Dekulakization (1930–1932) and the Great Terror (1937–1938), illustrating how most documented violence is concentrated in these two campaigns. Panel B maps repression intensity across 712 *uezds*, measured as repressions per 1,000 residents, and reveals substantial geographic heterogeneity, with clusters of high repression in parts of European Russia, modern Ukraine, and the North Caucasus. We further disaggregate repressions by sentence type, focusing on the most frequent categories: execution, GULAG camp imprisonment (forced-labor camps), imprisonment in non-camp facilities, exile, and special settlement (restricted residence). We analyze each type separately but place particular emphasis on executions, using levels, rates per capita, and the share of executions among all sentences as complementary indicators. Figure 1 shows that Dekulakization (1930–1932) is driven mainly by special settlements and exile, whereas the Great Terror (1937–1938) features a pronounced spike in executions alongside increases in GULAG and non-camp imprisonment, consistent with important narratives presented in Ignatova (2009). We also track two auxiliary indicators: released at sentencing (amnesty, dismissal, acquittal), reported as counts and as a share of all sentences, and cleared after Stalin (post-1953 rehabilitations linked to pre-1940 cases).

NKVD Data. The second set of outcomes captures activity within the security apparatus and comes from Memorial's NKVD personnel records. The microdata cover about 45,000 workers, compiled from rank lists, award and prize rolls, sanction and promotion orders, and service cards. We harmonize names and ranks, de-duplicate repeated entries across lists, and restrict the sample to officers with verified postings. All aggregations use the 1926 regional division; we harmonize historical boundaries to the 1926 map and apply a unit–to–1926 crosswalk. First, we construct a region-of-birth–by–birth-year panel to measure recruitment and cohort size joining the NKVD over time; Figure A3 shows the distribution of NKVD workers by region of birth across cohorts. Second, we

aggregate by region of service and calendar year (1936–1940) to track careers, including sanctions, rank demotions, promotions and awards, entries, and separations. Outcomes are reported as counts and as shares using the number of active officers in the region–year as the denominator, with event timing set to the recorded decision year. We study rank mobility in this region–year panel using a crosswalk that harmonizes promotion titles to common officer ranks (Sergeant, Jr. Lieutenant, Lieutenant, Sr. Lieutenant, Captain, Major) and compute promotion and demotion shares by rank and year as the number of events divided by the contemporaneous NKVD headcount in that region Figure A4; Figure A5 complements this by mapping the geographic distribution of officers across ranks. Exits from the apparatus are coded using archival dismissal grounds in personnel files—self-request or voluntary resignation, political unreliability, compromising ties, and misconduct or criminal offenses—and their time trend and geographic distribution are shown in Figure A6. Within-apparatus repression outcomes are defined as the share of NKVD workers recorded as repressed in a region–year, and the subset whose cases appear on Politburo approval ("Stalin's") lists Figure A7. Finally, we use the number of inspectors hired and recognition or awards given using the share receiving departmental or state prizes; these series provide complementary views of monitoring, rewards, and exits within the organization and help interpret the mobility patterns documented below.

Controls. To construct our control variables, we draw on a range of Soviet statistical reports and technical publications. We begin with electricity generation. Following Lenin's electrification program, Soviet authorities launched a systematic effort to expand power production throughout the 1920s and 1930s. Using the 1933 statistical report together with additional archival and historical sources, we compile a time-varying measure of electricity generation across regions (TsGANKh SSSR, 1932). Power stations are classified following contemporary Soviet terminology—hydroelectric plants (HPP), state thermal power stations (GRES; electricity-only), and combined heat-and-power plants (CHP; cogeneration). For each station we identify commissioning dates and the start-up dates of individual generation units. Total generation capacity as of 1940 is presented in Figure B6. All data were from archival statistical handbooks of the Central Statistical Administration (TsSU), contemporary engineering directories, and georeferenced historical maps.

To construct additional control variables, we apply the same procedure to theatres, universities, and industrial enterprises. For theatres, we use baseline figures from (*Cultural Development of the USSR: Statistical Compendium*, 1940) and complement them with

foundation years recovered from archival and regional historical sources. For universities, we rely on the 1939 accounting of higher education institutions reported in the same statistical compendium and extend the time series backward using establishment dates. For factories, we utilise the (*History of the Industrialisation of the USSR, 1938–1941: Industrial Enterprise Index*, 1972) which provides a comprehensive listing of industrial enterprises across the USSR during 1938–1941, supplemented by historical industrial directories to recover foundation dates. To control for distance to repression infrastructure, we digitise the entire network of GULAG camps and subcamps, including opening and closure years and geographic coordinates, based on archival registers and verified using the digital chronology GULAG Chronology.

Baseline social composition is constructed from the original estate categories reported in the *First General Census of the Population of the Russian Empire* (1897). The census distinguishes hereditary nobles and personal nobles, separating lineage nobility from individuals granted noble rank for service. Clergy includes Orthodox priests and recognised Christian denominations. Honorary citizens represent a privileged non-noble status introduced in 1832 for decorated officials and professionals. Merchants correspond to registered commercial guilds; townspeople represent urban commoners—artisans, small traders, craftsmen—without noble status. Peasants form the rural communal population and demographic majority. Military Cossacks constitute a hereditary military-settler class with service obligations. Inorodtsy refers to indigenous and non-Slavic groups under separate legal administration; Finnish natives are recorded separately due to Finland's autonomous status. The census also lists persons not belonging to any estate and persons without reported estate affiliation, reflecting mobility and incomplete registration. Finally, foreign subjects denote non-Russian citizens residing in the Empire. We convert these categories into population shares at the county level and use them as baseline controls capturing deep pre-Soviet social stratification.

Balance. Table A3 assesses whether our source of identifying variation is systematically related to pre-existing county characteristics. We regress predicted signal strength by year on a broad set of baseline covariates. Overall, we do not find systematic patterns that would suggest that reception is simply tracking underlying economic or political differences or changes. The set of covariates includes the share of nobles (historical elite presence and social stratification), the share of traders and merchants and the number of pre-radio factories (baseline economic activity), pre-1920 electricity generation capacity (baseline radio transmitter capacity), the number of universities (intellectual infrastruc-

ture), and the presence of ethnic minorities, foreigners, and *Cossacks*.

A few economic variables, such as factory counts or electricity production around 1930, occasionally reach conventional significance levels. This pattern is consistent with the historical timing of industrialization and with the fact that electricity generation and industrial centers were natural locations for installing and powering transmitters. Since radio use itself required electricity, we would expect some correlation between radio availability and early industrial development. Importantly, however, these correlations are modest and do not overturn the broader picture that reception is largely shaped by engineering rather than by political targeting. The absence of correlation for *Cossacks* is particularly informative. Cossack populations were historically singled out for harsh Stalinist policies because of their perceived political unreliability. The fact that counties with higher Cossack presence are not more likely to receive a stronger predicted signal is reassuring that pre-existing targets of repression are not mechanically located in high-reception areas. This is consistent with contemporary technical accounts, which describe network expansion as driven by engineering constraints and coverage goals rather than by the spatial distribution of perceived enemies of the regime (Radiofront, 1931).[10] Finally, in robustness checks we re-estimate our main specifications on an "ever-audible" sample that only includes counties that at some point have strictly positive predicted reception. We drop both counties that never receive any signal and the very earliest radio adopters. The estimates are essentially unchanged, which suggests that our results are not driven by a particular subset of counties entering the network very early or never receiving radio at all. These patterns indicate that the signal measure does not simply proxy for underlying economic, social, or political conditions but provides plausibly exogenous variation in exposure to Soviet radio.

4 Main Results

4.1 Radio and Repression

We are interested in how radio exposure relates to repression, which we measure as the number of arrests. Figure 3 plots persecution over time, distinguishing high- and low-radio reception areas. Persecution is residualized, taking account of population and

[10] As noted in the journal "the question of station location has been considered solely from the technical point of view." (Radiofront, 1931), Issue 19.

a host of other controls. We define high vs low coverage every year, based on signal strength. Areas with a distinguishable signal start off with below-average persecution (Panel A), but then quickly outpace the areas with a weak signal (too weak to listen). By the 1930s, the difference rises to 2 log points. The pattern for executions (Panel B) is similar, with high-radio areas consistently showing more deaths for political opponents than low-radio territories. Overall, while high-radio district-years account for 54% of our sample, they account for 77% of repressions and 87% of deaths. Figure A9 and Figure A10 present binscatters of persecution and radio strength for each year in our sample. We find upward-sloping patterns throughout, illustrating that in the yearly cross-sections, the basic patterns is very strong.

Not all differences in signal strength should affect reception equally. If signal strength increases from very poor to still poor (and impossible to use technically), the effect may be small; if it goes from poor to acceptable, it may be large. In Figure 5 we examine the effect of radio signal strength on repressions and executions, splitting the sample into quintiles of radio signal strength. We find that below the conventional cutoff for an audible signal, changes in radio signal strength had no effect on measures of persecution; but above the threshold, they systematically become associated with larger effects.

4.1.1 OLS results

To go beyond the visual evidence, we estimate panel fixed-effect regressions. The treatment is radio signal strength (dB) at unit centroids. We use terrain characteristics as well as distance to transmitters to predict radio signal strength. This is in the spirit of earlier papers in the media literature (Yanagizawa-Drott, 2014; Adena et al., 2015). However, our strategy differs in important respects. Soviet authorities used long wave signals to maximize domestic reach and to limit reception of foreign stations – in contrast to the shorter radio waves used in most other countries. Longwave signals propagate as a ground wave that bends with the curvature of the Earth and passes over mountains and they also reflect within the Earth–ionosphere waveguide. As a result, variation in reception quality is driven mainly by ground conductivity, path geometry, and ionospheric conditions rather than by topographic barriers. We exploit these physical features by predicting received signal strength along the propagation path, which yields spatial variation that is tightly linked to geophysics. As new transmitters were added, and existing ones upgraded, the strength of the radio signal changed. We estimate

$$y_{it} = \beta\, RadioSignal_{it} + \gamma \mathbf{X}_{it} + \sum_k \lambda_k Z_{ik} \cdot \delta_t + \alpha_i + \delta_t + \varepsilon_{it}, \tag{1}$$

We begin by examining how radio reception is related to repression on the extensive and intensive margins. Table 4, Panel A, relates predicted radio signal strength the log number of individuals repressed. Across columns, where we progressively add county characteristics interacted with year fixed effects and time-varying controls, the coefficient on Radio signal (dB) is positive and statistically precise. In our preferred specification (column 3), the estimate is 0.0081. Interpreted as a semi-elasticity, a one–standard–deviation increase in signal strength (4.215 dB) is associated with an increase of about 0.34 log points, or roughly 40% more repressions. Given a mean of about 1.2 individuals repressed per county–year, this corresponds to roughly 0.5 additional repressions per county–year. Panel B turns to the intensive margin, using the share of the repressed who are executed as the dependent variable. The coefficient on Radio signal (dB) is again positive and precisely estimated. In column 3, a one–standard–deviation increase in signal strength is associated with an increase in the execution share of about 1.2 percentage points, relative to a mean of 6.8 percent, or roughly a 20 percent increase in the probability that a repressed individual is executed. All specifications include county and year fixed effects; the most demanding specification additionally includes baseline county characteristics interacted with year fixed effects and time-varying controls. Standard errors are clustered at the county level.

In Figure 4, we examine how the arrival of radio affected persecution in event time. We use within-county changes in predicted longwave radio reception from an engineering model driven by distance. These change as new transmitters arrive or the power of existing ones is upgraded. Panel A shows pre-treatment coefficients fluctuating around zero, indicating an absence of pre-trends. After an area becomes treated with radio reception, the pace of persecution first picks up slows in year 1 and 2, before jumping up in year 3. The full impact is only reached in year 5. In Panel B, the coefficients for the share of executions among all repressions also display an upward drift after radio arrival, albeit with wider confidence intervals, suggesting that, conditional on repression, punishment becomes more severe over time. Overall, the static and dynamic patterns suggest that as radio coverage expands, the regime not only targets more individuals but also shifts toward harsher sanctions for those it represses, consistent with mass com-

munication and repression functioning as mutually reinforcing tools of state violence. The Callaway-Sant'Anna and Sun-Abraham indicators show very similar results. Again, there is no indication of pre-trends. The evolution of executions is similar (Panel B), but the rise is more steady over time.

4.1.2 Instrumentation Strategy.

The results in Table 2 may be driven by reverse causation, or by omitted variables. The arrival of radio may reflect concerns of the political center of a region's loyalty; or it may be part and parcel of an industrialization strategy that transformed all aspects of economic, social and political life in a region. To consider the estimated relationships as causal requires the use of plausibly exogenous variation in signal strength.

We isolate such variation by comparing the signal strength from our terrain model with that implied by optimal terrain conditions. The difference – the topographical signal gain – is plausibly exogenous because it only reflects the effect of waterways, deserts, and urban agglomerations on signal diffusion. This is in the spirit of earlier papers (Olken, 2009).

The identifying assumption is that when planners decided transmitter placement and/or allocated power, they did not take into account the effect of the ground characteristics relevant for reception in other oblasts. Two articles published in *Radiofront* in 1931 provide direct archival confirmation. First, Shulman (1931) documents that Soviet planners calculated station coverage using the Eckersly formula with a *single* average ground conductivity value ($\delta = 0.7 \times 10^{-13}$) derived from aggregate field-strength measurements across the USSR, rather than estimating conductivity along specific propagation paths to individual counties (*Radiofront*, 1931, No. 19–20, p. 1162). Planning maps show coverage as uniform circles of fixed radius, with no adjustment for variation in soil conditions across receiving locations. Second, and most directly, the same article notes that "often, contrary to technical data, a station must be placed somewhere due to national, ethnographic, or political considerations" (ibid.), confirming that placement decisions were driven by factors orthogonal to the geophysical variation in ground conductivity that generates our identifying variation.

Table 3 reports the results. When we re-estimate our main specifications using this topography-adjusted measure of signal strength, the sign and magnitude of the coefficients remain consistent with those obtained with the baseline signal index. Because long-

wave propagation depends on both terrain and the earth–ionosphere waveguide, collapsing these features into a single topographic gain term necessarily introduces approximation error, making this index plausibly noisier than our baseline measure. Nonetheless, we obtain highly significant and large coefficients for our topographic signal gain variable.

4.1.3 Heterogeneity of Effects over Time

Table 9 examines whether the association between radio and repression changed after the creation of the All-Union Committee for Radio Broadcasting in 1931. This institutional reform centralized control over programming and transmitter expansion. We interact Radio Signal (dB) with an indicator for the post–Radio Committee period. Panel A reports results for the log number of repressions, and Panel B for the share of executions among all repressions. Across columns, we progressively add year fixed effects, county fixed effects, county characteristics interacted with year fixed effects, and the full set of controls; column (4) corresponds to our most saturated specification. In Panel A, the coefficient on Radio Signal (dB) in column (4) suggests that pre-1931 effects of radio were small – or easily explained by county and time fixed effects. The interaction between Radio Signal and the post–Radio Committee indicator is positive and precisely estimated. The implied post-1931 effect is given by the sum of the two coefficients, about 0.19 per dB. Evaluated at one standard deviation of radio signal, this corresponds to an approximate doubling of the number of repressed individuals in high-signal counties. The post-1931 slope is therefore larger than in the baseline specification without the interaction. The pattern is consistent with radio becoming more tightly integrated into the coercive apparatus after the institutional consolidation of radio network. Panel B shows a similar interaction pattern for the intensive margin. In column (4), the main effect of Radio Signal (dB) on the share of executions is imprecisely estimated and very small, while the interaction with the post–Radio Committee period is positive and statistically significant. Since the dependent variable is measured in percentage points, a one–standard–deviation increase in radio signal is associated with an increase of around 40 percent in the probability that a repressed individual receives the death penalty. These estimates suggest that stronger radio reception is more strongly associated with severe punishments once radio broadcasting is centrally coordinated.

Are results dominated by the 'Great Terror' – the campaign of mass arrests and exe-

cutions in 1937–1938? To examine this question, we interact Radio Signal (dB) with an indicator for post–Great Terror years in Table A5 of Online Appendix A. Panel A shows little evidence that the extensive margin of repression responds differentially across periods in our most saturated specification: the coefficient on Radio Signal (dB) remains positive and statistically significant, while the interaction term is small and imprecise, implying similar semi–elasticities of the log number of repressions with respect to signal strength in pre- and post-Terror years.

In contrast, Panel B indicates that the intensive margin becomes more sensitive to radio coverage after the Great Terror. The main effect of Radio Signal (dB) on the share of executions is modest and not precisely estimated, but the interaction with the post-Terror indicator is positive and statistically significant. The implied post-Terror slope is substantially larger than the pre-Terror one, with point estimates suggesting that a one–standard–deviation increase in signal strength is associated with an increase in the execution share on the order of a few percentage points, relative to a mean of about seven percent. Although these estimates are noisy and should be interpreted cautiously, they are consistent with the idea that once the repression apparatus was fully mobilized, radio exposure was more clearly related to the severity than the incidence of punishment. Overall, our findings suggest that radio-induced repression was stronger among less educated populations, in periods of organizational centralization, and during the height of Stalinist terror.

4.1.4 Drivers of Heterogeneity

The preceding results estimate average effects; we now ask where radio mattered most. The arrival of radio did not spell the same spike of persecution everywhere – in some parts of Russia, it barely changed the frequency of arrests and executions, whereas in others, it caused a step change. In Figure 6 we plot the Targeting Operator Characteristic (TOC) curve. It shows the range of treatment effects derived from causal targeting framework of Wager and Athey (2018). The largest treatment effects, derived from causal forest estimates, are shown on the left-hand side together with the 95% confidence interval; the further right a plotted effect is, the smaller it is in relative terms. We find large differences, suggesting that the effect of radio exposure was much larger in some locations than others.

Estimated treatment effects depend on the covariates used to stratify the sample. Fig-

ure 7 shows the Shapley values from permutation tests of the treatment effect prediction exercise, with each dot representing the effect that correlates had on the magnitude of a prediction. Three variables stand out – distance to Leningrad, distance to Moscow, and distance to Gulag. The former two are mostly associated with positive predicted effects of radio; the last, with negative effects. This suggests one intuitive interpretation: Where the center of political power was far away, as reflected by large distances to the seat of government and the second-largest city, increases in persecution were greatest when radio arrived. Where there was already a local source of state power and government control, in the form of a gulag nearby, the opposite was true – radio only had small effects there. Compared to these three factors, all other socioeconomic variables like factory density, electric power, and university presence pale into insignificance.

4.1.5 Mechanism: Radio, Propaganda, and Ideological Alignment.

Our findings show that radio can complement local enforcement. But what drives the increase in persecution and executions? One possible interpretation is that radio facilitated the indoctrination of the population. This may have led to more denunciations as radio underlined the risks from 'subversive elements'.

First, we can examine whether more people from regions that received radio coverage attained positions of influence in the Soviet regime – ideological conformity was always a requirement to do so. Second, we can analyse whether the share of falsely accused individuals among those persecuted and punished was systematically higher in radio-affected regions. This would suggest a rapid broadening of the government's drag net, with a disproportionate rise in the share of 'Type I' errors.

In Table A6, we analyse representation in the Bolshaya Sovetskaya Entsiklopediya (Great Soviet Encyclopedia). To be included, people had to reach an elevated position in Soviet society. While not everyone was a party member, the vast majority was, and everyone included as a prominent pillar of the regime – this is the 'Who is Who' of Soviet Russia. We classify individuals into three categories of elite members – intellectuals, military personnel, and politicians. We test whether individuals from these regions are more likely to be listed if they come from regions covered by radio signals. We use log number of individuals from a county who appear in the *Bolshaya Sovetskaya Entsiklopediya (Great Soviet Encyclopedia)* (1969–1978) as the dependent variable. In Column 1, the coefficient on Radio signal is highly significant. Its magnitude implies that a one–standard–deviation increase

in signal strength (4.215 dB) is associated with roughly a 10 percent increase in the number of encyclopedia entries from that county, relative to the sample mean. Columns 2, 3, and 4 of Table A6 show similar magnitudes for intellectual, military, and political figures separately that are not statistically distinguishable from one another. These patterns suggest that higher-signal counties were more likely to produce individuals later included as elites across occupations. This is consistent with radio exposure being associated with the propagation of official narratives that elevated local supporters.

Did more denunciations drive the surge in persecutions in areas where radio arrived? We can examine the share of falsely accused among those persecuted—possibly indicative of a greater number of 'leads' pouring into the offices of the NKVD. Table 5 examines the relationship between radio coverage, trial outcomes, and later rehabilitations. Our original repression measure was based on the number of arrests. Here, we focus on individuals who received a formal sentence.

Columns 1–2 show that the coefficients on radio signal for releases at sentencing are small (0.002) and statistically insignificant, suggesting that radio coverage did not systematically affect the probability of immediate release or acquittal at trial. However, the pattern differs markedly when we examine post-Stalin rehabilitation proceedings. Columns 3–4 examine the outcomes of post-Stalin reviews of these judicial decisions. In particular, we look at whether the condemned later had their sentences reversed. We find positive coefficients on radio coverage that are highly significant. In column 4, a one-decibel increase in signal is associated with about 65 percent more sentences being cleared in rehabilitation proceedings. To assess the relative magnitude, we compare the coefficient on rehabilitations (0.017) to that on total repressions (0.011 from Table 2, Column 3). The difference of 0.006 indicates that for each additional decibel of radio signal strength, the increase in rehabilitations exceeds the increase in total repressions by approximately 55 percent. Expressed in terms of shares: in high-signal areas (top quartile of radio coverage), approximately 35% of those repressed were later rehabilitated, compared to 25% in low-signal areas (bottom quartile)—an increase of 10 percentage points in the rehabilitation rate. These patterns suggest that stronger radio reception is linked not only to more frequent and harsher repression in real time, but also to a larger stock of cases that later Soviet authorities judged to have been imposed in error.

Figure A8 illustrates the nature of our result. Soviet authorities had to trade off persecution – which had direct and indirect costs – against the risk of letting the guilty escape, and of persecuting the innocent. Using the data from post-Stalin judicial reviews, we

can proxy both for the share of true political opponents caught and persecuted, and the share of the innocents (Type I errors). Where radio coverage was highest, the share of those released later – suggestive of Type I errors – was largest. Our data suggest a share of approximately 40% in areas with best coverage. Where coverage was poorer, Type I errors were more rare. While we do not observe the true share of guilty accused (α) and of innocent persecuted (β), we can trace out relative changes. If we (arbitrarily) fix α at 1 for radio signal strength -100, we obtain the curves shown in Figure A8. In other words, as the information environment increasingly became dominated by centrally-controlled state propaganda, the share of innocents persecuted shot up. This may have raised the share of true opponents caught in the net, but at an ever higher cost of innocents falsely accused. Consistent with a decline in the marginal cost of persecution, higher radio intensity is associated with a reduction in repression precision and a corresponding increase in Type I errors. While later exoneration is an imperfect proxy for innocence, the results suggest that radio expansion altered the informational environment of repression, shifting it towards lower precision as overall capacity expanded.

4.2 Radio and the Soviet Secret Police

The preceding results establish that radio expanded and intensified repression of citizens. We now turn to the coercive apparatus itself. Did radio coverage change the way in which the NKVD, the key lever of the repressive apparatus, operated? Here, we examine two key dimensions – recruitment and discipline.

4.2.1 NKVD Recruitment.

We first examine recruitment into the coercive apparatus itself. Table 6 relates the mean predicted radio signal strength in a region–cohort to the log number of birthplaces that supplied NKVD officers from that region. The data are available at the regional rather than the county level, but the estimates are informative about how the security apparatus was geographically organized. Across specifications, which progressively add region and year fixed effects and interactions of year fixed effects with baseline regional characteristics, the coefficient on radio signal (dB) is negative and statistically significant. In column 3, the estimate is about -0.11. Interpreted as a semi-elasticity, a one–standard–deviation increase in signal strength is associated with a decline of about 0.59 log points in the number of birthplaces, or roughly 45 percent fewer localities sending recruits. The pat-

tern suggests that stronger radio reception is associated with fewer officers joining the NKVD from these regions.

4.2.2 NKVD Discipline.

We also examine whether radio coverage affected the disciplining of NKVD personnel. Table 7 reports regressions of the log share of officers who were repressed (Panel A) or demoted in rank (Panel B) in a region–year on predicted signal strength. Across panels, the coefficient on Radio signal (dB) is positive and estimated with reasonable precision. In column 3 of Panel A, a one–standard–deviation increase in signal strength (2.59 dB) is associated with about 0.35 log points more repressions among officers in that region, roughly a 40 percent increase relative to the mean share. In Panel B, the analogous estimate for rank demotions is about 0.27 log points, or close to a 30 percent increase. All specifications include region fixed effects; columns 2 and 3 add year fixed effects, and column 3 further introduces time-varying controls. Standard errors are clustered at the region level. These patterns are consistent with radio facilitating tighter central oversight of the security apparatus in high-signal regions and increasing the likelihood that NKVD officers themselves were subject to coercive discipline.[11]

5 Robustness and Alternative Explanations

5.1 Alternative Explanations

A natural concern is that predicted radio signal strength may be picking up other time-varying forces that are themselves related to repression, rather than capturing the effect of radio per se. In Table 8, we probe several such alternative explanations by adding a series of plausibly relevant time-varying controls to our baseline specification, one at a time. First, we consider the expansion of the repressive infrastructure: counties with more Gulag camps could experience higher repression simply because coercion is administratively easier. We therefore add a time-varying measure of the number of camps

[11]Complementary results in Table A Table A4 show that radio coverage is also negatively associated with positive career outcomes for NKVD personnel. In the most demanding specification, a one–standard–deviation increase in signal strength is linked to a decline of roughly two-thirds in the share of officers promoted and about one-third in the share receiving state prizes. While ancillary, these mobility patterns reinforce the interpretation that improved radio reception tightened central control over the NKVD by both raising the risk of punishment and weakening prospects for advancement in high-signal regions.

within a given distance of the county center; the coefficient on predicted signal strength remains stable in magnitude and significance, suggesting that the results are not driven by the spatial spread of Gulag camp infrastructure. The coefficient on signal strength is somewhat smaller and less significant for repressions than in the baseline set of results. As the TOC results suggest, there are possibly important interaction effects with Gulag presence. The coefficient on executions is large unaffected.

Next, we examine whether signal strength simply proxies for economic development. To this end, we add electricity generation and the number of factories to our setup. Including these controls leaves the estimated effect of signal strength essentially unchanged (col. 2+3).

An addition potential concern could be that counties with more intense political repression are on different trajectory in terms of state-sponsored intellectual life – places of potential unrest might be targeted by other forms of indoctrination, like universities. We add a time-varying measure of the number of universities in the county; the estimated relationship between signal strength and repression remains similar (col 4). Along the same lines, other forms of mass communication technology may have been similarly targeted as radio: theatres also served as another medium for propaganda. To ensure that our estimates are not simply capturing broader propaganda efforts, we add a measure of the opening of new theatres over time. The signal strength estimates remain close to the baseline (col. 6).

The historical literature also links repression to famine and food-supply shocks (Rozenas and Zhukov, 2019; Markevich et al., 2025). If radio signal strength were correlated with weather patterns that drive agricultural output, this could provide an alternative channel. We therefore augment the specification with time-varying weather controls that proxy for famine risk. Again, the coefficient on signal strength is unaffected (col 5).

Additional control variables barely affect the magnitude and significance of results in our specifications, reported in Table 8. While these exercises cannot rule out all possible alternative mechanisms, they suggest that our signal measure is unlikely to be proxy for the expansion of repression infrastructure, industrialization, higher education, famine risk, or other propaganda channels.

5.2 Statistical Robustness Tests

Table A7 speaks to the concern that early-covered locations might be special, especially if the timing of radio expansion is endogenous; this might be a problem. However, as we sequentially postpone the first year in which radio can affect repression, thereby effectively dropping the earliest-covered counties, the estimates for both the extensive and intensive margins remain stable. We next consider alternative difference-in-differences implementations and functional-form choices. Table A8 reports estimates from a synthetic DiD specification that reweights control counties to match treated counties on pre-treatment trends (Arkhangelsky et al., 2021). The resulting coefficients are close to the baseline and remain precisely estimated. Table A9 follows the guidance of Chen and Roth (2024) and shows that the extensive-margin results are also robust to alternative treatments of zero repression counts, where we replace zeros with a range of small positive values before taking logs. Figure A11 implements the Rambachan and Roth (2023) "honest" DiD procedure: for both outcomes, the confidence sets remain strictly above zero for a wide range of bounds on allowed trend deviations, suggesting that moderate violations of parallel trends would not overturn the qualitative conclusions.

Finally, we examine whether our inference is overstated because of spatial correlation. Table A10 reports a series of alternative standard-error corrections. Rows 2–5 show Conley-style standard errors at distance cutoffs from 10 to 100 km; rows 6–9 implement the Müller and Watson (2022) worst-case spatial-correlation correction across several AVC parameters; and row 10 applies the multiple-outcomes adjustment of DellaVigna et al. (2025). In all cases, p-values rise somewhat but remain below conventional significance levels. Figure A12 complements these checks with a clustered wild-bootstrap procedure that treats effective treatment as potentially varying over a small number of propagation corridors rather than counties MacKinnon and Webb (2017). The bootstrap distribution of the estimates is centered near the baseline coefficients and yields similar rejection rates. These robustness exercises suggest that our main results are not driven by particular sample choices, functional-form assumptions, or overly optimistic inference.

6 Conclusion

Did the arrival of centralized mass-media pave the way for Stalin's "Great Terror"? Using plausibly exogenous, terrain-induced variation in longwave radio reception across Soviet

counties, we show that signal strength boosted repression, raising the number of arrests, convictions, and executions. These patterns are robust to a wide range of identification and inference checks. Areas far from Moscow and Leningrad saw particularly large increases in persecution once radio arrived.

Radio was synergistic with repression because it sent a real-time, synchronized, centrally-controlled signal about party policy, the types of subversion to guard against, and the latest slogans. As the NKVD's arrest rates surged, the net of persecuted widened – subsequent exonerations by post-Stalin courts show clearly that many more innocents were convicted, and all the more so in areas with good radio coverage. This implies that many more ultimately exonerated individuals were swept up in the wave of repressions induced by better radio coverage.

The NKVD's modus operandi also changed when radio coverage improved. It reduced local recruitment – possibly by shifting the emphasis from local expertise to pan-Soviet enforcement. It was also associated with more frequent purges of officers, showing that the repression apparatus itself was subject to tighter discipline in areas receiving radio coverage.

Our results suggest that radio was an important catalyst that transformed the nature of Stalinist repression. While the secret police initially targeted political 'enemies' in the narrow sense, radio expansion coincided with repression becoming a generalized instrument of social control – punishing small transgressions, disciplining the newly urbanized masses, and making the regime truly 'totalitarian' in both ambition and reach (Shearer, 2009; Hagenloh, 2009). Mass communication does more than shape beliefs; it can be synergistic with state enforcement.

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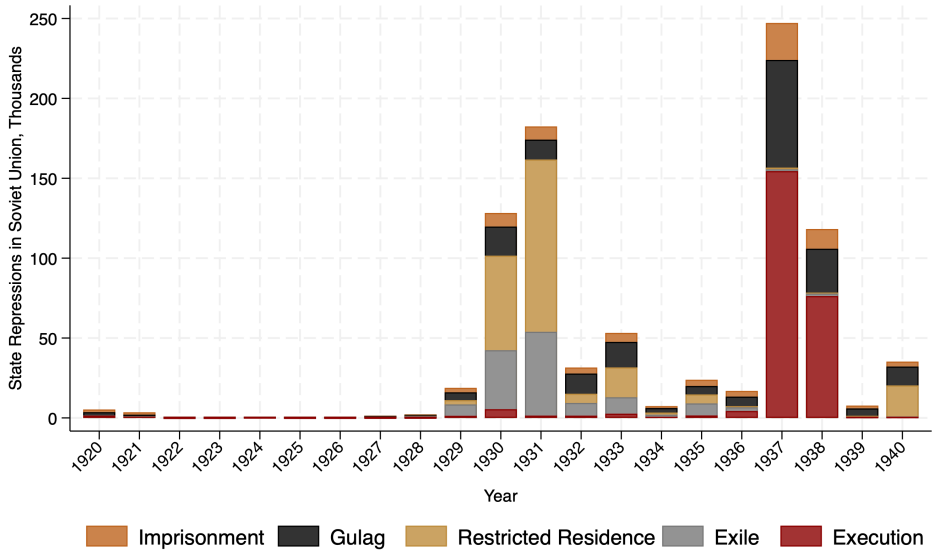
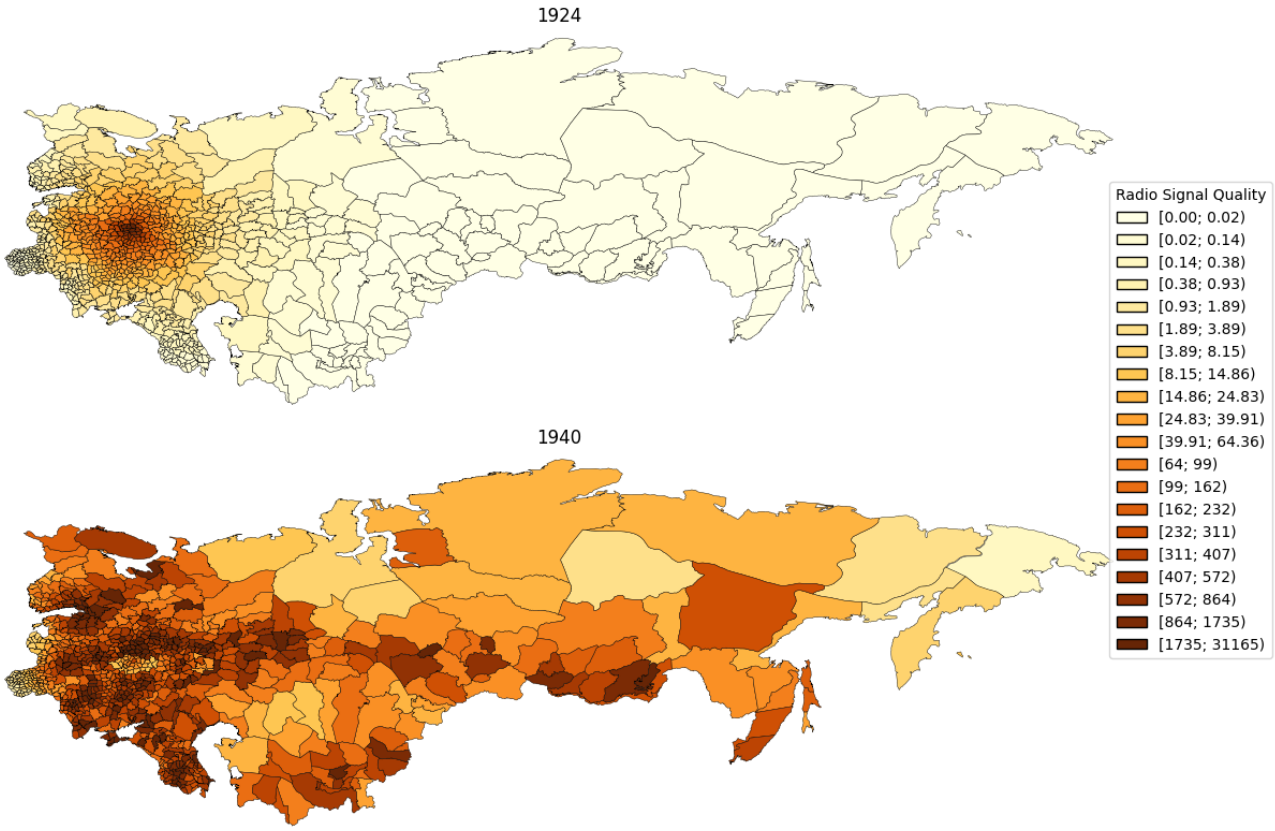
7 FIGURES AND TABLES

Figure 1: Annual Repressions by Sentence Type in the USSR, 1920–1940



Note: The figure shows the annual number of individuals subjected to different types of state repression in the Soviet Union from 1920 to 1940, using data from the *Memorial Database of Political Repressions in the USSR (1914–1960)*. Sentence types include: *Execution* — capital punishment; *GULAG* — imprisonment in forced labor camps; *Imprisonment* — incarceration in non-camp facilities; *Exile* — forced removal to remote areas; and *Special Settlement* — restricted residence under surveillance.

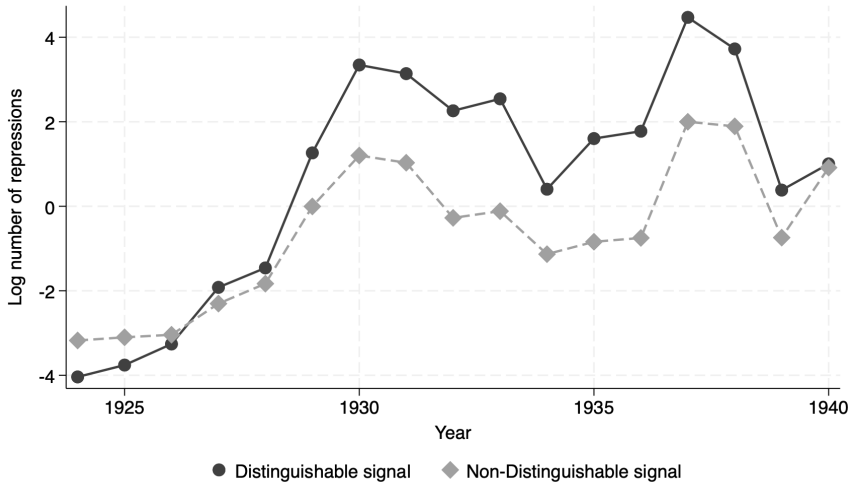
Figure 2: Geographic Distribution of Radio Signal Coverage, 1924 and 1940



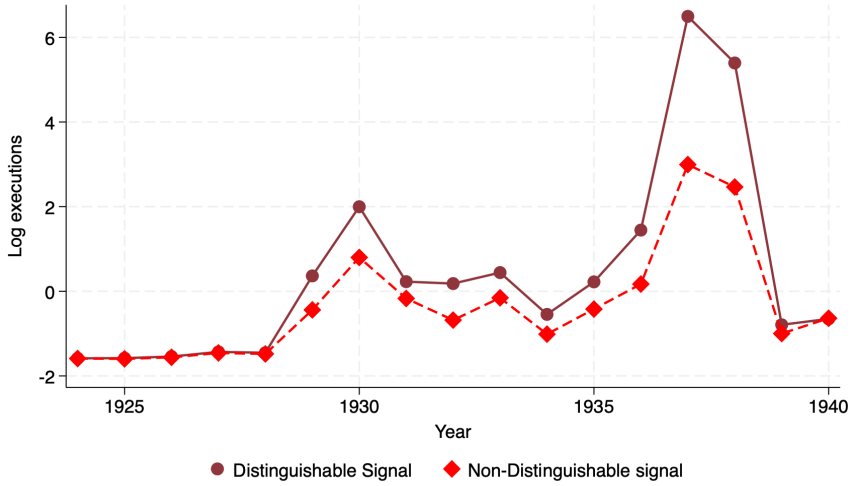
Note: The displays modeled radio signal quality across Soviet administrative regions in 1924 and 1940. To construct spatial radio penetration, we follow the procedure detailed in Appendix B3, combining station-level transmitter characteristics with signal propagation modeling of longwave radio signals. Predicted field strength at each location is computed as a function of transmitter power, distance, and an attenuation coefficient that varies with ground conductivity. We aggregate these predicted values to administrative boundaries to obtain a continuous index of radio signal quality for each county and year.

Figure 3: Radio Signal Exposure and Repression Outcomes

Panel A: Log Number of Repressions



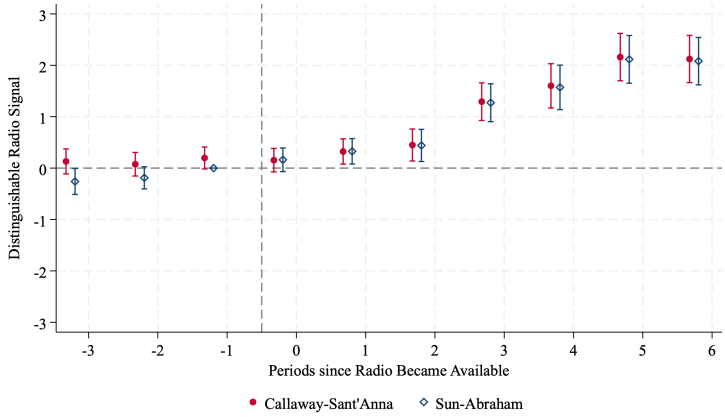
Panel B: Log Number of Executions



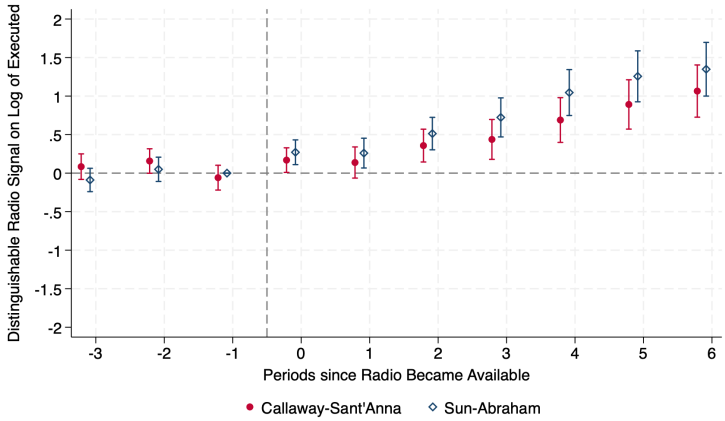
Note: The figure plots average repression outcomes over time for counties with high versus low predicted radio signal exposure. Counties are classified as high- or low-signal based on whether the predicted radio signal at the county seat is above or below the median. Panel A reports the mean of log total repressions, and Panel B reports the mean of log executions. Outcomes are residualized with respect to population size and the full set of control variables prior to aggregation. Each point corresponds to the average residualized outcome across counties within a given signal group and year, with lines connecting yearly means. The figure is intended to provide a descriptive visualization of the underlying data patterns rather than causal estimates.

Figure 4: Radio Signal and Soviet Repressions Over Time

Panel A: Log of Repressions



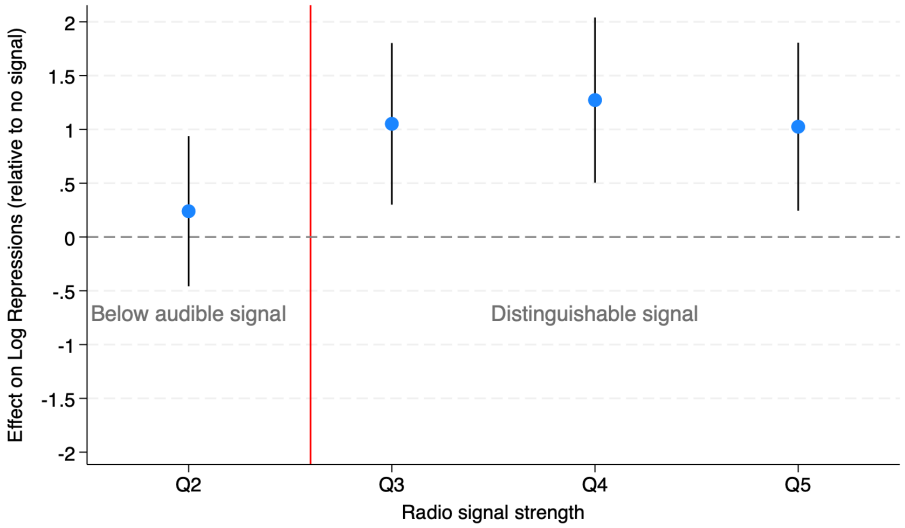
Panel B: Log of Executions



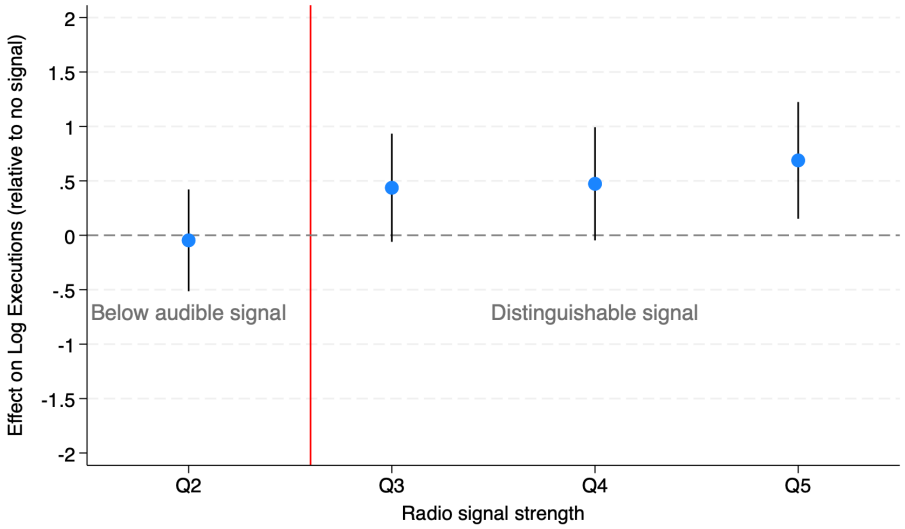
Note: The figure plots event–time effects of radio coverage on the log number of total repressions in a county–year using three difference-in-differences estimators: Callaway–Sant'Anna (red), Sun–Abraham (blue) (Callaway and Sant'Anna, 2021; Sun and Abraham, 2021). Treatment is defined at the county (uezd) level as the first year in which the predicted radio signal at the county seat becomes distinguishable; the treatment indicator switches to 1 from that year onward. Event time 0 is the first treated year; the baseline is the last pre-treatment year. All specifications include county and year fixed effects; pre-trend coefficients (negative event times) assess parallel trends. The sample covers 1936–1940 and the universe of counties for which radio coverage and repression data are observed. Standard errors are clustered at the county (uezd) level.

Figure 5: Radio Signal Strength and Repression Outcomes: Flexible Specification

Panel A: Log Number of Repressions

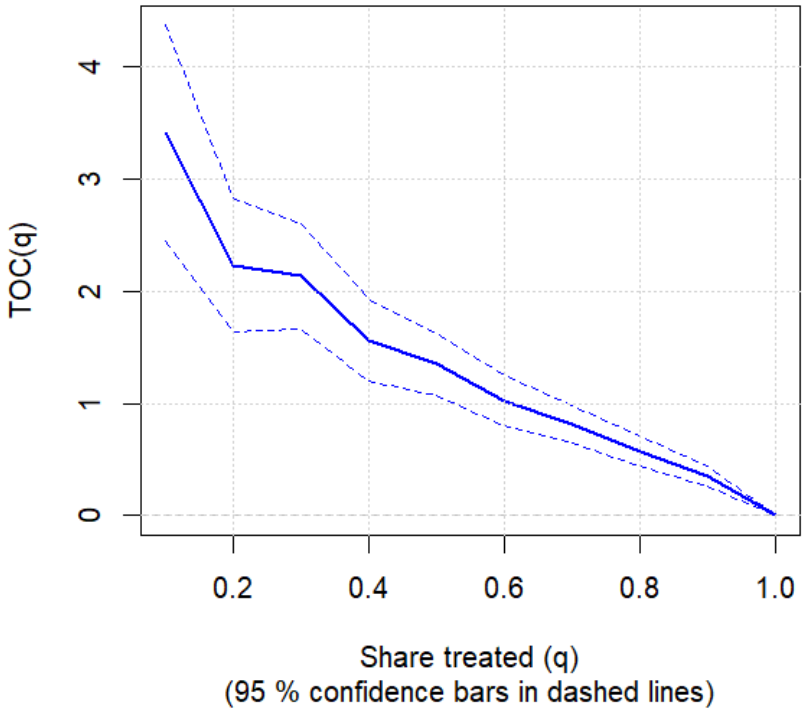


Panel B: Log Number of Executions



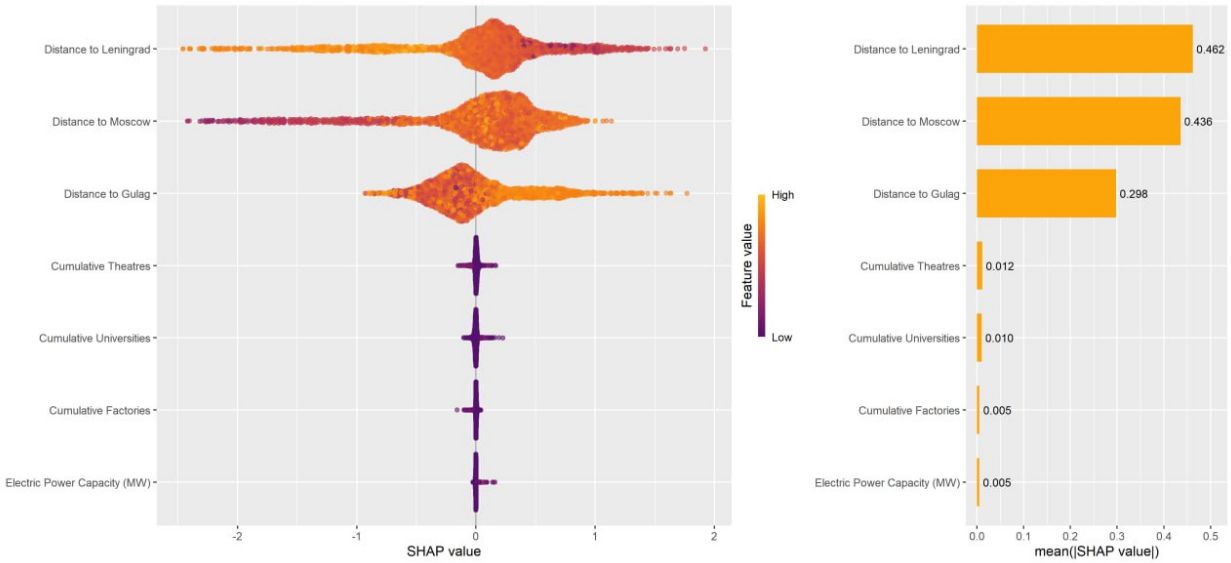
Notes. This figure plots coefficient estimates from regressions that replace the linear radio signal measure with indicator variables for discrete ranges of contemporaneous radio signal strength. Signal strength is measured using predicted topographical signal intensity and divided into quantile-based bins. Coefficients are reported relative to the lowest signal category (Q1), which corresponds to locations with no or negligible radio signal and is omitted from the figure. Vertical bars denote 95% confidence intervals. The dashed horizontal line indicates zero, and the vertical line marks the threshold at which radio transmissions become audible and distinguishable. The estimates show little systematic association between radio exposure and repression outcomes at low signal levels (Q2), but a pronounced increase in both repressions and executions once signal strength exceeds the audibility threshold (Q3–Q5). All regressions include county (uezd) and year fixed effects, the full set of baseline controls described in the text, and standard errors clustered at the county level.

Figure 6: Treatment Effect Heterogeneity in Repressions



Notes. The figure plots the Targeting Operator Characteristic (TOC) curve, which summarizes heterogeneity in estimated treatment effects following the causal targeting framework of Wager and Athey (2018). Treatment effects are defined with respect to the log number of repressions at the county–year level. Counties are ranked by their predicted conditional average treatment effects (CATEs), from largest to smallest. The horizontal axis reports the share q of counties with the largest estimated effects, while the vertical axis reports the average treatment effect among this subset, normalized relative to the full-sample average effect. A downward-sloping curve indicates meaningful treatment effect heterogeneity, with a subset of counties exhibiting larger repression responses than the average. Treatment effects are estimated using a causal forest that conditions on substantively relevant geographic and time-varying covariates. The specification excludes district and year fixed effects and does not include interaction expansions. To avoid overfitting, we implement five-fold cross-fitting: the sample is randomly partitioned into five folds; treatment effects are estimated on four folds and evaluated on the held-out fold to construct the TOC curve. This procedure is repeated five times, and the figure reports the average TOC across folds. Dashed lines indicate 95 percent confidence bands.

Figure 7: Drivers of Treatment Effect Heterogeneity



Notes. The figure reports SHAP (Shapley Additive Explanations) values summarizing the contribution of each covariate to heterogeneity in estimated treatment effects from the causal forest. Treatment effects measure the impact of radio signal exposure on the log number of repressions. Higher mean absolute SHAP values indicate variables that contribute more to variation in predicted conditional average treatment effects (CATEs). The forest conditions on substantively meaningful geographic and time-varying covariates and excludes district and year fixed effects. Geographic distance to Moscow, Leningrad, and Gulag infrastructure emerges as the primary driver of treatment effect heterogeneity, while economic and cultural covariates play a comparatively limited role.

TABLE 1: Exogeneity Check

	Nobility	Merchants	Factories	Electricity	Universities	Foreigners	Cossacks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Above vs below median average signal strength							
1924	-0.083***	-0.026*	2.227	0.221	1.814	-0.515**	-0.246
	(0.028)	(0.013)	(2.221)	(0.398)	(2.172)	(0.257)	(0.225)
1925	-0.076***	-0.010	0.601	0.089	-0.810	-0.481*	-0.244
	(0.028)	(0.013)	(2.221)	(0.398)	(2.172)	(0.257)	(0.226)
1926	-0.066**	-0.006	4.349**	0.911**	3.802*	-0.226	-0.240
	(0.028)	(0.013)	(2.206)	(0.395)	(2.158)	(0.257)	(0.224)
1927	-0.071**	-0.009	4.897**	0.914**	3.779*	-0.191	-0.241
	(0.028)	(0.013)	(2.204)	(0.395)	(2.158)	(0.257)	(0.224)
1928	-0.011	0.018	5.774***	0.919**	4.740**	-0.198	-0.228
	(0.028)	(0.013)	(2.201)	(0.395)	(2.156)	(0.257)	(0.224)
1929	-0.019	0.002	5.450**	0.919**	4.735**	-0.144	-0.240
	(0.028)	(0.013)	(2.202)	(0.395)	(2.156)	(0.257)	(0.224)
1930	-0.035	0.004	7.137***	0.963**	4.656**	-0.179	-0.243
	(0.028)	(0.013)	(2.196)	(0.395)	(2.156)	(0.257)	(0.224)
1931	-0.000	0.015	7.137***	0.963**	4.673**	-0.161	-0.240
	(0.028)	(0.013)	(2.196)	(0.395)	(2.156)	(0.257)	(0.224)
1932	0.003	0.014	7.271***	0.881**	4.528**	-0.250	-0.245
	(0.028)	(0.013)	(2.195)	(0.395)	(2.156)	(0.257)	(0.224)
1933	-0.006	0.014	6.673***	0.944**	4.768**	-0.357	-0.245
	(0.028)	(0.013)	(2.198)	(0.395)	(2.156)	(0.256)	(0.224)
1934	-0.004	0.013	6.673***	0.944**	4.768**	-0.355	-0.244
	(0.028)	(0.013)	(2.198)	(0.395)	(2.156)	(0.256)	(0.224)
1935	-0.008	0.009	5.880***	0.937**	4.718**	-0.243	-0.241
	(0.028)	(0.013)	(2.201)	(0.395)	(2.156)	(0.257)	(0.224)
1936	0.007	0.014	5.690***	0.937**	4.779**	-0.233	-0.236
	(0.028)	(0.013)	(2.202)	(0.395)	(2.156)	(0.257)	(0.224)
1937	0.019	0.019	5.690***	0.937**	4.818**	4.818**	-0.236
	(0.028)	(0.013)	(2.202)	(0.395)	(2.155)	(2.155)	(0.224)
Obs	716	716	716	716	716	716	716

Note: Continued on the next page

TABLE 1: Exogeneity Check

	Nobility	Merchants	Factories	Electricity	Universities	Foreigners	Cossacks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1938	0.02	0.02	5.69***	0.94**	4.82**	-0.22	-0.24
	(0.03)	(0.01)	(2.20)	(0.40)	(2.16)	(0.26)	(0.22)
1939	0.020	0.019	5.690***	0.937**	4.818**	4.818**	-0.236
	(0.028)	(0.013)	(2.202)	(0.395)	(2.155)	(2.155)	(0.224)
Obs	716	716	716	716	716	716	716

Panel B: Early vs late time to first coverage

	Nobility	Merchants	Factories	Electricity	Universities	Foreigners	Cossacks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Early	-0.06**	-0.01	4.59**	0.94**	3.98*	3.98*	-0.23
	(0.03)	(0.01)	(2.25)	(0.40)	(2.20)	(2.20)	(0.22)
Obs	15,024	15,024	15,024	15,024	15,024	15,024	15,024

Note: This table examines whether radio exposure is systematically correlated with pre-treatment county characteristics. The unit of observation is a county (uezd). Panel A reports differences in baseline characteristics between counties above and below the median average predicted radio signal strength. Each row corresponds to a separate cross-sectional comparison by year. Panel B reports differences in baseline characteristics between counties that receive radio coverage earlier versus later, based on the median year of first coverage. Reported coefficients are differences in means between the respective groups, with standard errors in parentheses. Observations correspond to county–year cells in Panel A and to counties in Panel B. Nobility is the number of individuals belonging to the hereditary nobility per 100 population; Merchants is the share of the merchant estate per 100 population; Factories is the number of factories in 1920; Electricity is baseline installed electric power capacity; Universities is the number of universities; Foreigners is the share of foreign subjects residing locally per 100 population; and Cossacks is the share of the Cossack estate per population, a legally defined military–settler class distinct from both nobles and peasants.

TABLE 2: Radio Signal Strength and Repressions

Panel A: Repressions			
	Log of Repressed		
	(1)	(2)	(3)
Radio signal (dB)	0.007***	0.015***	0.011***
	(0.003)	(0.004)	(0.004)
Observations	13838	13838	13838
Mean Dep. Var	0.257	0.257	0.257
Mean Radio Signal	15.474	15.474	15.474
SD Radio Signal	59.134	59.134	59.134
Panel B: Executions			
	Log of Executed		
	(1)	(2)	(3)
Radio signal (dB)	0.017***	0.021***	0.016***
	(0.002)	(0.003)	(0.003)
Year Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
County Characteristics $\times$ Year FE	No	Yes	Yes
Controls	No	No	Yes
Observations	13838	13838	13838
Mean Dep. Var	-2.802	-2.802	-2.802
Mean Radio Signal	15.474	15.474	15.474
SD Radio Signal	59.134	59.134	59.134

Note: The table reports estimates of the relationship between radio signal coverage and the log of executions. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each county (uezd), accounting for local topography. The dependent variable in Panel A is the log number of repressions, and in Panel B the log of executions in a given county–year. The sample covers 717 counties observed annually from 1920 to 1940. Column (1) includes year and county (uezd) fixed effects. Column (2) additionally includes time-varying controls—the total number of electricity-generating plants, theatres, factories, universities, mean seasonal precipitation days, mean seasonal tempruture and distance to the nearest GULAG camp. Column (3) further adds interactions of year fixed effects with log population from the 1897 census, ahsre of urban population, and with log distance to Moscow and to Leningrad. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 3: Radio Signal Strength and Repressions, Topographic Signal Gain

Panel A: Repressions			
	Log of Repressed		
	(1)	(2)	(3)
Topographic Signal Gain (dB)	0.038***	0.040***	0.034***
	(0.006)	(0.006)	(0.006)
Observations	15024	15024	15024
Mean Dep. Var	0.170	0.170	0.170
Mean Radio Signal	-4.295	-4.295	-4.295
SD Radio Signal	7.731	7.731	7.731
Panel B: Executions			
	Log of Executions		
	(1)	(2)	(3)
Topographic Signal Gain (dB)	0.033***	0.032***	0.023***
	(0.005)	(0.006)	(0.006)
Year Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
County Characteristics × Year FE	No	Yes	Yes
Controls	No	No	Yes
Observations	15024	15024	15024
Mean Dep. Var	-2.825	-2.825	-2.825
Mean Radio Signal	-4.295	-4.295	-4.295
SD Radio Signal	7.731	7.731	7.731

Note: The table reports estimates of the relationship between radio signal coverage and the log of executions. Topographic Signal Gain is defined as the difference between predicted radio signal strength along the transmitter–county seat path when accounting for actual land cover and terrain characteristics (e.g., forests, urban areas, water bodies) and predicted signal strength along the same path under a baseline scenario assuming maximal signal transmissivity. This measure captures the attenuation (or amplification) of radio signals induced exclusively by local topography and land cover. Intuitively, the measure reflects how radio reception would differ if the signal traveled through an idealized environment with minimal obstruction, compared to the actual physical environment. The dependent variable in Panel A is the log of number of repressions and log of executions in Panel B in a given county–year. Columns (1)–(3) progressively add controls: Column (1) includes no fixed effects; Column (2) adds both year and county (uezd) fixed effects, interactions of year with population and with distance to Moscow, Leningrad; Column (3) and a controls–the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp . The sample covers 712 counties observed annually from 1920 to 1940. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 4: Radio Signal Strength and Repressions, Spillovers

	Log of Repressed		
	(1)	(2)	(3)
Radio signal (dB)	0.013***	0.018***	0.016***
	(0.004)	(0.005)	(0.004)
Avg Signal in 100 km	-0.002	-0.004***	-0.003**
	(0.001)	(0.001)	(0.001)
Avg Signal in 250 km	0.000	-0.003	-0.004
	(0.003)	(0.003)	(0.003)
Avg Signal in 500 km	-0.007	-0.003	-0.005
	(0.005)	(0.005)	(0.005)
Year Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
County Characteristics $\times$ Year FE	No	Yes	Yes
Controls	No	No	Yes
Observations	15024	15024	15024
Mean Dep. Var	0.170	0.170	0.170
Mean Radio Signal	20.035	20.035	20.035
SD Radio Signal	61.780	61.780	61.780

Note: The table reports estimates of the relationship between radio signal coverage and the log number of repressions at the county (uezd) level. The main explanatory variable is *Radio Signal (dB)*, measured as predicted signal strength at the administrative center of each county, accounting for local topography. Spillover exposure is captured by the average radio signal in other counties located within 100 km, 250 km, and 500 km of a county centroid. Neighbor averages exclude the county itself and are computed as means across counties within each radius. For ease of interpretation and comparability across measures, neighbor signal variables are rescaled to a decibel-type metric; observations with no neighbors in a given radius are assigned a low baseline value. The dependent variable is the log number of repressions in a given county–year. The sample covers 717 counties observed annually from 1920 to 1940. All specifications include county (uezd) and year fixed effects. Column (2) additionally includes interactions of year fixed effects with baseline population and distance to Moscow and to Leningrad. Column (3) further adds time-varying controls, including the total number of electricity-generating plants, theatres, factories, universities, seasonal precipitation, seasonal temperature, and distance to the nearest GULAG camp. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 5: Radio Coverage and Trial Clearance vs. Post-Stalin Review

	Log of Repressions			
	Released at Sentencing		Cleared After Stalin (USSR)	
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.001	0.003	0.016***	0.018***
	(0.002)	(0.003)	(0.002)	(0.004)
Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
County Characteristics × Year FE	No	Yes	No	Yes
Observations	15024	15024	15024	15024
Mean Dep. Var	-2.792	-2.792	-1.851	-1.851
Mean Radio Signal	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196

Note: The table reports estimates of the relationship between radio signal coverage and the log of executions. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each county (uezd), accounting for local topography between the broadcasting station and the county centroid. Columns (1)–(2) use as the dependent variable the log number of individuals released at sentencing, identified from case-level mentions of amnesty, dismissal, or acquittal (e.g., amnesty, case closed, insufficient evidence). Columns (3)–(4) use as the dependent variable the log number of individuals cleared after Stalin (USSR), defined as posthumous charge clearances during post-Stalin reviews. The sample covers 717 counties observed annually from 1920 to 1940. Columns (1) and (3) include year and county (uezd) fixed effects. Columns (2) and (4) additionally include time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 6: Radio Signal Strength and NKVD Recruitments Born

	Log of Number Birthplaces of Recruited NKVD Officers		
	(1)	(2)	(3)
Radio signal (dB)	0.002	-0.011***	-0.011***
	(0.003)	(0.003)	(0.004)
Region Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
County Characteristics × Year FE	No	No	Yes
Observations	2077	2077	2077
Mean Dep. Var	-0.007	-0.007	-0.007
Mean Radio Signal	16.385	16.385	16.385
SD Radio Signal	25.384	25.384	25.384

Note: The table reports estimates of the relationship between radio signal coverage and the log number of individuals recruited into the NKVD. The main explanatory variable is Mean Radio Signal (dB), measured as predicted signal strength at the administrative center of each region and aggregated as the cohort's mean exposure from birth through age 18 in the region of birth. Columns (1)–(3) progressively add region and year fixed effects and covariate sets, including interactions of year fixed effects with log population from the 1926 census and with log distance to Moscow and log distance to Leningrad. The sample comprises 2,077 region–cohort observations across 60 regions. Standard errors are clustered at the region level.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 7: Radio Signal Strength and and NKVD Repressions and Rank Demotions

Panel A: Rrepressions			
	Log of NKVD Repressed Among All NKVD Officers		
	(1)	(2)	(3)
Radio Signal (dB)	0.168***	0.107***	0.094***
	(0.045)	(0.028)	(0.027)
Observations	300	300	300
Mean Dep. Var	-1.311	-1.311	-1.311
Mean Radio Signal	53.049	53.049	53.049
SD Radio Signal	22.243	22.243	22.243
Panel B: Runk Demotions			
	Log of Demoted in Rank		
	(1)	(2)	(3)
Radio Signal (dB)	0.127***	0.026	0.039*
	(0.012)	(0.022)	(0.022)
Regions Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
Observations	300	300	300
Mean Dep. Var	-1.534	-1.534	-1.534
Mean Radio Signal	53.049	53.049	53.049
SD Radio Signal	22.243	22.243	22.243

Note: The table reports estimates of the relationship between radio signal coverage and both repressions and rank demotions of NKVD officers. Panel A uses the log of repressed NKVD officers among all working officers within a region–year. Panel B uses the of rank demotions to a lower rank. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each region, accounting for local topography between the broadcasting station and the region centroid. The sample covers 60 regions observed annually from 1936 to 1940. Columns (1)–(2) progressively add region and year fixed effects and covariate sets, Column (3) additionally include time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp. Standard errors are clustered at the region level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 8: Radio Signal Strength and Repressions, Time-Varying Controls

Panel A: Repressions						
	Log of Repressed					
	(1)	(2)	(3)	(4)	(5)	(6)
Radio signal (dB)	0.007***	0.010**	0.010***	0.011***	0.011***	0.011***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	13838	13838	13838	13838	13838	13838
Mean Dep. Var	0.257	0.257	0.257	0.257	0.257	0.257
Mean Radio Signal	15.474	15.474	15.474	15.474	15.474	15.474
SD Radio Signal	59.134	59.134	59.134	59.134	59.134	59.134
Panel B: Executions						
	Log of Executed					
	(1)	(2)	(3)	(4)	(5)	(6)
Radio signal (dB)	0.014***	0.010**	0.010***	0.011***	0.011***	0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Distance to GULAG	No	Yes	Yes	Yes	Yes	Yes
Electricity Generation	No	Yes	Yes	Yes	Yes	Yes
Number of Factories	No	No	Yes	Yes	Yes	Yes
Number of Universities	No	No	No	Yes	Yes	Yes
Number of Theatres	No	No	No	No	Yes	Yes
Weather Controls	No	No	No	No	No	Yes
Observations	13838	13838	13838	13838	13838	13838
Mean Dep. Var	0.257	0.257	0.257	0.257	0.257	0.257
Mean Radio Signal	15.474	15.474	15.474	15.474	15.474	15.474
SD Radio Signal	59.134	59.134	59.134	59.134	59.134	59.134

Note: The table reports estimates of the relationship between radio signal coverage and the log of executions. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each county (uezd), accounting for local topography. The dependent variable in Panel A is the log number of repressions, and in Panel B the log of executions in a given county–year. The sample covers 717 counties observed annually from 1920 to 1940. Column (6) presents baseline specification estimated in table 2, column 3. Columns (1) - (6) add displayed controls one by one. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 9: Radio Signal Strength and Repressions

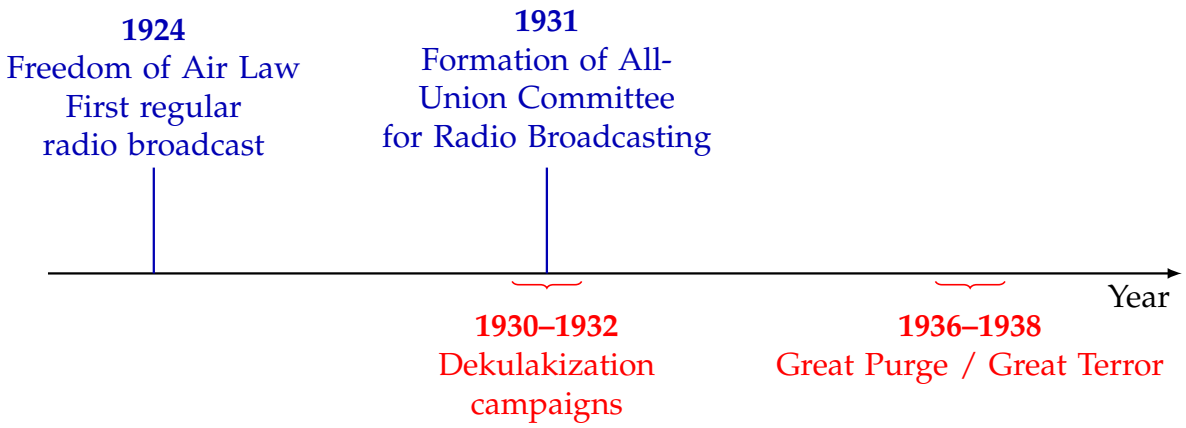
Panel A: Repressions				
	Log of Repressions			
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.007***	0.027***	-0.002	-0.003
	(0.000)	(0.004)	(0.002)	(0.003)
Radio signal (dB)	0.068***	0.051***	0.029***	0.025***
× Post-Radio Committee	(0.007)	(0.006)	(0.003)	(0.004)
Observations	15024	15024	15024	15024
Mean Dep. Var	0.170	0.170	0.170	0.170
Mean Radio Signal	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196
Panel B: Executions				
	Log of Executions			
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.003***	0.009***	0.008***	0.002
	(0.000)	(0.002)	(0.002)	(0.002)
Radio signal (dB)	0.043***	0.033***	0.025***	0.025***
× Post-Radio Committee	(0.005)	(0.004)	(0.004)	(0.005)
Year Fixed Effects	No	Yes	Yes	Yes
County Fixed Effects	No	No	Yes	Yes
County Characteristics × Year FE	No	No	No	Yes
Controls	No	No	No	Yes
Observations	15024	15024	15024	15024
Mean Dep. Var	-2.825	-2.825	-2.825	-2.825
Mean Radio Signal	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196

Note: The table reports estimates of the relationship between radio signal coverage and the log repressions / Log of Executions. Table uses Radio Signal (dB) as the explanatory variable, measured as predicted signal strength at the administrative center of each county (uezd); and Post-Radio Committee as the after 1931 dummy (Formation of All-Union Committee for Radio Broadcasting). The dependent variable in Panel A is the log of number of repressions and log of executions in Panel B in a given county–year. Columns (2)–(4) progressively add controls: Column (1) includes no fixed effects; Column (2) adds year fixed effects; Column (3) adds both year and county (uezd) fixed effects; Column (4) adds interactions of year with population and with distance to Moscow and Leningrad, and a controls–the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp. The sample covers 712 counties observed annually from 1920 to 1940. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

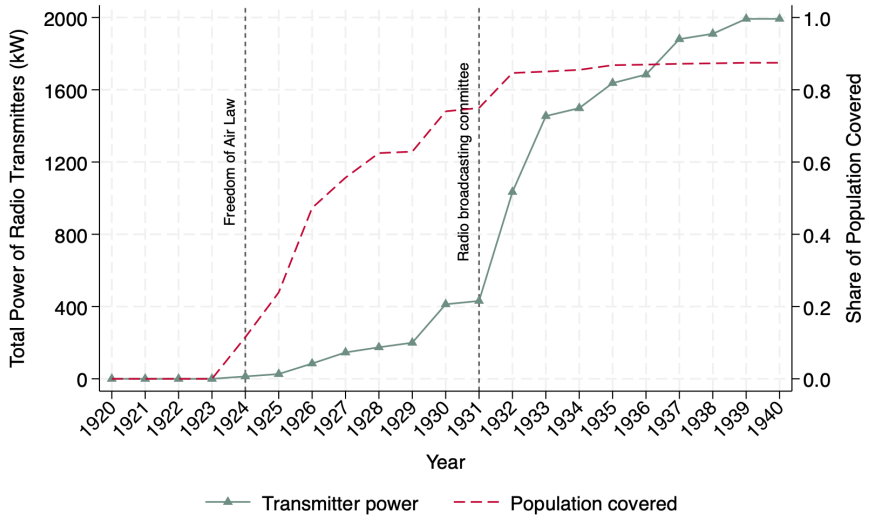
A Appendix

Figure A1: Development of the radio in the USSR, 1920-1940

Panel A: Timeline of Soviet Radio Expansion and Repression, 1920–1940

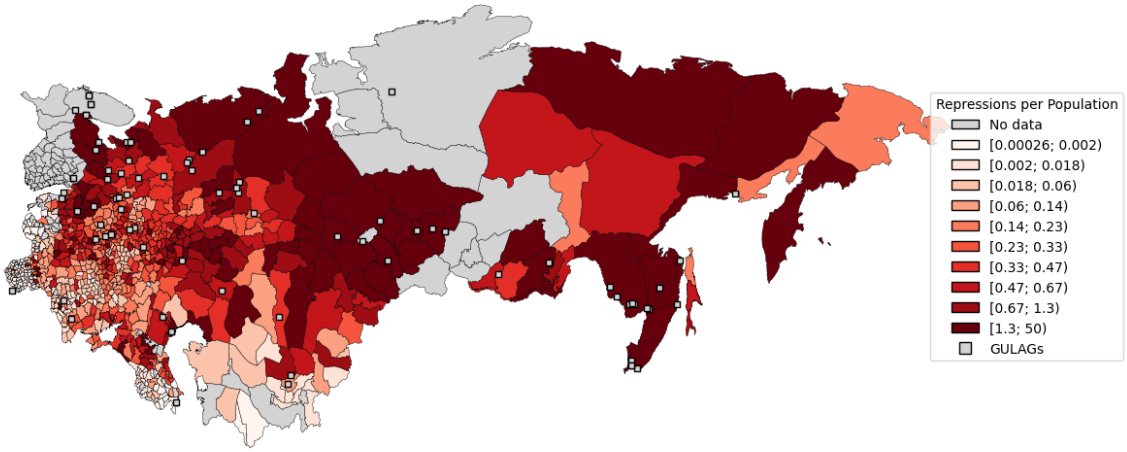


Panel B: Expansion of Radio Broadcasting Capacity and Coverage in the USSR, 1920–1940



Note: The solid line (left axis) reports the cumulative total power of radio transmitters operating in the USSR, measured in kilowatts. The dashed line (right axis) shows the share of the population living in locations where predicted radio signal strength exceeds the distinguishability threshold. Vertical lines mark two key institutional milestones: the 1924 *Freedom of the Air* decree, which initiated regular state radio broadcasting, and the 1931 establishment of the All-Union Committee for Radio Broadcasting, which centralized control over radio expansion. Population coverage is computed using population-weighted predicted signal strength and abstracts from individual listening behavior.

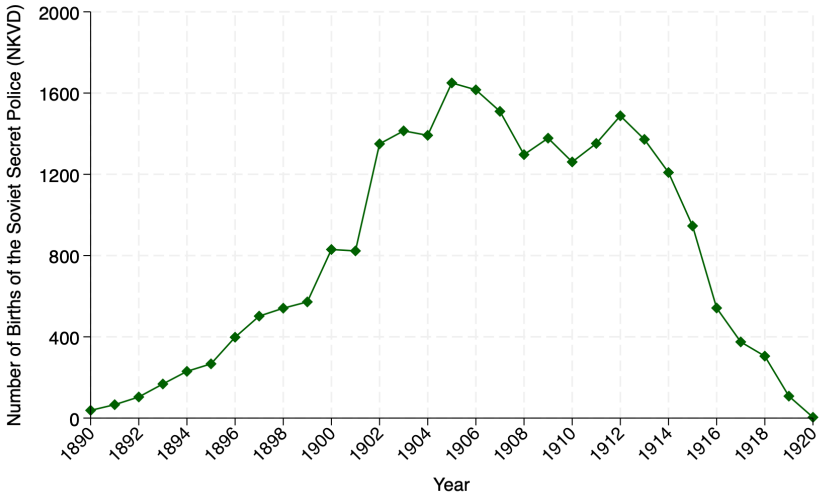
Figure A2: Geographic Distribution of Repressions per 1,000 Population



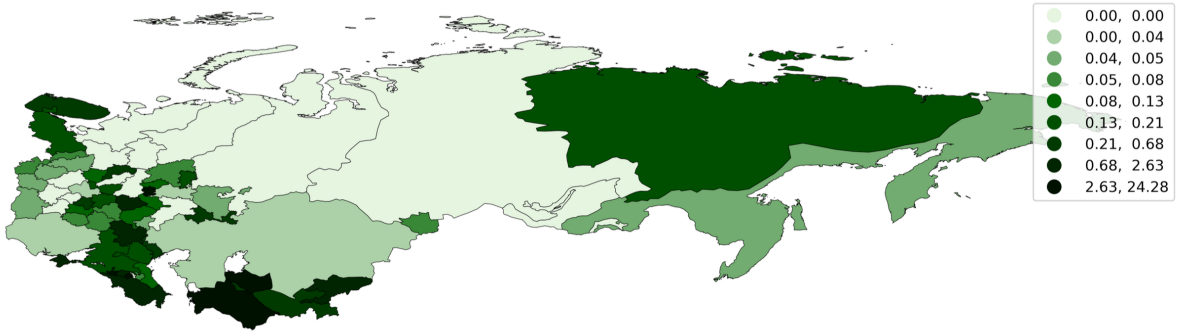
Note: The figure shows repression intensity across 712 uezds, normalized per 1,000 population. Gray areas indicate missing data; light gray squares denote GULAG camp locations. Data: *Memorial Database of Political Repressions in the USSR (1914–1960)*. For a sample of the raw dataset structure, see Figure B5.

Figure A3: Birth cohorts of NKVD officers

Panel A: Birth cohort distribution of Soviet secret police (NKVD) personnel

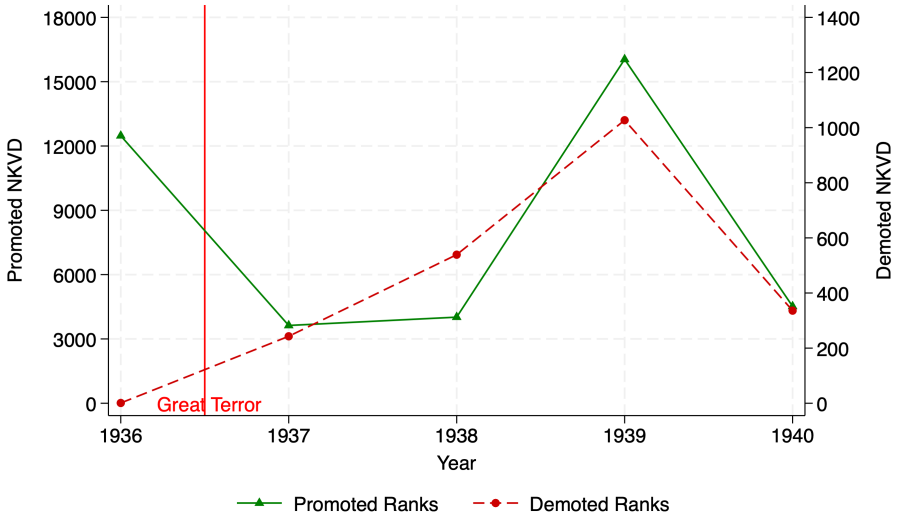


Panel B: Regional origins (birthplaces) of NKVD personnel



Note: Panel A shows the number of individuals later affiliated with the NKVD by year of birth (1890–1920). These individuals were primarily active between 1935 and 1940. Panel B shows a choropleth of the number of individuals born in each region who later joined the NKVD, normalized per million population; darker shades indicate higher density. Data: International Memorial (2023) (biographical dossiers; >45,000 individuals).

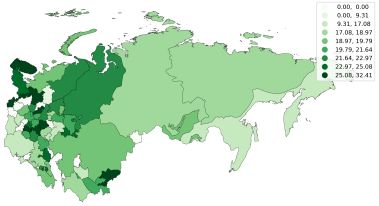
Figure A4: Annual NKVD Promotions and Demotions to Officer Ranks, 1936–1940



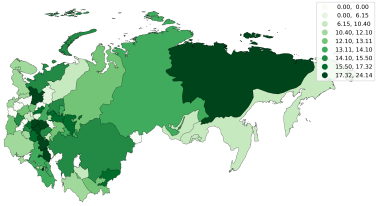
Note: The figure plots annual number of NKVD personnel promotions to officer ranks (green, left axis) and demotions (red, right axis), 1936–1940. Officer ranks include Sergeant, Junior Lieutenant, Lieutenant, Senior Lieutenant, Captain, and Major. Data are from the (International Memorial, 2023); coverage spans 63 regions and more than 45,000 NKVD personnel.

Figure A5: NKVD Promotions to Officer Ranks, 1936–1940 (Shares per 100 Workers)

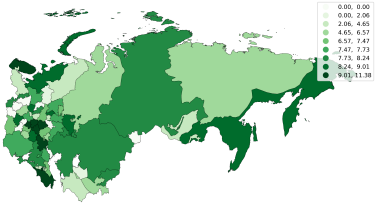
Panel A: Sergeant



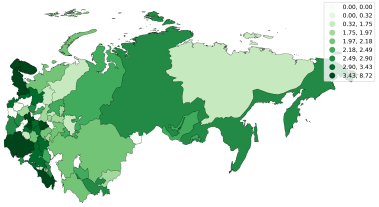
Panel B: Jr. Lieutenant



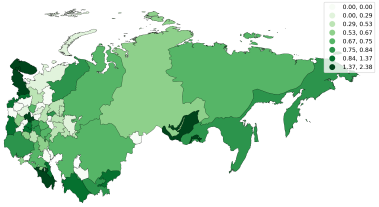
Panel C: Lieutenant



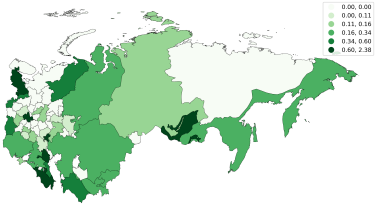
Panel D: Sr. Lieutenant



Panel E: Captain



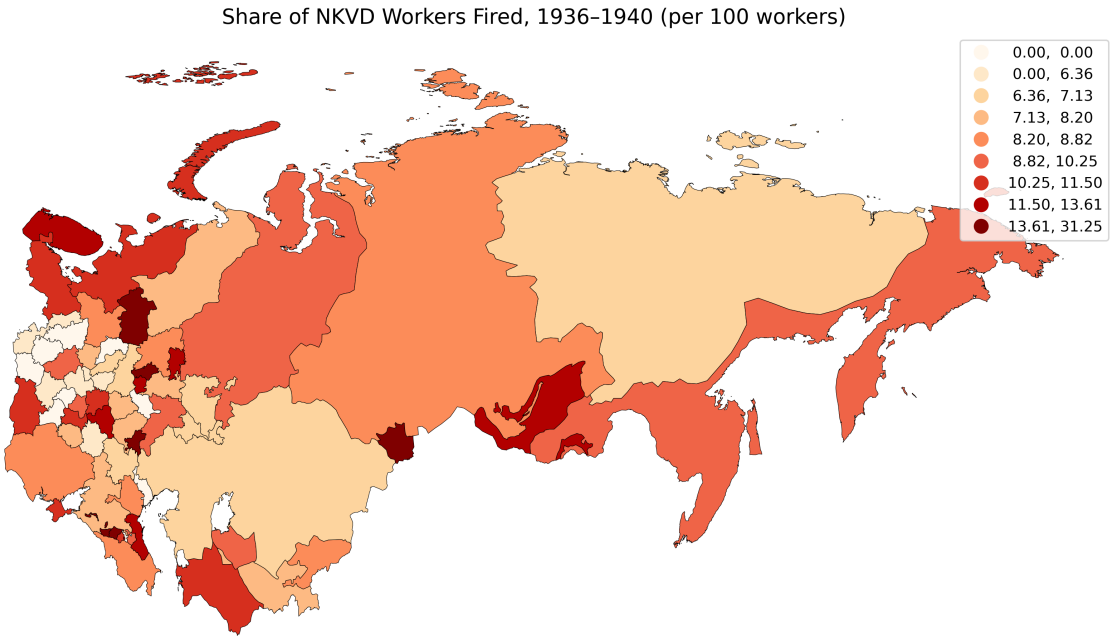
Panel F: Major



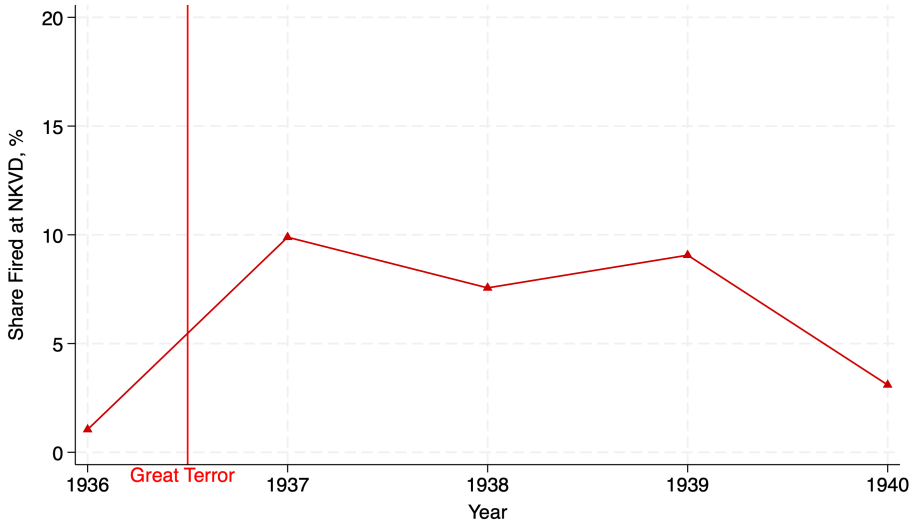
Note: Each panel maps the share (percent per 100 workers) of NKVD personnel promoted to the indicated rank in 1936–1940: the number of promotion events in a region divided by that region's total NKVD workforce. Gray areas denote missing data.The data are drawn from the *Memorial Database of Victims of Political Terror in the USSR*, covering more than 45,000 NKVD personnel (International Memorial, 2023).

Figure A6: NKVD Dismissals, 1936–1940

Panel A: Share of NKVD Workers Fired (per 100 workers)



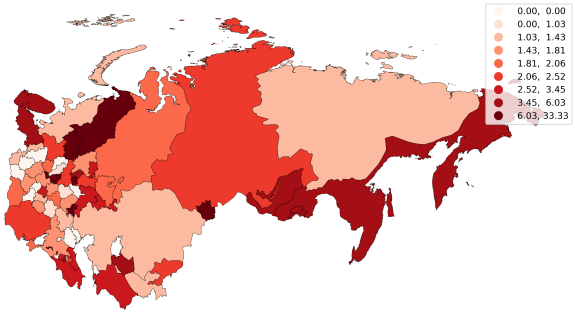
Panel B: Annual Number of Dismissals



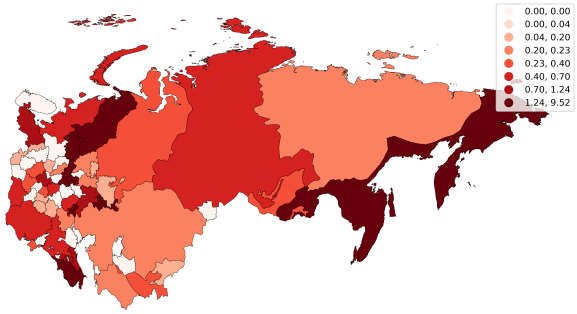
Note: Panel A maps the pooled (1936–1940) share of NKVD personnel dismissed in each region, computed as total dismissals over 1936–1940 divided by the regional NKVD headcount over the same period (per 100 workers). Shading reflects binned values of this share; gray areas denote regions without matched workforce data. Panel B plots annual shares of dismissals by archival category: code 37—Self Request (voluntary resignation); code 38a—Political Unreliability; code 38b—Compromising Ties; code 38v—Misconduct / Criminal Offenses. Labels follow NKVD personnel regulations used to classify dismissal grounds. Data come from the (International Memorial, 2023) (biographical dossiers of NKVD personnel; >45,000 individuals).

Figure A7: NKVD Repressions: Geography and Time, 1936–1940

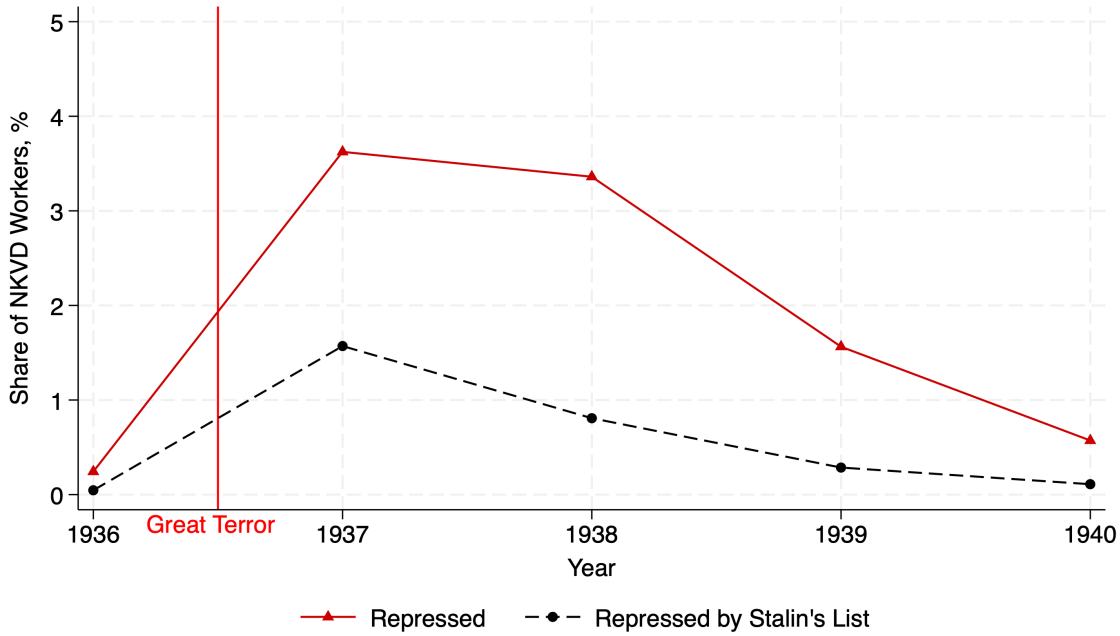
Panel A: NKVD Repressed



Panel B: NKVD Repressed by Stalin's Lists

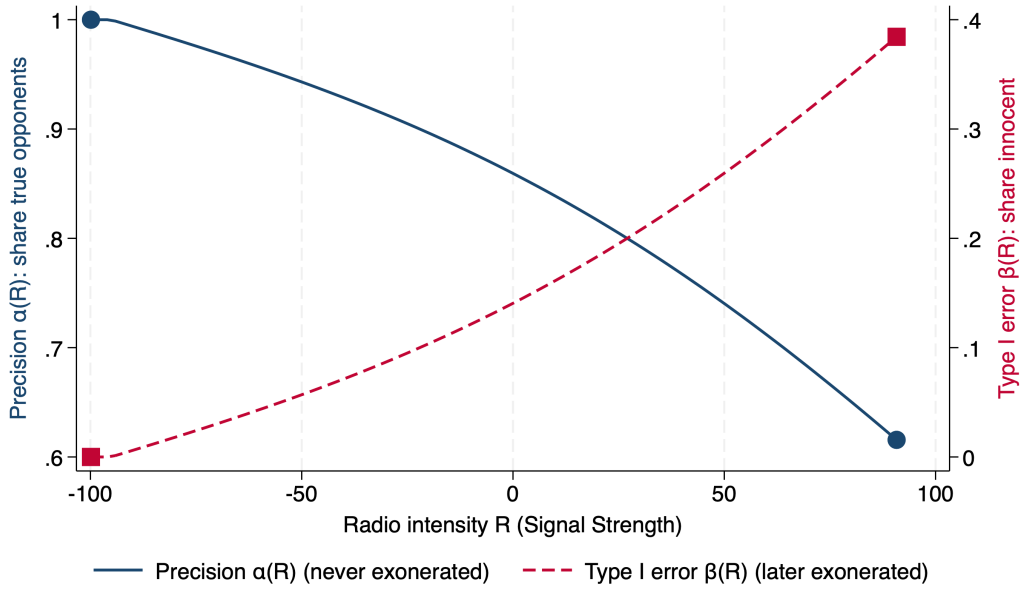


Panel C: Repressed vs. Repressed by Stalin's List (Annual)



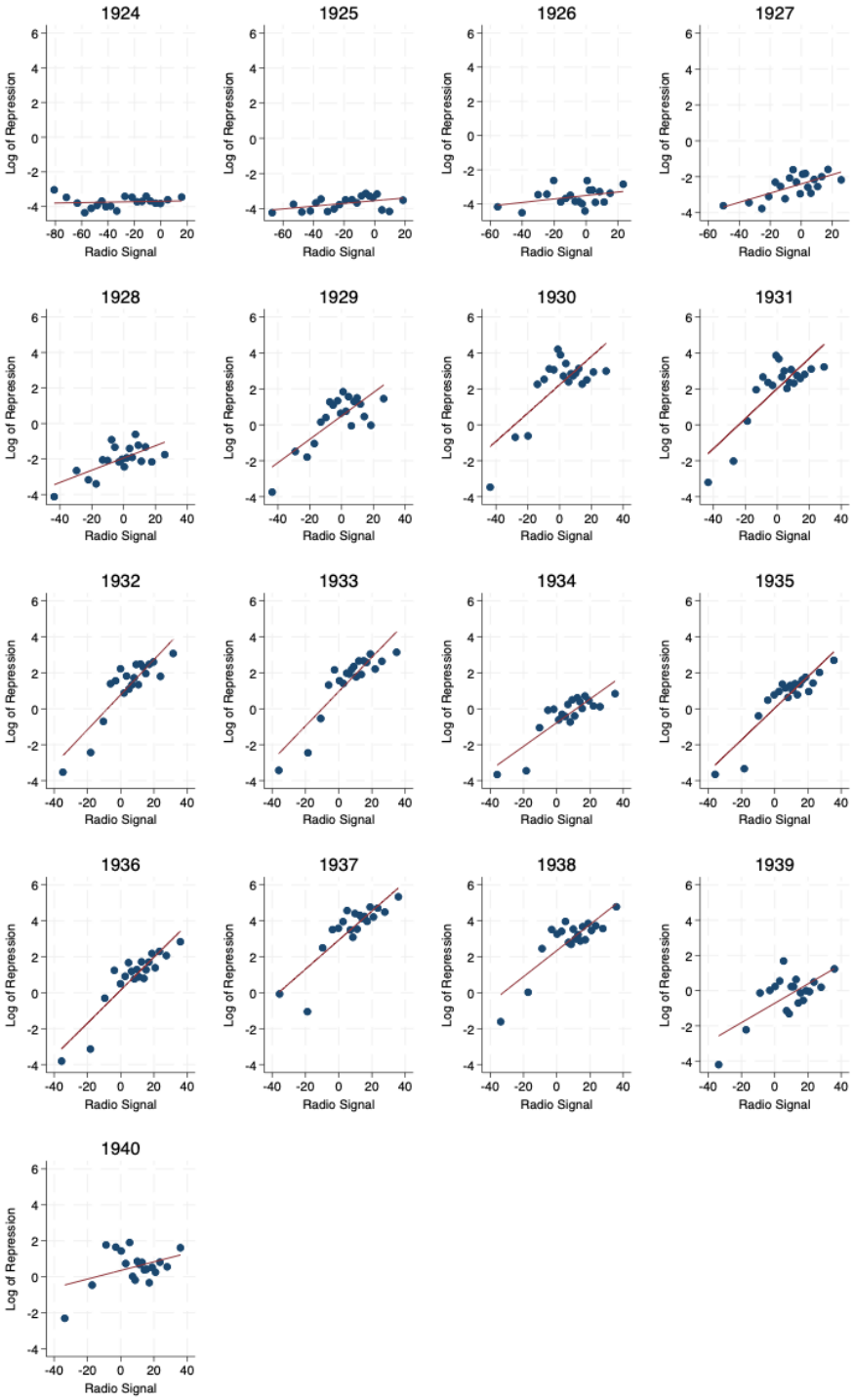
Note: Panels A–B map pooled (1936–1940) shares of NKVD personnel repressed across regions. Panel A shows the share of NKVD workers repressed (percents). Panel B shows the share repressed by Stalin's lists, a subset defined by inclusion on Politburo "approval lists" compiled in 1937–1938 that authorized first-category (execution) or second-category (10-year camp) sentences; the compendium comprises roughly 380+ lists totaling about 44,000 named individuals. Panel C plots annual national shares for both measures. Data are from the (International Memorial, 2023) (biographical dossiers of NKVD personnel; >45,000 individuals).

Figure A8: The Precision - Cost Tradeoff of Repression and Radio Intensity



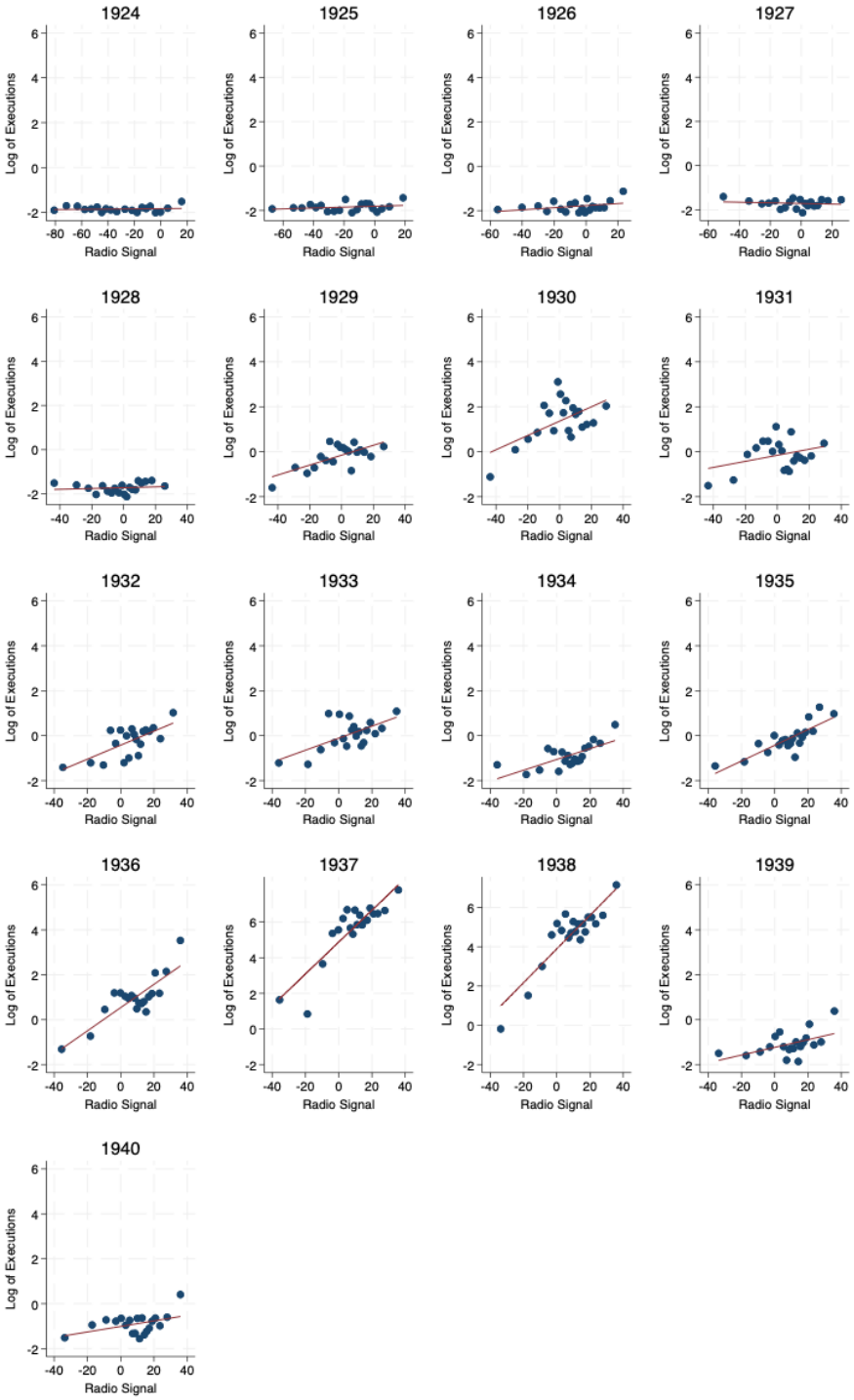
Notes. The figure illustrates an empirical analogue of the precision–cost tradeoff generated by radio expansion. The horizontal axis reports radio intensity R, proxied by log signal strength. The left vertical axis plots repression precision $\alpha(R)$, defined as the share of never-exonerated cases among all repressions. The right vertical axis plots the Type I error rate $\beta(R)$, defined as the share of later-exonerated cases. Both objects are constructed from predicted values obtained from county-level regressions with county and year fixed effects. Specifically, we estimate separate linear log-count models for (i) never-exonerated repressions and (ii) later-exonerated repressions as functions of radio signal strength. Predicted counts are converted into shares, $\alpha(R) = \widehat{TP}/(\widehat{TP} + \widehat{FP})$ and $\beta(R) = \widehat{FP}/(\widehat{TP} + \widehat{FP})$, and averaged across years. Markers indicate the endpoints of the radio support. Consistent with a decline in the marginal cost of persecution, higher radio intensity is associated with a reduction in repression precision and a corresponding increase in Type I errors.

Figure A9: Radio Signal and Repression, 1924–1940



Notes: Each panel reports a binscatter plot of log repression outcomes against radio signal strength for a given year. The horizontal axis shows predicted radio signal topography, and the vertical axis reports log repression. Dots represent within-bin means, and the solid line shows the linear fit. All panels share common axis scales to facilitate visual comparison across years.

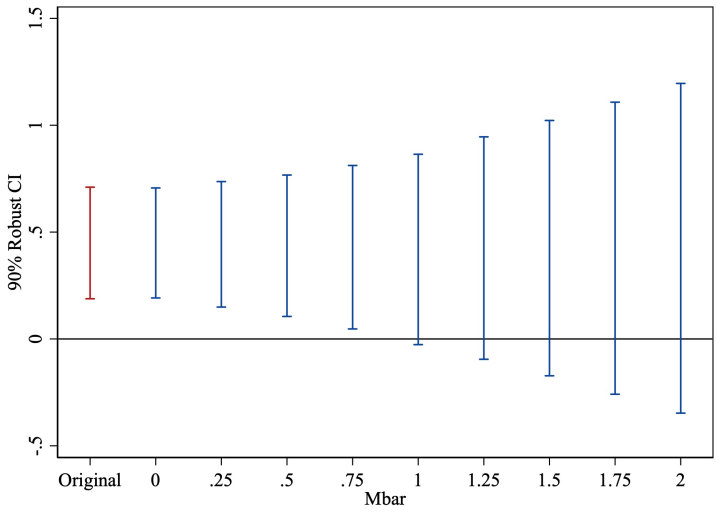
Figure A10: Radio Signal Topography and Executions, 1924–1940



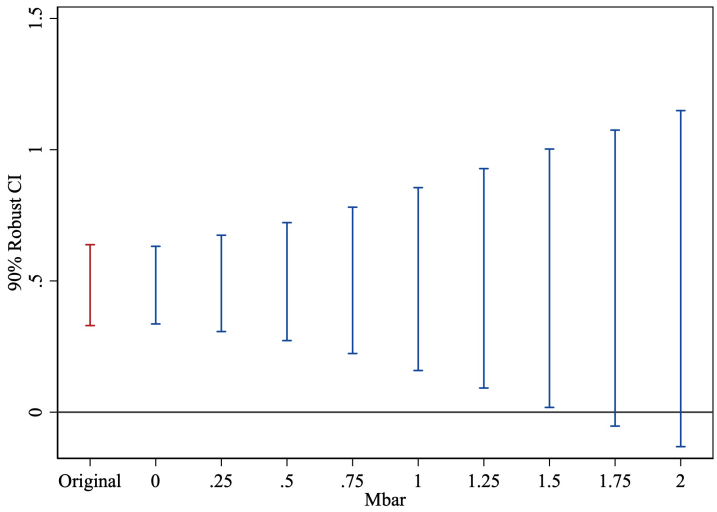
Notes: Each panel reports a binscatter plot of log executions against radio signal strength for a given year. The horizontal axis shows predicted radio signal topography, and the vertical axis reports log executions. Dots represent within-bin means, and the solid line shows the linear fit. All panels share common axis scales to facilitate visual comparison across years.

Figure A11: Rambachan and Roth Honest Difference in Differences

Panel A: Log Repressions



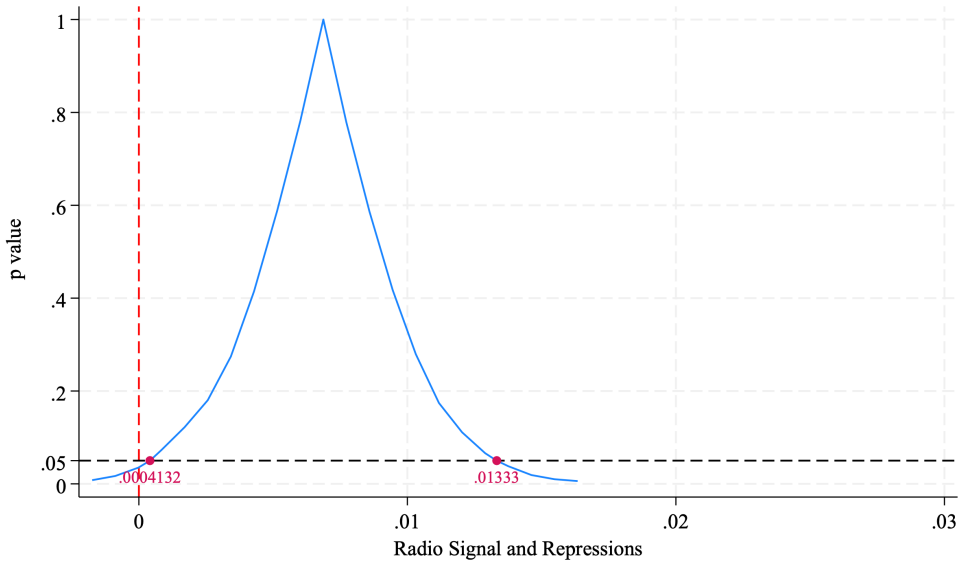
Panel B: Log Executions



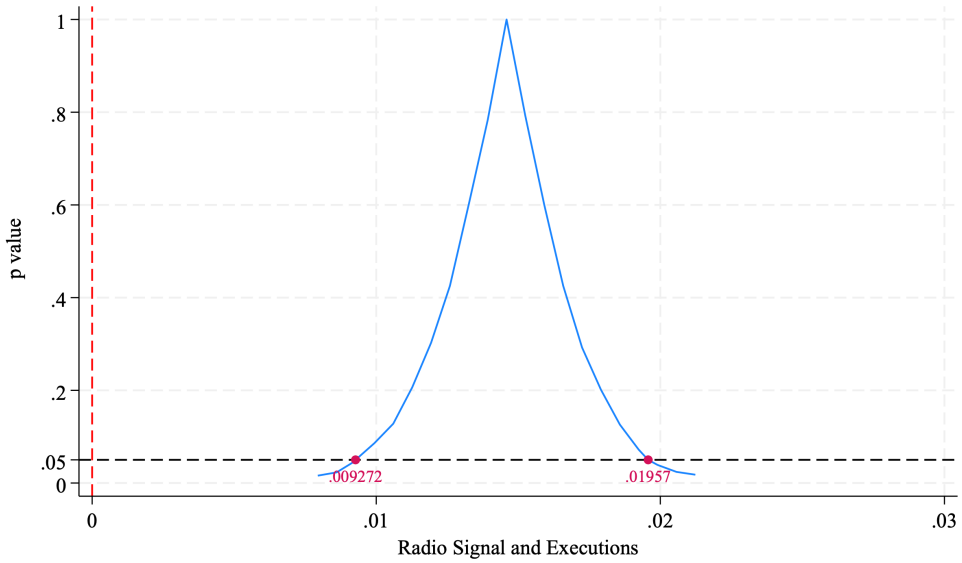
Notes: The figure evaluates the robustness of the estimated treatment effects to potential violations of the parallel trends assumption using the sensitivity analysis procedure of Rambachan and Roth (2023). The curves display the identified set for the Average Treatment Effect on the Treated (ATT) under different bounds on deviation from parallel trends. Wider bands indicate greater uncertainty when larger departures from parallel trends are permitted. Panel A reports results for log repression counts; Panel B shows the log number of executions among all repression cases. For each outcome, the solid line plots the estimated ATT, while the surrounding envelope traces the confidence region as the relaxation parameter increases. The covariance matrix is computed using the Callaway and Sant'Anna (2021) interaction-weighted Difference-in-Differences estimator. Using 90% CI for the 2-7 post treatment periods. Overall, the patterns suggest that the main results remain stable under moderate relaxations of the identifying assumptions.

Figure A12: Wild-Bootstrap Confidence Intervals for Radio Signal Effects on Repression Outcomes

Panel A: Log of Repressions



Panel B: Log of Executions



Notes: The figure shows wild-bootstrap confidence interval curves for four repression-related outcomes using the clustered wild-bootstrap procedure of Cameron et al. (2008). For each outcome, the curve plots the bootstrap distribution of the estimated coefficient on Radio Signal (dBμV/m) and marks the 5% significance cutoff. Panel A reports results for repressions; Panel B for executions. All specifications include the full set of fixed effects and controls used in the baseline regressions. Standard errors are clustered at the county (uezd) level.

TABLE A1: Description of variables

Variable	Description
Memorial Database of Political Repressions (1914–1960)	
Repressions	Number of individuals repressed in a county–year, including executions, imprisonment, exile, or GULAG sentences.
Executions	Number of individuals sentenced to death in a county–year.
Prison/GULAG	Number of individuals sentenced to incarceration in prisons or GULAG camps.
Exile/Special Settlement	Number of individuals sentenced to forced relocation or assigned residence under surveillance.
Released at Sentencing	Individuals released at trial (e.g., acquittal, case closed, insufficient evidence).
Cleared after Stalin	Individuals cleared posthumously during post-Stalin reviews (rehabilitation records).
Memorial NKVD Personnel Data (1935 - 1940)	
NKVD Recruitment	Number of individuals recruited into the NKVD, by birth cohort and region of origin.
NKVD Repressed	Share of NKVD officers repressed in a given region–year.
NKVD Demotions	Share of NKVD officers demoted in rank in a given region–year.
NKVD Promotions	Share of NKVD officers promoted in rank in a given region–year.
NKVD Prizes	Share of NKVD officers receiving decorations or service awards (e.g., Order of the Red Star, Order of the Badge of Honor).

Description of variables

Variable	Description
Radio Infrastructure Data (Radiofront, Radio for All (1924-1940))	
Radio Signal (dB)	Predicted longwave signal strength at the administrative center of each county (uezd), computed from station frequency, power, distance, and ground conductivity.
Topographic Signal Loss (dB)	Constructed measure of radio signal attenuation due to local geographic features (forests, water bodies, terrain).
Control Variables	
Population (1897/1926)	Population size from Imperial Census (1897) and Soviet Census (1926), used with year interactions.
Distance to Moscow	Distance from county administrative center to Moscow (km), interacted with year effects.
Distance to GULAG	Distance to nearest GULAG camp, updated as camps open/close.
Number of Theatres	Cumulative number of theateres was founded in county before (including) year of observation.
Number of Factories	Cumulative number of factories was founded in county before (including) year of observation.
Number of Universities	Cumulative number of universities was founded in county before (including) year of observation.
Mean Seasonal Temperature	Sum of mean temperature for each season divided on 4.
Mean Seasonal Nunber of Precipitation Days	Sum of Precipitation days for each season divided on 4.

Description of variables

Variable	Description
County Characterisitcs (Census 1897)	
Nobility	Number of People in noble families.
Bureaucrats	Number of People in families of personal nobles, officials not from the nobility.
Priests	Number of Clergy of all Christian denominations and their families.
Honorees	Number of Hereditary and personal honorary citizens and their families.
Merchants	Number of Merchants and their families.
Townspeople	Number of Philistines.
Peasants	Number of Peasant.
Cossacks	Number of Military Cossacks.
Non-Russian minorities	Number of National Minorities.
Finish natives	Number of Finnish natives.
Other estates	Number of Others classes.
Estate-Less	Number of People did not indicate their class.
Foreigners	Number of Foreigners.

Note: The table presents descriptions for the key variables used in the analysis. First panel describes repression outcomes; Second panel describes characteristics variables of NKVD officers; Third panel describes radio coverage measures; Fourth panel describes regional control variables; Fifth panel reports description of pre-revolution county-level characteristics from the 1897 Census. Data sources include archival sentencing records, NKVD personnel files, radio infrastructure reports, and the 1897 Russian Imperial Census.

Summary statistics

	Mean	Min	Max	SD	N obs
Panel A: Repressions					
Log of Repressions	-0.361	-4.605	10.29	3.943	17304
Log of Execution	-3.021	-4.605	8.992	2.905	17304
Share of GULAG	12.68	0	100	23.43	17304
Share of Imprisonments	6.516	0	100	16.81	17304
Share of Exiles	6.777	0	100	17.56	17304
Shere of Restricted Residences	3.056	0	100	12.29	17304
Share of Literate	0.0317	0	1	0.105	17304
Share with Primary Education	0.126	0	1	0.236	17304
Share with Secondary Education	0.0375	0	1	0.113	17304
Share with Higher Education	0.0209	0	1	0.0897	17304
Share Released at Sentencing	5.352	0	100	16.07	17304
Panel B: NKVD Officers					
Log of Number Birthplaces	-0.00711	-4.605	5.971	3.228	2077
Log of Repressed	-1.311	-4.605	5.509	3.223	300
Log of Demoted in Rank	-1.534	-4.605	5.485	3.361	300
Log of Promoted in Rank	1.015	-4.605	8.916	4.510	300
Log of Recieved a Prize	-0.848	-4.605	6.288	3.293	300
Panel C: Radio Coverage					
Radio Signal	25.43	-40	90.78	37.10	17304
Topographical Signal Gain	-4.693	-41.48	2.417	7.653	17304
Distinguishable Signal Dummy	0.512	0	1	0.500	17304
Panel D: Controls					
Log Distance To GULAG	6.547	1.144	8.711	0.993	17304
Total number of foreign subjects	0.403	0	52.80	3.428	15057
Number of Theatres	6.316	0	532	23.38	17304
Number of Factories	5.880	0	967	37.99	17304
Number of Universities	6.466	0	1582	50.12	17304
Mean Seasonal Temperature	5.637	-16.82	28.83	3.943	17241
Mean Seasonal Nunber of Precipitation Days	46.64	10.67	72.33	10.86	17229

TABLE A2: Summary statistics

Panel E: County Characterisitcs (Census 1897)					
Nobility	0.334	0	9.011	0.981	15057
Bureaucrats	0.144	0	3.689	0.373	15057
Priests	0.148	0	2.247	0.303	15057
Honorees	0.0779	0	1.815	0.192	15057
Merchants	0.0594	0	2.968	0.176	15057
Townspeople	3.614	0	90.08	8.297	15057
Peasants	25.93	0	448.3	42.32	15057
Cossacks	12.62	0	8027.0	299.7	15057
Non-Russian minorities	2.239	0	447.9	19.54	15057
Finnish natives	0.0283	0	12.51	0.503	15057
Other estates	0.155	0	10.70	0.865	15057
Estate-Less	0.445	0	100.8	5.377	15057
Foreigners	0.403	0	52.80	3.428	15057

Note: The table presents descriptive statistics for the key variables used in the analysis. Panel A summarizes repression outcomes, including log counts and log of executions, GULAG sentences, imprisonments, exiles, restrictions on residence, literacy, educational attainment, and releases at sentencing. Panel B presents characteristics of NKVD officers, including birthplace distribution, repression within the corps, demotions, promotions, and awards. Panel C summarizes radio coverage measures, including average signal strength, topographical signal loss, and the distinguishable-signal dummy. Panel D provides regional control variables, such as distance to the nearest GULAG, presence of foreigners, and counts of theatres, factories, and universities, along with climate controls (seasonal temperature and precipitation days). Panel E (Table A4) reports pre-revolution county-level characteristics from the 1897 Census, including shares of nobility, bureaucrats, clergy, honourable citizens, merchants, townspeople, peasants, Cossacks, non-Russian minorities, Finnish natives, other estates, estate-less population, and foreign subjects. Data sources include archival sentencing records, NKVD personnel files, radio infrastructure reports, and the 1897 Russian Imperial Census.

TABLE A3: Signal Strength and Baseline Characteristics

	Nobility	Merchants	Factories	Electricity	Universities	Minorities	Foreigners	Cossacks
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Signal 1924	0.002	0.096	0.176	0.144	0.225	0.001	0.028	0.063
Signal 1925	0.020	0.623	0.080	0.173	0.133	0.003	0.116	0.255
Signal 1926	0.956	0.035	0.022	0.050	0.042	0.008	0.331	0.458
Signal 1927	0.357	0.203	0.014	0.035	0.042	0.007	0.342	0.496
Signal 1928	0.928	0.014	0.013	0.035	0.034	0.128	0.393	0.226
Signal 1929	0.939	0.022	0.013	0.037	0.035	0.112	0.446	0.227
Signal 1930	0.409	0.084	0.010	0.029	0.034	0.012	0.391	0.242
Signal 1931	0.872	0.023	0.011	0.030	0.036	0.072	0.390	0.277
Signal 1932	0.317	0.006	0.011	0.032	0.026	0.033	0.506	0.384
Signal 1933	0.444	0.012	0.012	0.033	0.033	0.030	0.365	0.217
Signal 1934	0.236	0.008	0.012	0.034	0.034	0.070	0.358	0.346
Signal 1935	0.295	0.014	0.012	0.033	0.035	0.052	0.471	0.325
Signal 1936	0.224	0.011	0.012	0.033	0.036	0.070	0.487	0.374
Signal 1937	0.188	0.010	0.013	0.033	0.035	0.040	0.457	0.366
Signal 1938	0.189	0.011	0.014	0.033	0.035	0.059	0.459	0.354
Signal 1939	0.174	0.011	0.014	0.033	0.035	0.067	0.455	0.354
Joint p-value	0.002	0.001	0.467	0.809	0.813	0.067	0.000	0.816
Observations	716.000	716.000	716.000	716.000	716.000	716.000	716.000	716.000

Note: The table examines whether early radio penetration is systematically correlated with pre-treatment district characteristics. The unit of observation is a county (uezd). Each column reports p-values from regressions of the corresponding baseline characteristic on year-specific radio signal strength dummies (1924–1939). The last row reports p-values from joint F-tests of whether the full set of signal indicators jointly predicts each characteristic. Nobility is the share of hereditary nobles in the population; Merchants is the share of the merchant estate; Factories is the number of factories in 1920; Electricity is baseline installed electric power capacity; Universities is the number of universities; Minorities is the share of non-Russian ethnic or national minority groups; Foreigners is the share of foreign subjects residing locally; and Cossacks is the share of the Cossack estate, a legally defined military–settler class distinct from both nobles and peasants. In other words, areas with stronger radio reception do not appear to differ systematically from low-signal areas in terms of these pre-treatment characteristics. All variables are aggregated at the county level, and both coefficient-specific p-values and the joint significance test (: $allcoefficients = 0)arereported$.

TABLE A4: Radio Signal Strength and Moblity in the Soviet Secret Police

Panel A: NKVD Promotions			
	Log of Promoted in Rank		
	(1)	(2)	(3)
Radio Signal (dB)	-0.039	-0.104***	-0.124***
	(0.032)	(0.028)	(0.021)
Observations	300	300	300
Mean Dep. Var	1.015	1.015	1.015
Mean Radio Signal	53.049	53.049	53.049
SD Radio Signal	22.243	22.243	22.243
Panel B: NKVD Prizes			
	Log of NKVD Recieved a Prize		
Radio Signal (dB)	-0.004	-0.072***	-0.082***
	(0.019)	(0.015)	(0.016)
Regions Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	No	Yes	Yes
Controls	No	No	Yes
Observations	300	300	300
Mean Dep. Var	-0.848	-0.848	-0.848
Mean Radio Signal	53.049	53.049	53.049
SD Radio Signal	22.243	22.243	22.243

Note: The table reports estimates of the relationship between radio signal coverage and service outcomes within the NKVD. Panel A uses as the dependent variable the log of NKVD personnel receiving a rank promotion in a given region–year (number of promotions divided by the total NKVD headcount). Panel B uses as the dependent variable the log of NKVD personnel receiving a prize in a given region–year (number of prize recipients divided by the total headcount). Prizes in the data include both departmental decorations and state orders; examples include the badge Honorary Worker (15th Anniversary) and the state orders Order of the Red Star and Order of the Badge of Honor, awarded for distinguished service or merit.The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each region, accounting for local topography between the broadcasting station and the region centroid. The sample covers 60 regions observed annually from 1936 to 1940. Columns (1)–(2) progressively add region and year fixed effects and covariate sets. Column (3) additionally includes time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp. Standard errors are clustered at the region level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A5: Radio Signal Strength and Repressions During The Great Terror

Panel A: Repressions				
	Log of Repressions			
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.018***	0.045***	0.005**	0.009***
	(0.000)	(0.005)	(0.002)	(0.003)
Radio signal (dB)	0.050***	0.023***	0.005**	0.000
× Post-Radio Great Terror	(0.007)	(0.004)	(0.002)	(0.003)
Observations	15024	15024	15024	15024
Mean Dep. Var	0.170	0.170	0.170	0.170
Mean Radio Signal	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196
Panel B: Executions				
	Log of Executions			
Radio signal (dB)	0.006***	0.015***	0.011***	0.008***
	(0.000)	(0.002)	(0.002)	(0.002)
Radio signal (dB)	0.047***	0.038***	0.031***	0.024***
× Post-Radio Great Terror	(0.006)	(0.005)	(0.004)	(0.005)
Year Fixed Effects	No	Yes	Yes	Yes
County Fixed Effects	No	No	Yes	Yes
County Characteristics × Year FE	No	No	No	Yes
Controls	No	No	No	Yes
Observations	15024	15024	15024	15024
Mean Dep. Var	-2.825	-2.825	-2.825	-2.825
Mean Radio Signal	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196

Note: The table reports estimates of the relationship between radio signal coverage and the log of executions. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each county (uezd), accounting for local topography between the broadcasting station and the county centroid. Columns (1)–(2) use as the dependent variable the log number of individuals released at sentencing, identified from case-level mentions of amnesty, dismissal, or acquittal (e.g., amnesty, case closed, insufficient evidence). Columns (3)–(4) use as the dependent variable the log number of individuals cleared after Stalin (USSR), defined as posthumous charge clearances during post-Stalin reviews. The sample covers 717 counties observed annually from 1920 to 1940. Columns (1) and (3) include year and county (uezd) fixed effects. Columns (2) and (4) additionally include time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A6: Radio Signal Strength and Repressions and Great Soviet Encyclopedia' People

Occupation:	Log People In GSE			
	Every	Intellectuals	Military	Politic
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.002***	0.002***	0.002**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	15024	15024	15024	15024
Mean Dep. Var	-2.073	-2.214	-2.952	-3.308

Note: The table reports estimates of the relationship between radio signal coverage and log of number of people included in Great Soviet Encyclopedia. Table uses Radio Signal (dB) as the main explanatory variable, measured as predicted signal strength at the administrative center of each county (uezd). Column (1) use as the dependent variable the log number of individuals included in GSE. Columns (2)–(4) use as the dependent variable the log number of individuals included in GSE, computed separately by occupation group — Intellectuals (e.g. artist, researcher), Military, Poolitic. All specifications include year fixed effects, county (uezd) fixed effects, and county characteristics interacted with year fixed effects, and time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp, and interactions of year fixed effects with log population from the 1897 census and with log distance to Moscow and to Leningrad. Sample sizes vary by outcome due to the coverage of clearance information; the panel spans 712 counties over 1920–1940. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A7: Radio and Repression Excluding Early Adopters from 1925 (After 1924 Introduction)

Panel A: Repressions						
	Log of Repressed					
Radio After:	1925	1926	1927	1928	1929	1930
	(1)	(2)	(3)	(4)	(5)	(6)
Radio signal (dB)	0.011***	0.011***	0.013***	0.014***	0.014***	0.015***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	14562	14142	13365	12147	12000	11769
Mean Dep. Var	0.146	0.134	0.111	0.130	0.102	0.150
Mean Radio Signal	14.353	13.969	13.143	12.059	12.080	12.021
SD Radio Signal	58.801	58.635	58.200	57.814	57.841	57.835
Panel B: Executions						
	Log of Executions					
Radio After:	1925	1926	1927	1928	1929	1930
	(1)	(2)	(3)	(4)	(5)	(6)
Radio signal (dB)	0.011***	0.012***	0.012***	0.013***	0.013***	0.013***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Characteristics × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14562	14142	13365	12147	12000	11769
Mean Dep. Var	-2.840	-2.859	-2.876	-2.857	-2.863	-2.845
Mean Radio Signal	14.353	13.969	13.143	12.059	12.080	12.021
SD Radio Signal	58.801	58.635	58.200	57.814	57.841	57.835

Note: This table reports estimates of the effect of radio signal strength on repression outcomes using the ever-radio sample, which excludes counties that never reach audible signal strength at any point in the period. The main explanatory variable is Radio Signal (dBV/m) , measured as the predicted electric-field strength at the administrative center of each county (uezd), accounting for local topography between the broadcasting station and the county centroid. In Panel A, the dependent variable is the log number of individuals repressed in a given county–year. In Panel B, the dependent variable is the log of executed in the same county–year. Column (1) uses the full ever-radio sample. Columns restrict the sample to counties. All specifications include year fixed effects, county (uezd) fixed effects, and county characteristics interacted with year fixed effects, and time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp, and interactions of year fixed effects with log population from the 1897 census and with log distance to Moscow and to Leningrad. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A8: Synthetic difference-in-differences estimation

	Log Repressions		Log of Executions	
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.638***	0.495***	0.919***	0.742***
	(0.135)	(0.150)	(0.140)	(0.168)
Controls	No	Yes	No	Yes
Observations	15057	15057	15057	15057
Mean Dep. Var	0.165	0.165	-2.828	-2.828

Note: The table reports estimates of the relationship between radio signal coverage and the log of number of repressions and Log of Executions. Table uses Radio Signal (dB) as the main explanatory variable, measured as predicted signal strength at the administrative center of each county (uezd). In Columns (1)-(2) depended variable is log of number of repressions and repressions and Log of Executions in colunbs (3)-(4) Used Synthetic difference-in-differences estimation with 50 bootstrap replications. All models include year and county fixed effects. Controls include the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp.
Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE A9: Radio Signal Strength and Repressions, Robustness to Chen and Roth (2024)

	Log of Repressed			
Value of X if Number if Repressions = 0:	X=0	X=-0.1	X=-1	X=-5
	(1)	(2)	(3)	(4)
Radio signal (dB)	0.007***	0.007***	0.007***	0.008**
	(0.002)	(0.002)	(0.002)	(0.003)
Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
County Characteristics × Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	15024	15024	15024	15024
Mean Dep. Var	1.800	1.764	1.446	0.029
Mean Radio Signal	26.656	26.656	26.656	26.656
SD Radio Signal	37.412	37.412	37.412	37.412

Note: The table reports robustness checks of the relationship between radio signal strength and political repressions. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each county (uezd), accounting for local topography. The dependent variable is the log number of repressed individuals, where Columns (1)–(4) impose alternative lower bounds for zero-repression observations by recoding counties with zero repressions to X={0, -0.1, -1, -5} prior to taking logs.The sample includes 717 counties observed annually from 1920 to 1940. All specifications include year fixed effects, county (uezd) fixed effects, and county characteristics interacted with year fixed effects, and time-varying controls—the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature and distance to the nearest GULAG camp, and interactions of year fixed effects with log population from the 1897 census and with log distance to Moscow and to Leningrad. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A10: Robustness to Spatial Correlation

	Log of Repressions Count	Log of Executions
County Clustered	0.015	0.000
Conley, 10 km	0.013	0.000
Conley, 25 km	0.013	0.000
Conley, 50 km	0.038	0.000
Conley, 100 km	0.188	0.000
SCPC, ρ = 0.01	0.587	0.018
SCPC, ρ = 0.03	0.736	0.126
SCPC, ρ = 0.05	0.773	0.163
SCPC, ρ = 0.10	0.813	0.246
DellaVigna et al., TMO	0.345	0.000
Year and County FE	Yes	Yes

Note: The table presents robustness checks for spatial correlation using Clustered at County (uezd) level, Conley standard errors (rows 2-5), Müller framework (rows 6-9) and Thresholding Multiple Outcomes (row 10). Four distance cutoffs of 10, 25, 50, 100 km are used for Conley spatial correlation. Four AVC parameters of 0.01, 0.03, 0.05, 0.10 are used for Müller framework. p-values for each specification are displayed. We use two outcomes: log of repressions count and Log of Executions. Columns (1) report estimations for log of repressions count as dependent variable and auxiliary outcomes (for TMO) denoted as log executions, log imprisonment, log exile; while column (2) focus on Log of Executions and auxiliary outcomes (for TMO) denoted as log repressions, log imprisonment, log exile. Signal is the log of signal from topographical maps. Fixed effects for location and year are included in all specifications.

TABLE A11: Radio Signal Strength and Stalin's executions lists

	Log People In Stalin's List		
	(1)	(2)	(3)
Radio signal (dB)	0.011***	0.019***	0.007***
	(0.002)	(0.004)	(0.002)
Year Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
Controls	No	No	Yes
Observations	15024	15024	15024
Mean Dep. Var	-2.073	-2.073	-2.073

Note: The table reports estimates of the relationship between radio signal coverage and log of number of people included in Stalin' Executions list. Table uses Radio Signal (dB) as the main explanatory variable, measured as predicted signal strength at the administrative center of each county (uezd). Columns (1)–(3) progressively add controls: Column (1) includes county and year fixed effects; Column (2) county characteristics interacted with year fixed effects; Column (3) and a controls–the total number of electricity-generating plants, theaters, factories, universities, mean seasonal precipitation days, mean seasonal temperature, log of distance to the GULAG camp. The panel spans 712 counties over 1920–1940. Standard errors are clustered at the county (uezd) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A12: Radio Signal Strength and Repressions

Panel A: Repressions					
	No FE	Year FE	County FE	Year & County FE	Clustered SE
	(1)	(2)	(3)	(4)	(5)
Radio signal (dB)	0.022***	0.044***	0.020***	0.006***	0.006**
	(0.000)	(0.001)	(0.000)	(0.002)	(0.002)
Observations	15024	15024	15024	15024	15024
Mean Dep. Var	0.170	0.170	0.170	0.170	0.170
Mean Radio Signal	15.049	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196	59.196
Panel B: Executions					
	No FE	Year FE	County FE	Year & County FE	Clustered SE
	(1)	(2)	(3)	(4)	(5)
Radio signal (dB)	0.013***	0.020***	0.012***	0.015***	0.015***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)
Year FE	No	Yes	No	Yes	Yes
County FE	No	No	Yes	Yes	Yes
Observations	15024	15024	15024	15024	15024
Mean Dep. Var	-2.825	-2.825	-2.825	-2.825	-2.825
Mean Radio Signal	15.049	15.049	15.049	15.049	15.049
SD Radio Signal	59.196	59.196	59.196	59.196	59.196

Note: The table reports estimates of the relationship between radio signal coverage and the log of executions. The main explanatory variable is Radio Signal (dB), measured as predicted signal strength at the administrative center of each county (uezd), accounting for local topography. The dependent variable in Panel A is the log number of repressions, and in Panel B the log of executions in a given county–year. The sample covers 717 counties observed annually from 1920 to 1940. Column (1) includes no fixed effects. Column (2) includes year FE. Column (3) includes county (yezd) FE. Column (4) includes both. Column (5) clustering SE at county (yezd) level. All specifications include log of population as control. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

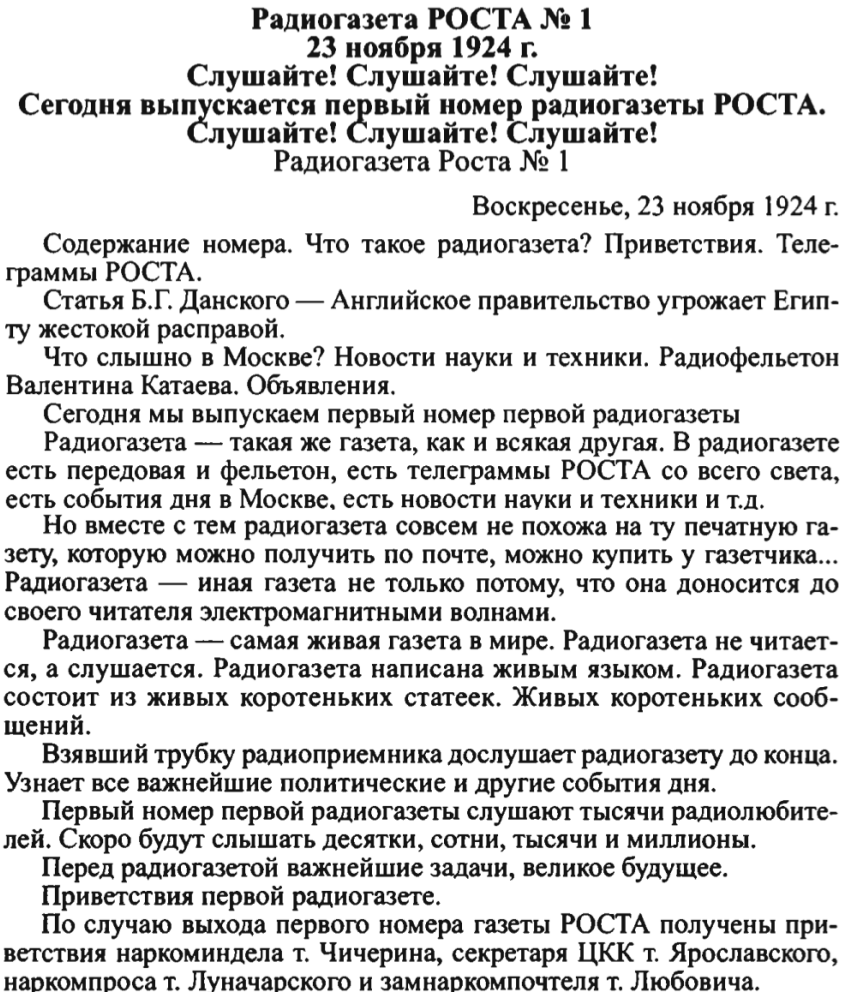
B Appendix

B1 Additional Figures on Raw Data

Figure B1: Cover of "Radiofront" Magazine

Note: The figure shows the cover of the monthly magazine "Radiofront" (January 1933), published since 1926, included detailed technical data on Soviet radio stations, including their geographic locations, transmission frequencies, output power, and annual broadcast plans. The data from this and other issues form the basis of the archival dataset on early Soviet radio infrastructure (see Figure B4 for an example of raw tabular content published in this magazine). The January 1933 issue, shown here, reflects the dual function of the magazine: propagating Stalinist ideology and documenting the technological expansion of mass communication.

Figure B2: First Issue of the ROSTA Radio Newspaper (23 November 1924)



Радиогазета РОСТА № 1
23 ноября 1924 г.
Слушайте! Слушайте! Слушайте!
Сегодня выпускается первый номер радиогазеты РОСТА.
Слушайте! Слушайте! Слушайте!

Радиогазета Роста № 1

Воскресенье, 23 ноября 1924 г.

Содержание номера. Что такое радиогазета? Приветствия. Телеграммы РОСТА.

Статья Б.Г. Данского — Английское правительство угрожает Египту жестокой расправой.

Что слышно в Москве? Новости науки и техники. Радиофельетон Валентина Катаева. Объявления.

Сегодня мы выпускаем первый номер первой радиогазеты

Радиогазета — такая же газета, как и всякая другая. В радиогазете есть передовая и фельетон, есть телеграммы РОСТА со всего света, есть события дня в Москве, есть новости науки и техники и т.д.

Но вместе с тем радиогазета совсем не похожа на ту печатную газету, которую можно получить по почте, можно купить у газетчика... Радиогазета — иная газета не только потому, что она доносится до своего читателя электромагнитными волнами.

Радиогазета — самая живая газета в мире. Радиогазета не читается, а слушается. Радиогазета написана живым языком. Радиогазета состоит из живых коротеньких статеек. Живых коротеньких сообщений.

Взявший трубку радиоприемника дослушает радиогазету до конца. Узнает все важнейшие политические и другие события дня.

Первый номер первой радиогазеты слушают тысячи радиолюбителей. Скоро будут слышать десятки, сотни, тысячи и миллионы.

Перед радиогазетой важнейшие задачи, великое будущее.

Приветствия первой радиогазете.

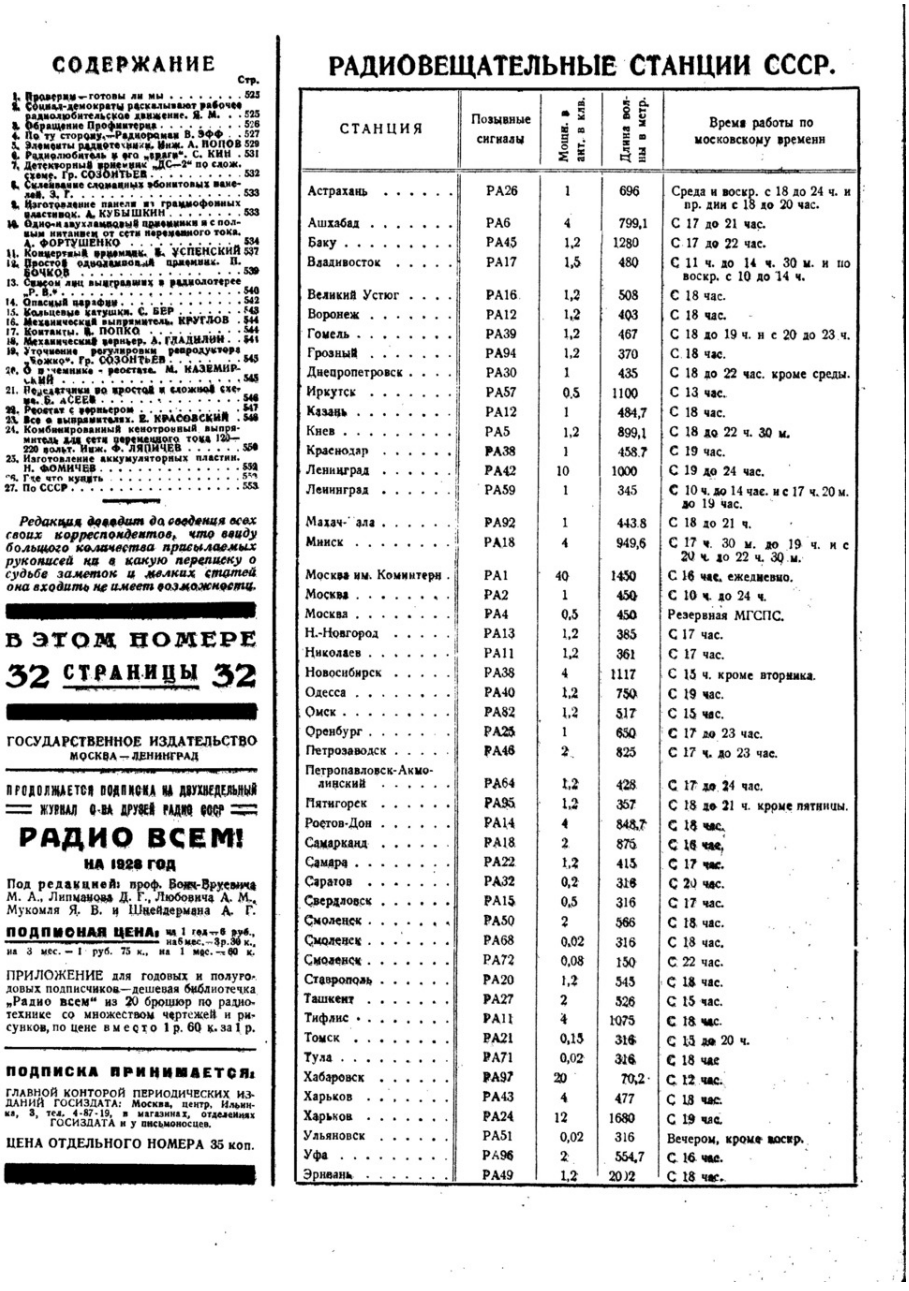
По случаю выхода первого номера газеты РОСТА получены приветствия наркоминдела т. Чичерина, секретаря ЦКК т. Ярославского, наркомпроса т. Луначарского и замнаркомпочтеля т. Любовича.

Note: The figure illustrates an example of the archival microphone script used for early Soviet radio broadcasting. The issue was titled "Radiogazeta ROSTA No. 1" and opened with the announcement: "Listen! Listen! Listen! Today, the first issue of the ROSTA radio newspaper is being released. Listen! Listen! Listen!". ROSTA (Russian Telegraph Agency) produced spoken radio newspapers that were transmitted live across the USSR. Source: Goryaeva (2007) (GARF, f. 391, op. 6, d. 27, ll. 26–35).

Figure B3: Archival Map of Radio Signal Propagation

Note: The map shows audibility regions of operating and proposed radio stations. This map is consistent with the approximated radio signal in the bottom figure Panel B on Page 3. Source: Radio vsem (Radio for All).

Figure B4: Broadcasting Stations in the USSR (January 1933)



СОДЕРЖАНИЕ

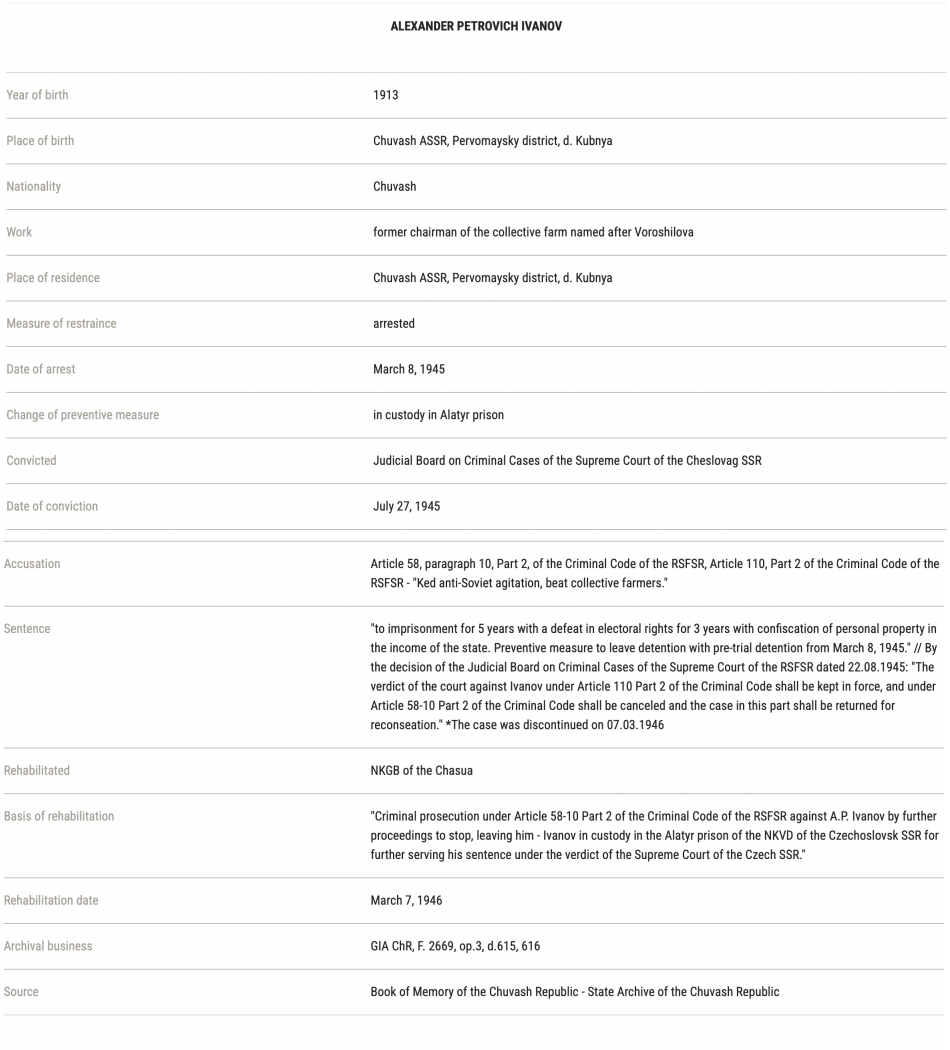
Редакция доведит до сведения всех своих корреспондентов, что ввиду большого количества присылаемых рукописей на в какую переписку о судьбе заметок и мелких статей она входить не имеет возможности.

РАДИОВЕЩАТЕЛЬНЫЕ СТАНЦИИ СССР.

СТАНЦИЯ	Позывные сигналы	Мощн. в ант. в клв.	Длина волны в метр.	Время работы по московскому времени
Астрахань	РА26	1	696	Среда и воскр. с 18 до 24 ч. и пр. дни с 18 до 20 час.
Ашхабад	РА6	4	799,1	С 17 до 21 час.
Баку	РА45	1,2	1280	С 17 до 22 час.
Владивосток	РА17	1,5	480	С 11 ч. до 14 ч. 30 м. и по воскр. с 10 до 14 ч.
Великий Устюг	РА16	1,2	508	С 18 час.
Воронеж	РА12	1,2	403	С 18 час.
Гомель	РА39	1,2	467	С 18 до 19 ч. и с 20 до 23 ч.
Грозный	РА94	1,2	370	С 18 час.
Днепропетровск	РА30	1	435	С 18 до 22 час. кроме среды.
Иркутск	РА57	0,5	1100	С 13 час.
Казань	РА12	1	484,7	С 18 час.
Киев	РА5	1,2	899,1	С 18 до 22 ч. 30 м.
Краснодар	РА38	1	458,7	С 19 час.
Ленинград	РА42	10	1000	С 19 до 24 час.
Ленинград	РА59	1	345	С 10 ч. до 14 час. и с 17 ч. 20 м. до 19 час.
Махач-ала	РА92	1	443,8	С 18 до 21 ч.
Минск	РА18	4	949,6	С 17 ч. 30 м. до 19 ч. и с 20 ч. до 22 ч. 30 м.
Москва им. Коминтерн.	РА1	40	1450	С 16 час. ежедневно.
Москва	РА2	1	450	С 10 ч. до 24 ч.
Москва	РА4	0,5	450	Резервная МГСПС.
Н.-Новгород	РА13	1,2	385	С 17 час.
Николаев	РА11	1,2	361	С 17 час.
Новосибирск	РА38	4	1117	С 15 ч. кроме вторника.
Одесса	РА40	1,2	750	С 19 час.
Омск	РА82	1,2	517	С 15 час.
Оренбург	РА25	1	650	С 17 до 23 час.
Петрозаводск	РА46	2	825	С 17 ч. до 23 час.
Петропавловск-Акмолинский	РА64	1,2	428	С 17 до 24 час.
Пятигорск	РА95	1,2	357	С 18 до 21 ч. кроме пятницы.
Ростов-Дон	РА14	4	848,7	С 18 час.
Самарканд	РА18	2	875	С 16 час.
Самара	РА22	1,2	415	С 17 час.
Саратов	РА32	0,2	316	С 20 час.
Свердловск	РА15	0,5	316	С 17 час.
Смоленск	РА50	2	566	С 18 час.
Смоленск	РА68	0,02	316	С 18 час.
Смоленск	РА72	0,08	150	С 22 час.
Ставрополь	РА20	1,2	545	С 18 час.
Ташкент	РА27	2	526	С 15 час.
Тифлис	РА11	4	1075	С 18 час.
Томск	РА21	0,15	316	С 15 до 20 ч.
Тула	РА71	0,02	316	С 18 час
Хабаровск	РА97	20	70,2	С 12 час.
Харьков	РА43	4	477	С 18 час.
Харьков	РА24	12	1680	С 19 час.
Ульяновск	РА51	0,02	316	Вечером, кроме воскр.
Уфа	РА96	2	554,7	С 16 час.
Эривань	РА49	1,2	2012	С 18 час.

Note: This figure reproduces a page from the January 1933 issue of "Radiofront", listing Soviet radio broadcasting stations. The table includes each station's location, call sign, frequency (in meters), power (in kilowatts), and scheduled broadcasting hours (Moscow time). The dataset extracted from this and similar tables forms the empirical foundation for our analysis of early Soviet radio infrastructure. This example illustrates the format and structure of the raw data digitized for this study.

Figure B5: Memorial Data Screenshot

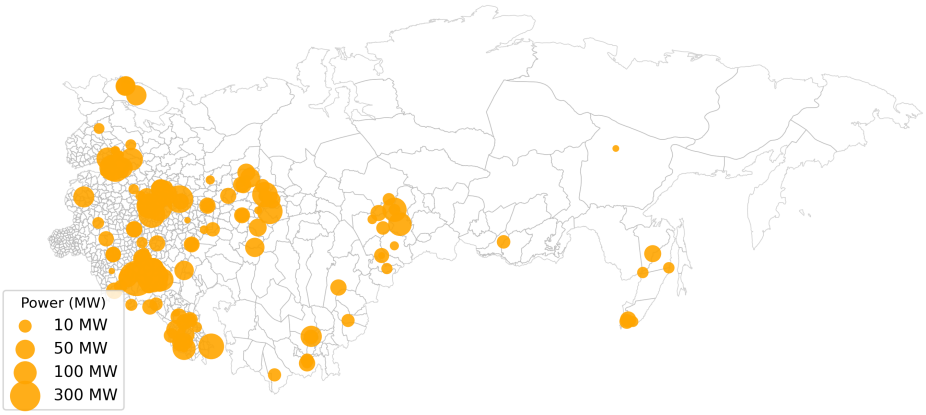


ALEXANDER PETROVICH IVANOV

Year of birth	1913
Place of birth	Chuvash ASSR, Pervomaysky district, d. Kubnya
Nationality	Chuvash
Work	former chairman of the collective farm named after Voroshilova
Place of residence	Chuvash ASSR, Pervomaysky district, d. Kubnya
Measure of restrainсe	arrested
Date of arrest	March 8, 1945
Change of preventive measure	in custody in Alatyr prison
Convicted	Judicial Board on Criminal Cases of the Supreme Court of the Cheslovag SSR
Date of conviction	July 27, 1945
Accusation	Article 58, paragraph 10, Part 2, of the Criminal Code of the RSFSR, Article 110, Part 2 of the Criminal Code of the RSFSR - "Ked anti-Soviet agitation, beat collective farmers."
Sentence	"to imprisonment for 5 years with a defeat in electoral rights for 3 years with confiscation of personal property in the income of the state. Preventive measure to leave detention with pre-trial detention from March 8, 1945." // By the decision of the Judicial Board on Criminal Cases of the Supreme Court of the RSFSR dated 22.08.1945: "The verdict of the court against Ivanov under Article 110 Part 2 of the Criminal Code shall be kept in force, and under Article 58-10 Part 2 of the Criminal Code shall be canceled and the case in this part shall be returned for reconseation." *The case was discontinued on 07.03.1946
Rehabilitated	NKGB of the Chasua
Basis of rehabilitation	"Criminal prosecution under Article 58-10 Part 2 of the Criminal Code of the RSFSR against A.P. Ivanov by further proceedings to stop, leaving him - Ivanov in custody in the Alatyr prison of the NKVD of the Czechoslovsk SSR for further serving his sentence under the verdict of the Supreme Court of the Czech SSR."
Rehabilitation date	March 7, 1946
Archival business	GIA ChR, F. 2669, op.3, d.615, 616
Source	Book of Memory of the Chuvash Republic - State Archive of the Chuvash Republic

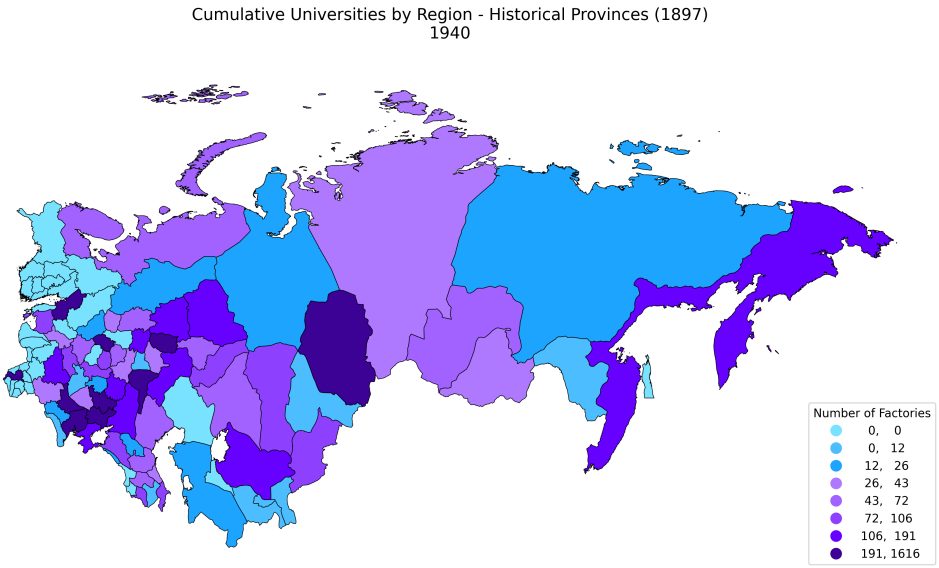
Note: *Memorial* Data *Victims of Political Terror in The USSR* (1914-1960). Individual level data covers date and place of birth, type of sentence, location of repression, type of charge, distance to *GULAG*, and nearest rail station. *GULAG* is a system of USSR labor camps for political prisoners, famously referred to as “Enemies of people”.

Figure B6: Power of Soviet Electric Power Plants count by 1940 with 1897 administrative borders



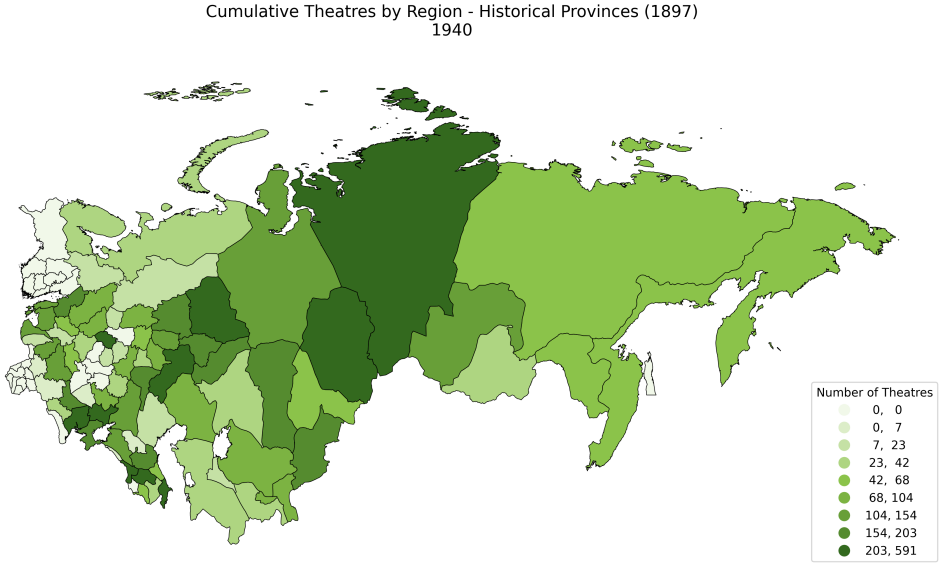
Notes: Figure shows total electricity generation power by 1940 Each circle marks a power plant; circle area is proportional to installed capacity (MW).

Figure B7: Total universities count by 1940 with 1897 administrative borders



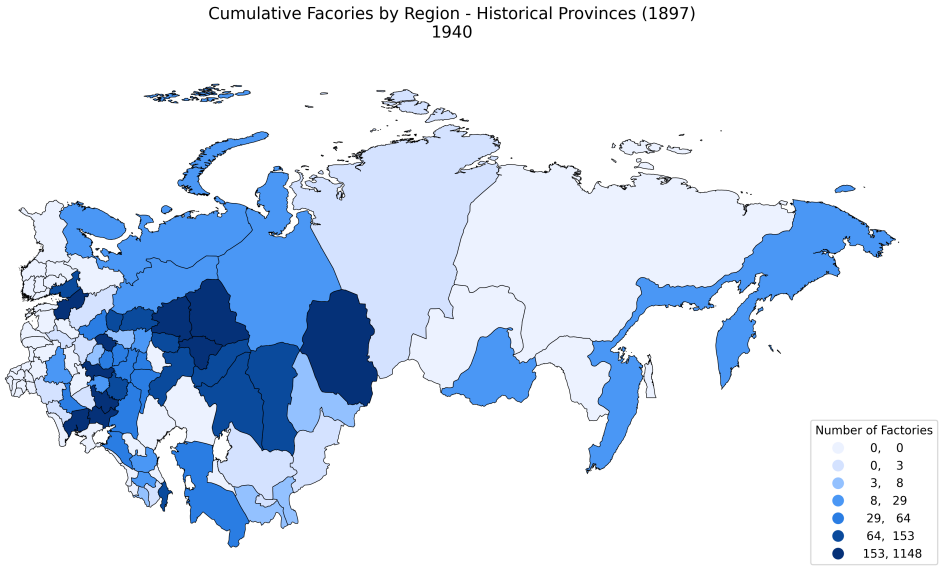
Note: Figure shows quantity of universities by 1940. Border lines show historical district (uezd) borders used for orientation only

Figure B8: Total theaters count by 1940 with 1897 administrative borders



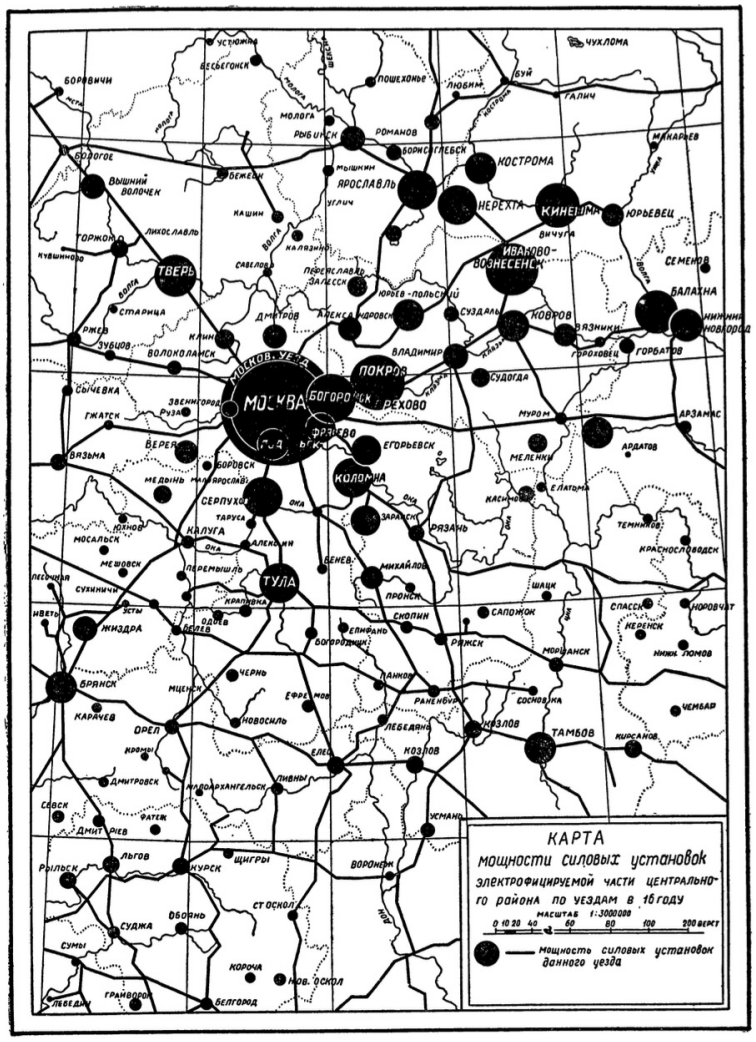
Note: Figure shows quantity of Theaters by 1940. Border lines show historical district (uezd) borders used for orientation only

Figure B9: Total factories count by 1940 with 1897 administrative borders



Note: Figure shows quantity of Factories by 1940. Border lines show historical district (uezd) borders used for orientation only

Figure B10: GOELRO Plan: Map of Power Installations in the Central Industrial Region (RSFSR), 1920



Точное воспроизведение карты, приложенной к «Плану электрификации РСФСР», 1920 г.

Source (archival facsimile): *Plan of Electrification of the RSFSR (GOELRO)*. Scientific and Technical Department of the Supreme Council of the National Economy (VSNKh), State Commission for the Electrification of Russia (GOELRO). Gosudarstvennoe Tekhnicheskoe Izdatel'stvo, Moscow, 1920. The figure reproduces the original thematic map of installed power by *uezd* used in the GOELRO report. Shown here as a raw reference image to document historical coverage and symbology (bubble sizes).

B2 Data Construction

Political Repression Data. Primary Source: The Memorial Society's database of victims of political terror (available at memo.ru). This archive compiles individual records from Soviet state security files, "Memory Books" published by regional authorities, and other historical documents. Content: Each record contains fields for: full name, year and place of birth, nationality, occupation, education level, date and place of arrest, the criminal article applied, date and type of sentence (execution, GULAG imprisonment, non-camp imprisonment, exile, special settlement), place where the sentence was carried out, and information on rehabilitation (see Figure B5).

NKVD Personnel Data. Source: A separate collection within the Memorial database, compiled from NKVD personnel files, service cards, award lists, and disciplinary orders. Content: The microdata cover approximately 45,000 individuals and include: name, year and region of birth, dates and locations of service, rank, information on promotions and demotions, receipt of state or departmental awards, grounds for dismissal (e.g., voluntary resignation, political unreliability), and whether the officer was themselves repressed.

Control Variables Electrical Power Plants: Data on the location, type (Hydroelectric/HPP, State District Power Station/GRES, Combined Heat and Power/CHP), installed capacity, and commissioning dates of power plants were compiled from the 1932 statistical report of the GOELRO plan (TsGANKh SSSR, 1932) and supplemented with information from historical engineering directories. This controls for regional electrification.

textbfIndustrial Enterprises: A list of factories and plants for the period 1938–1941 was taken from the *History of the Industrialisation of the USSR, 1938–1941: Industrial Enterprise Index* (1972) and expanded using historical industrial catalogs to establish founding dates for earlier periods.

Cultural & Educational Institutions: Counts of theaters and universities by location were obtained from searching their foundation years with the number of theaters and universities at the 1940 from *Cultural Development of the USSR: Statistical Compendium* (1940) as a baseline.

GULAG Camp Network: The locations (geographic coordinates) and operational years (opening and closing dates) of all known GULAG camps and sub-camps were collected from GULAG Chronology. For each county and year, a time-varying variable for the distance to the nearest operational camp was computed. **Baseline Socio-Demographic Controls:** Data from the *First General Census of the Population of the Russian*

Empire (1897) were used to construct county-level shares of various pre-revolutionary social estates (sosloviya): hereditary nobles, personal nobles, clergy, honorary citizens, merchants, townspeople (meshchane), peasants, Cossacks, indigenous groups (inorodtsy), estate-less individuals, and foreign subjects.

Geocoding Procedure. Location Name Extraction: Text strings denoting locations (e.g., place of birth from repression records, town name for a radio station, city for a university) were isolated from the relevant fields in all datasets. **API Geocoding:** Standardized location names were submitted in batches to the Google Maps Geocoding API to obtain latitude and longitude coordinates. **Historical Verification and Manual Correction:** For a significant sample of points the API-derived coordinates were verified against historical maps, atlases, and geographic dictionaries. Discrepancies were resolved through manual research and correction.

Data Aggregation. County (Uezd) Panel: The primary unit for analyzing repressions. Historical borders of the Russian Empire's uezds as of 1897 were digitized. All point data (repression events, infrastructure locations) were spatially joined to these polygons based on their coordinates. **Region (1926) Panel:** The primary unit for analyzing NKVD internal dynamics. Borders of the Soviet administrative regions as of 1926 were digitized. NKVD personnel data were aggregated to this level. **Creating Crosswalks:** A concordance table was created to link uezds (1897 borders) to the larger 1926 regions, allowing for the merging of controls and the analysis of effects across different spatial aggregations.

Building the Panels: For each uezd and each year (1920–1940), we summed the number of repression events (total, and by sentence type: execution, GULAG, etc.), calculated the share of executions, and computed the number of releases at sentencing and post-Stalin rehabilitations. Infrastructure counts (number of power plants, theaters, universities, factories within the uezd) were calculated for each year based on their known founding/opening dates. For the NKVD region-cohort analysis, personnel were grouped by their region of birth and year of birth. For the NKVD region-year analysis, career events (promotions, demotions, repressions, awards) were aggregated by the region of service and the calendar year of the event.

B3 Radio Signal Modeling Procedure

Signal strength was modeled with *ground wave propagation model*. The model comes from several theories. First, let's examine the intensity of electromagnetic wave. The intensity I from a point source (radio antenna in our case) with power P at distance r is determined as following Balanis (2016), equation (2.11):

$$I = \frac{P}{4\pi r^2} \quad (W/m^2) \tag{B1}$$

Further, we need to derive the electric field of radio wave E, using following formula from Balanis (2016), example (2.15):

$$I = \frac{E^2}{2\eta} \tag{B2}$$

where η is the intrinsic impedance of the medium($\approx 120\pi$ ohms for a free-space medium). Now we can derive the connection between E electric field strength, P power of radio station and r the distance from the radio station.

$$E^2 = \frac{\eta P}{2\pi r^2} \Rightarrow E = \sqrt{\frac{\eta P}{2\pi r^2}} \approx \frac{\sqrt{P}}{r} \tag{B3}$$

Radio wave is a form of electromagnetic radiation, thus it corresponds with electromagnetic propagation concepts. To model attenuation of radio signal we used *the Beer–Bouguer–Lambert (BBL) extinction law* (Mayerhöfer et al. (2020)). The law describes empirical connection between loss in intensity with a homogeneous medium with each it interacts. According to this law, the radio strength exponentially decreases with distance from radio station. So, the final formula for radio signal strength will be:

$$E = \frac{\sqrt{P}}{r} e^{-\alpha r} \tag{B4}$$

where α is topographical loss of radio signal.

In decibels:

$$\text{Radio Signal Strength} = log_{10}(E) \tag{B5}$$

The topographical gain depends on ground conductivity, there are five types of ground types: *open ground, grassland, forest, rural area, urban area*. The topographical loss for all five types are empirically determined. Hence, the radio signal strength depends on initial power of radio station, decreases with distance from source. Terrain effects varies with type of ground and environment. For instance, urban area has high topological loss as radio wave faces metal and concrete constructions, which are reflective and conductive materials. In such region radio signal will have higher loss. On the other hand, farmland has lower topological loss as radio wave propagates almost without encountering obstacles and most loss happens because of humid ground.

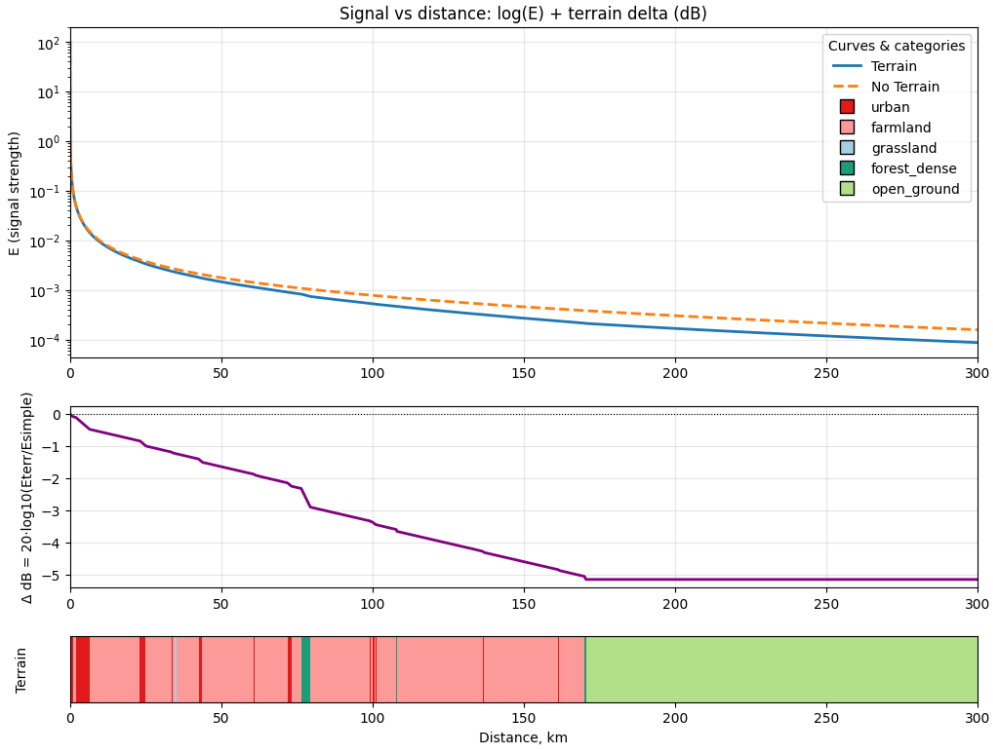
We construct a measure of *Topographical Signal Gain* that captures how local propagation conditions affect radio signal strength along the transmission path. Long-wave radio signals are sensitive to ground conductivity and surface characteristics encountered between the transmitter and the receiver. We therefore compare predicted signal strength under observed propagation conditions to a counterfactual benchmark that assumes the most favorable propagation conditions along the same path.

$$\text{Topographical Signal Gain} \;=\; \log_{10} E_d^{\text{actual}} \;-\; \log_{10} E_d^{\text{best}} \tag{B6}$$

In equation (B6), E_d^{actual} denotes predicted signal strength at county d accounting for ground conductivity and surface characteristics along the propagation path, while E_d^{best} denotes the signal that would prevail along the same path under uniformly favorable propagation conditions (i.e., maximal ground conductivity). The log difference therefore captures proportional amplification or attenuation of the signal driven purely by local topography and land cover.

Further, we need to determine distinguishable signal from our approximations of radio signal in a point. To address this question, we use normative level for FM broadcasting from International Telecommunication Union (2017) (p. 1, table 1). According to this recommendation, the minimum usable field strength, which gives a distinguishable signal for radio users, should be not lower than 48 dB in rural ares. This level of field strength is equal to approximately 0.1 mV/m or 10^{-4} V/m. Hence, our threshold of distinguishable signal will be 10^{-4} V/m.

Figure B11: Signal Strength Comparison of Terrain and No Terrain Models



Note: The top figure shows the dependence of approximated signal strength and the distance between point of interest and radio station. The blue line represents modeled signal from radio station to the point of interest with terrain on its path, while the orange dot-line is modeled with no terrain on the path. The medium figure represents logarithm of signal strength ratio between terrain and no-terrain models. Someone can see that signal difference is increasing with terrain and different types of terrain corresponds with different attenuation coefficients. And the bottom figure shows 5 types of terrain on the path of radio signal.