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This paper examines the impact of mass media on cultural assimilation by exploiting Japan's *Nippon Hoso Kyokai* (NHK) radio monopoly. By broadcasting exclusively in Tokyo-based standard Japanese, NHK introduced a uniform linguistic shock. Using comprehensive linguistic atlases and exogenous variation in radio signal strength driven by topography, I find that NHK radio exposure significantly reduced the linguistic distance from local dialects to the Tokyo dialect. Heterogeneity analysis reveals distinct mechanisms. Radio served as a substitute for physical connectivity, promoting assimilation in isolated regions lacking railway access, but acted as a complement to human capital, with larger effects observed in areas with higher educational penetration.

Media and Cultural Assimilation: Evidence from NHK Radio*

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Abstract: This paper examines the impact of mass media on cultural assimilation by exploiting Japan's *Nippon Hoso Kyokai* (NHK) radio monopoly. By broadcasting exclusively in Tokyo-based standard Japanese, NHK introduced a uniform linguistic shock. Using comprehensive linguistic atlases and exogenous variation in radio signal strength driven by topography, I find that NHK radio exposure significantly reduced the linguistic distance from local dialects to the Tokyo dialect. Heterogeneity analysis reveals distinct mechanisms. Radio served as a substitute for physical connectivity, promoting assimilation in isolated regions lacking railway access, but acted as a complement to human capital, with larger effects observed in areas with higher educational penetration.

Keywords: Media, Culture, Language, Japan

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Introduction

Technological shocks play a fundamental role in reshaping the evolution of culture. Language, as the primary carrier of culture, offers a unique lens this process (Ginsburgh and Weber, 2020). Historically, linguistic diversity was a natural outcome of geographic barriers limiting contact between communities, and it sustained distinct local norms, identities, and ways of life (e.g., Michalopoulos, 2012). The introduction of mass media, beginning with radio, delivered an unprecedented shock to this isolation. Radio transmitted a uniform language to a mass audience. This technological shift therefore creates a powerful setting to study linguistic and cultural evolution.

Japan presents a distinct case to examine this question. With mountains covering about 75% of its landmass,¹ the archipelago’s geography naturally isolated communities. The political institutions of the Tokugawa Shogunate (1603–1868) exacerbated this geographic fragmentation by strictly controlling mobility (Gottlieb, 2005; Koyama, Moriguchi, and Sng, 2018). Consequently, late-Tokugawa Japan functioned as a dialect mosaic where people from distant regions often remained mutually unintelligible (Shibatani, 1990). By today, however, Japan had transformed into a linguistically and culturally homogeneous nation (Befu, 2001; Alesina et al., 2003), unified around a standard language based on the Tokyo dialect.² This paper argues that mass media, specifically the public monopoly broadcaster *Nippon Hoso Kyokai* (NHK), was instrumental in bridging this divide by providing the unifying linguistic infrastructure that geography had long denied

The drive for this linguistic assimilation began before the radio era, but it faced structural friction. After the Meiji Restoration in 1868, the new government prioritized standard language to centralize the state and modernize the economy. This led to the selection of the Tokyo dialect as the standard language, reflecting its association with the educated elite and Tokyo’s dominance as the country’s political and economic hub. (Shibatani, 1990). While the government attempted to enforce this standard through the school system, early efforts were hampered by a chronic shortage of qualified teachers and the instability of the standard itself (Carroll, 1997). Radio emerged as the technological solution to this bottleneck. Founded in 1926, NHK held a monopoly and broadcasted exclusively in the Tokyo dialect (Shioda, 2007), bypassing local limitations to deliver a uniform standard directly to households. Thus, unlike the gradual and uneven progress of schooling, NHK served as an immediate, scalable instrument of linguistic integration.

I exploit this context to study the effect of media-driven linguistic assimilation. NHK’s use of the Tokyo dialect created a setting that allows for a rigorous identification strategy for three reasons. First, NHK held a complete monopoly on radio broadcasting from 1926 to 1951 (Nippon Hoso Kyokai, 2001), which provides a clear environment to measure the exposure without the confounding effects of competition. Second, this monopoly spanned

¹ See [Land and Climate of Japan](#).

² For instance, Alesina et al. (2003) assigns Japan a linguistic fractionalization score of 0.0178, one of the lowest in the world. My paper investigates the historical process that generated this equilibrium.

distinct political regimes, from the liberal 1920s and wartime militarism to the post-war democracy. This variation allows me to disentangle the effect of linguistic assimilation from the influence of any single political ideology, isolating the role of the medium itself. Third, Japan offers comprehensive historical linguistic data, enabling me to conduct a rigorous empirical examination of the linguistic change.

I empirically test this effect by constructing a novel dataset that merges digitized linguistic atlases with historical radio exposure data. My primary outcome is the linguistic distance from local dialects to the Tokyo dialect. Leveraging the linguistic atlases, I reconstruct linguistic snapshots of Japan for 1909 and 1926 (pre-radio), and 1950 (post-radio). I primarily measure radio exposure using the Irregular Terrain Model (ITM) of signal propagation. To isolate the causal effect of broadcasting, I employ an identification strategy that exploits Japan’s rugged topography. Following Olken (2009), I calculate a ‘free signal’ (assuming hypothetical flat topology) to capture the strategic placement and configuration of radio stations, and a ‘real signal’ that incorporates real terrain. By controlling for the free-space signal, I isolate the exogenous variation in reception driven solely by topographic features. Finally, I include prefecture fixed effects and a vector of geographic and economic controls to mitigate remaining confounders.

My baseline results find that radio broadcasting drove linguistic assimilation. The exposure to NHK radio broadcasting significantly reduced the linguistic distance from local dialects to the Tokyo dialect by 1950. In terms of magnitude, a one standard deviation increases in real signal strength led to a 1.716-unit reduction in linguistic distance, approximately 5.3% of the average distance. Crucially, I find no such effect for the pre-radio periods (1909 and 1926). This placebo test supports that my baseline results are not simply picking up pre-existing trends of convergence but capturing the impact of NHK radio exposure.

To further validate the main finding, I implement two supplementary identification strategies. First, I estimate a difference-in-differences (DiD) model using a constructed panel of 30 common items surveyed in both the pre-radio (1909) and post-radio (1950) atlases. By including municipality fixed effects, the DiD estimation results ensure that the linguistic assimilation was not driven by time-invariant unobserved heterogeneity. Second, I address potential measurement errors in the simulated signal by using the actual radio subscription rate as the measure of radio exposure, instrumenting it with my computed signal signals. Both strategies yield estimates consistent with the baseline.

I also show that my baseline results are robust against multiple tests. The baseline results hold after controlling for competing mechanisms such as railway infrastructure, migration, and education. Furthermore, the results remain significant when excluding linguistically important regions (Tokyo, Okinawa, Hokkaido, and Kyoto), as well as using different measures of linguistic distance, adjusting standard errors for spatial correlation.

To understand the mechanisms driving this assimilation, I examine the heterogeneous effects of NHK radio. The results reveal distinct patterns of substitution and

complementarity. First, radio served as a substitute for initial endowments. Assimilation was stronger in isolated regions with higher ruggedness and greater initial linguistic distance, but weaker in areas with established railway links or migration. This suggests that radio bridged linguistic gaps where face-to-face contact was most limited. By contrast, radio acted as a complement to institutional penetration. Regions with higher penetration in standard language education experienced larger assimilation effects. This implies that while schools provided the formal foundation of the standard language, radio provided the necessary daily exposure.

This paper contributes to two strands of literature. First, it adds to work on the political and social effects of mass media (see Prat and Strömberg, 2013; DellaVigna and La Ferrara, 2015; Zhuravskaya, Petrova, and Enikolopov, 2020; Campante, Durante, and Tesei, 2022 for literature review). While existing studies focus on how media shape voting behavior or social norms, I show that radio broadcasting also shapes linguistic assimilation. The closest related study is concurrent work by Castiello (2025) on radio in Fascist Italy. While our baseline findings on assimilation are complementary, I distinguish my contribution through mechanism and context. Whereas Castiello emphasizes the political economy of propaganda and fertility, I further isolate economic development mechanisms. Furthermore, Japan's extreme topographic fragmentation provides a uniquely severe test of media's capacity to overcome physical isolation

Second, I contribute to the literature on the origins of linguistic diversity. Previous work has highlighted how geography (Galor, Özak, and Sarid, 2020), biological factors (Michalopoulos, 2012), human settlement history (Ahlerup and Olsson, 2012), trade (Dickens, 2021), and education (Blanc and Kubo, 2025) can impact language outcomes. This paper contributes by offering evidence showing media can influence linguistic assimilation. Whether media can affect language is debatable in sociolinguistics (see Sayers (2014); Trudgill (2014) for a discussion). This paper provides a piece of evidence supporting that media technology alone can drive linguistic assimilation.

The rest of the paper is arranged as follows. Section 2 introduces the basic historical background. Section 3 describes the data used in this paper, while Section 4 introduces empirical strategies and results. Section 5 covers the heterogeneous effect analyses; while Section 6 concludes.

2. Historical Background

Linguistic fragmentation inherited from the Tokugawa era (1601–1868) impeded economic and social integration following the Meiji Restoration of 1868. The absence of a common language raised transaction costs and hindered the mobility of labor and capital across regions. The Meiji government recognized that overcoming these barriers was essential not only for political centralization but for the formation of a unified national market to achieve modernization (Gottlieb, 1991, 2005). To address this problem, the government pursued a standard Japanese (*hyojungo*). Policymakers selected the Tokyo dialect as the base of

standard Japanese because it signaled status with educated elites and the status of Tokyo (Shibatani, 1990).

Compulsory education served as the initial mechanism for standardization. By 1900, standard Japanese became the required medium of instruction. Through this centralized school system, the Meiji government systematically exposed generations of children to the written and spoken forms of standard language. This policy laid the groundwork for national linguistic assimilation. However, a shortage of teachers fluent in the standard language impeded these mandates. Without frequent exposure to native speakers, the transmission of the spoken standard remained inefficient, and local dialects persisted as the dominant medium of daily life (Carroll, 1997).

The launch of radio broadcasting by NHK in 1926 altered the technology of assimilation. As a monopoly broadcaster, NHK provided a scalable solution to the exposure problem. Households in isolated regions gained direct, daily access to the standard Tokyo dialect for the first time. This access significantly reduced the cost of language acquisition. Contemporary experts held high expectations for the new technology. As Jimbo Kaku (1931) wrote,

“In order to spread the standard language, it is necessary to have as many people as possible hear the standard language as often as possible... I hope that in the future, as the radio stations become more and more prosperous, the standard Japanese language will flood into the very corner of the country...”

The NHK network expanded rapidly. The infrastructure grew from the founding of the network to include 86 stations by 1950. Household subscriptions rose concurrently. The subscriber exceeded 1 million in 1932 and reached 7.5 million by 1944. Subscriptions declined following the surrender but rebounded to surpass 10 million by 1952. This penetration rate covered over half of all households (Nippon Hoso Kyokai, 2001). This period of monopoly expansion (1926–1951) defines the scope of my study, because the broadcasting environment changed significantly after 1950 with the legalization of commercial radio and the introduction of television.

3. Data

I analyze a sample of 543 municipalities from the 10,467 total units in the 1950 Japanese administrative map.³ I construct the 1950 administrative boundaries using historical shapefiles from the Geoshape Repository.⁴ These 543 municipalities correspond to the sample locations used in the linguistic atlas data introduced below. The atlas sampled

³ In 1950, Japan’s administrative structure can be classified into two hierarchical levels. The first level is the prefecture, which includes prefecture proper (*ken*), urban prefecture (*fu*), territory (*do*), and metropolis (*to*). The second level is the municipality, which includes city (*shi*), special district (*ku*), town (*machi*), and village (*mura*).

⁴ I obtain the data from the [Geoshape Repository](#).

locations at regular geographic intervals. This design ensures systematic coverage of Japan. I detail the specific sampling procedures in the description of dataset.

3.1 Linguistic Distance to Tokyo Dialect

My main outcome variable is the linguistic distance between local dialects and the Tokyo dialect. I construct this distance using data from three comprehensive linguistic atlases compiled by National Institute for Japanese Language and Linguistics (1966–1977, 1989–2006, 2025). These atlases systematically document the geographic variation of the Japanese language. For each surveyed item, the atlas produces a map displaying the spatial distribution of usage. For example, it plots the specific words used for 'tomorrow' (*ashita* vs. local variants) across Japan (see Figure 1 for an example). I exploit this spatial variation to calculate a quantitative measure of distance between each local dialect and the Tokyo dialect.

[Figure 1 around here]

3.1.1 Linguistic Atlas

I construct my dataset using three linguistic atlases compiled by National Institute for Japanese Language and Linguistics (1966–1977, 1989–2006, 2025). These atlases cover distinct time periods and linguistic features. First, the Linguistic Atlas of Japan (LAJ), surveyed between 1957 and 1965, documents variation in 300 lexical (vocabulary) items from 2,402 informants across 2,289 unique municipalities. Second, the Grammar Atlas of Japanese Dialects (GAJ), surveyed from 1979 to 1983, provides data on 267 grammatical items from 829 informants on 801 unique municipalities. Third, the Field Research Project to Analyze the Formation Process of Japanese Dialects (FPJD), surveyed between 2010 and 2015, cover 9 phonetic, 79 lexical, and 117 grammatical items from 554 informants at 543 unique municipalities.⁵

All three atlases employed a consistent sampling strategy designed to capture deeply rooted local dialects (National Institute for Japanese Language and Linguistics, 1966–1977, 1989–2006, 2025). The LAJ, for example, surveyed 2,402 informants, with survey points distributed at roughly 100 km² intervals across 2,289 unique municipalities (with more informants in municipalities with more complex dialectal patterns). To ensure the data reflected the authentic local dialect rather than transient speech patterns, Surveyors selected informants based on three strict criteria: (1) gender (male), (2) age (over 60 years), and (3) residency (no migration between ages 3 and 15). The gender restriction addressed

⁵ I standardize the transcriptions in all three linguistic atlas datasets to romaji. This harmonization addresses variation in raw data formats. The LAJ records entries in romaji. The FPJD uses katakana, except for the Okinawa region which uses the international phonetic alphabet (IPA). The GAJ uses IPA. I convert katakana forms to romaji using a deterministic mapping. For entries recorded in IPA, I map symbols to the closest romaji equivalents. The digitized data of LAJ is retrieved from the [Linguistic Atlas of Japan Database \(LAJDB\)](#); GAJ from the [Grammar Atlas of Japanese Dialects All Data](#); FPJD from the [Field Research Project to Analyze the Formation Process of Japanese Dialects](#).

a historical confounder. Women in this cohort frequently migrated to their husband’s municipality upon marriage (patrilocality), whereas men typically remained in their natal communities. The age and residency criteria similarly isolated the dialect acquired during the critical period of childhood. This selection minimized measurement error from lifetime migration or linguistic attrition. The subsequent GAJ and FPJD atlases retained these inclusion criteria but adopted a slightly sparser spatial grid.

The retrospective nature of these atlases requires a specific interpretative framework. Because the atlas targeted informants over 60 years old, the recorded speech does not represent the linguistic norms of the interview year (e.g., 1960), but rather those of an earlier era. To address this, I rely on the apparent time construct, a foundational principle in sociolinguistics (Bailey, 2004; Bailey et al., 1991). This framework posits that an individual’s core vernacular is acquired during the critical period of childhood and remains largely stable throughout adulthood. Therefore, I treat the speech of older informants as a valid proxy for the linguistic environment of their youth.

Applying this construct, I assign the effective time of each linguistic atlas to the end of each informant cohort’s critical period of language acquisition. Consistent with the atlases’ own criteria regarding childhood migration, I define the end of this acquisition period as age 15. I calculate the average birth year of informants in each survey and add 15 years. This calculation anchors the LAJ patterns to approximately 1909, the GAJ to 1926, and the FPJD to 1950. This timeline underpins the identification strategy. I classify the LAJ and GAJ as pre-treatment baselines because they predate the widespread diffusion of radio. The FPJD represents the post-treatment outcome. The data capture linguistic patterns following a generation of exposure to NHK broadcasting.

3.1.1 Measuring the Linguistic Distance

To calculate this linguistic distance, I use the Levenshtein distance, an algorithm in computational linguistics that has been adopted in recent economic history research (Dickens, 2021; Blanc and Kubo, 2025; Castiello, 2025). This algorithm defines the string distance as the minimum number of single-character edits (insertions, deletions, or substitutions) required to transform one string into another. For each linguistic item in the atlases, I apply this algorithm to measure the distance between the local dialect and the Tokyo dialect.

An example illustrates this calculation. The Tokyo dialect of ‘tomorrow’ in romaji is ‘*asita*’ (see Figure 1). Some local dialects use ‘*asisyuta*’. The Levenshtein distance between these two strings is 3. This corresponds to the three insertions (s, y, and u) required to transform the Tokyo form into the local variant. To construct a municipality-level measure, I extend this calculation to all linguistic items documented in the atlas. I compute the distance for each item relative to the Tokyo dialect and aggregate these scores into a composite index, as formalized by the following equation:

$$LD_m = \frac{100}{KJI} \sum_{i=1}^I \sum_{j=1}^J \sum_{k=1}^K \frac{levi(str_i^k, str_j^k)}{\max(|str_i^k|, |str_j^k|)}$$

The linguistic distance index, LD_m for municipality m , is defined as the simple average of normalized Levenshtein distance, scaled by a factor of 100. As shown in the equation, for each of the K linguistic items, I compare the variant reported by each of the I local informants in municipality m against the variant reported by each of the J Tokyo informants. This procedure generates a total of $K \times J \times I$ pairwise comparisons for each municipality. For every comparison, I calculate the normalized Levenshtein distance, the raw distance, $levi(str_i^k, str_j^k)$ divided by the maximum length of the two strings $\max(|str_i^k|, |str_j^k|)$. I then average these normalized scores across all item-informant pairs to derive the composite measure for the municipality. Finally, I multiply this result by 100 to produce the index LD_m . This yields a continuous variable where a score of 0 indicates perfect identity with the Tokyo dialect, and higher scores indicate greater linguistic divergence.

For the 1950 linguistic distance constructed from the FPJD atlas, I restrict the analysis exclusively to lexical items. This decision reflects the specific mechanics of assimilation. Radio operates as a passive medium that exposes listeners to Tokyo dialect without offering interactive correction. Sociolinguistic evidence indicates that while grammatical and phonetic structures often require active pedagogical intervention to modify, vocabulary is readily acquired through passive listening during the critical period (Trudgill, 1986). Lexical distance therefore serves as the most precise distance to identify the impact of broadcasting.

Figure 2 the spatial distribution of linguistic distance to Tokyo dialect in 1950. The size of each blue circle corresponds to the magnitude of the distance index. Larger circles indicate greater divergence from the Tokyo dialect. The map reveals a distinct core-periphery pattern. Municipalities closer to Tokyo exhibit high levels of convergency (small circles). Conversely, as geographic distance from the capital increases, linguistic distance grows. The peripheral Ryukyu Islands consequently exhibit the largest deviations.⁶

[Figure 2 around here]

3.2 Exposure to NHK Radio

I measure exposure to NHK radio primarily through signal strength, using municipal radio subscription rates as a supplementary proxy. I use signal strength as the primary measure

⁶ The Ryukyu islands (Okinawa) exhibit the largest deviations. This reflects deep historical and linguistic roots. Japan formally annexed the Ryukyu Kingdom only in 1879. Furthermore, linguists classify Ryukyuan varieties as a distinct branch of the Japonic language family rather than dialects (Shibatani, 1990). Hokkaido, conversely, displays a small linguistic distance to Tokyo dialect relative to its geographic remoteness. Settlement history explains this convergence. Migrants from diverse prefectures colonized the frontier during the Meiji era. This mixing triggered dialect leveling. The resulting speech variety resembles standard language more closely than the traditional dialects of northern Honshu (Shibatani, 1990).

because it is more exogenous. Signal strength is a supply-side variable mainly determined by transmitter configurations and transmission topography, factors that are more independent of local radio demand. Radio subscription rates represent an equilibrium outcome. These rates capture not only supply but also local demand. Besides, subscription rates are an incomplete measure of exposure, because they do not account for listening on public radios installed in schools and parks. Signal strength thus provides a more exogenous source of variation to identify the effect of radio exposure on linguistic assimilation.

I calculate the NHK radio signal strength for each municipality in 1950 using the Irregular Terrain Model (ITM). The model calculates signal strength using topographical features, radio station configurations, and the geographic distance between the station and the receiver.⁷ I obtain the data on radio station configurations, including frequency, tower height and power, from the 1951 NHK Yearbook (Nippon Hoso Kyokai, 1951). The computed signal strength is in decibel milliwatts (dBm), a logarithmic power unit. To facilitate the interpretation of my regression coefficient, I follow Wang (2021) and standardize the raw signal value into a z-score. Given that Japan operated 86 NHK transmitters by 1950, most municipalities were within range of multiple stations.⁸ I therefore define a municipality's exposure to NHK radio as the maximum signal strength it receives from any single transmitter. This maximum value serves as my primary independent variable, Real Signal.

In addition to the Real Signal, I compute a counterfactual measure termed the Free Signal, using the same Irregular Terrain Model specifications but assuming a perfectly flat terrain. This assumption simulates a free-space propagation environment devoid of topographical obstacles. The Free Signal therefore captures the effect of geographic distance and radio configurations on signal strength, removing the variation caused by mountains and hills. I also standardize this measure into a z-score.

Figures 3 and 4 map the Real Signal and Free Signal distributions before standardization. In both graphs, lighter colors indicate higher signal strength. The light blue symbols denote the locations of NHK radio stations, where symbol size represents the transmitter's power. A comparison of the two maps reveals a difference in signal distribution. While Free Signal radiates from transmitters in smooth and concentric gradients, Real Signal appears staggered and fragmented. Japan's rugged topography creates signal shadows, as a result nearby municipalities can experience vastly different reception quality. This spatial discontinuity is central to the identification strategy. The irregular variation in Real Signal provides the idiosyncratic exposure shocks necessary to identify the causal impact of radio on linguistic assimilation.

⁷ I thank for Benjamin A. Olken for sharing the customized software to calculate the signals.

⁸ Several major transmitters, such as the Tokyo station, operated two distinct channels. For these dual-transmitter sites, I include data only for the first channel. Historical records indicate that second channels began broadcasting later and accounted for significantly lower listening hours during the period of study (Nippon Hoso Kyokai Broadcasting Culture Research Institute, 1955).

[Figure 3 and Figure 4 around here]

3.3 Control Variables

3.3.1 Geographical Controls

I control for the logarithm value of the distance from each municipality to Tokyo. Figures 2 and 4 show that proximity to the capital correlates with both linguistic distance to the Tokyo dialect and stronger reception from Tokyo’s high-power transmitter. I also include controls for elevation and the terrain ruggedness index. They directly attenuates radio signals, and also isolates communities, hindering the social exchange that shapes linguistic diversity (Michalopoulos, 2012).

3.3.2 Economic Variables

I control for baseline economic conditions using data from the 1920 National Census (*kokusei chosa*).⁹ These pre-radio variables account for factors that likely influenced both the initial linguistic patterns and the strategic placement of radio infrastructure. I include the logarithm of population density. NHK prioritized placing transmitters in densely populated regions to maximize coverage. High density also fosters the social and economic interactions that can drive linguistic convergence. I further account for economic structure using labor force shares in industry and agriculture. Industrialized areas integrated more deeply into the national economy. These regions likely encountered the Tokyo dialect through trade and migration while attracting radio infrastructure investment. Conversely, agrarian regions were often more isolated, which could preserve local dialects and make them a lower priority for NHK.

3.3.3 Prefecture Fixed Effects

Finally, I include prefecture fixed effects to account for deep historical path dependence. While prefecture serve as modern prefectural boundaries following the 1871 administrative reforms, they largely align with the ancient provinces (*kuni*) that defined regional identities. The fixed effects absorb unobserved historical and cultural heterogeneity. My estimates therefore rely on within-prefecture variation in radio signal strength.

Table 1 presents the summary statistics of the main variables.

[Table 1 around here]

4. Empirical Strategies and Results

⁹ I obtain the digitized data from the [Historical Geography Data](#).

4.1 Baseline model

My empirical strategy is designed to examine the causal effect of radio exposure to NHK radio on linguistic assimilation. The main identification challenge is that radio signal strength is not random. To address this endogeneity, I estimate the following baseline specification:

$$LD_m = \alpha + \textit{Real Signal}_m + \textit{Free Signal}_m + \mathbf{X}_m + \sigma_p + \epsilon_m,$$

where LD_m is the linguistic distance to Tokyo dialect in 1950 for municipality m . $\textit{Real Signal}_m$ measures a municipality's real exposure to NHK radio in 1950. $\textit{Free Signal}_m$ serves as a counterfactual radio signal in 1950. By measuring signal strength over a hypothetical flat terrain, it proxies for the supply-side factors that determined radio stations' location and configurations. By including *Free Signal* in the regression, I control for the intended signal coverage of the NHK radio. The coefficient on *Real Signal* is therefore identified from the residual variation, the difference between the intended signal and the actual signal received. This difference is generated by the quasi-random attenuation of the signal by topographical features, such as mountains and hills, located along the transmission path. This identification strategy follows the method pioneered by Olken (2009). To ensure this variation is exogenous, I incorporate the full set of controls discussed in Section 3.3: geographic and economic factors $\mathbf{X}_m$, and prefectural fixed effects σ_p .

The validity of this identification strategy rests on a key assumption that after including controls, the Real Signal is uncorrelated with other unobserved factors that can influence linguistic distance to Tokyo dialect. While this assumption is inherently untestable, I provide empirical support by examining whether the identifying variation in the Real Signal is correlated with a wide range of observable characteristics. To do this, I follow Wang (2021) and conduct balance tests. I regress Real Signal on individual socioeconomic variables once at a time, including Free Signal as control. Table 2 shows that nearly all the examined coefficients are statistically insignificant. This lack of correlation demonstrates that once the intended signal coverage of NHK is captured by the Free Signal, the remaining variation in Real Signal strength is largely orthogonal to observable economic or demographic factors.

To confirm that the Free Signal control is performing its intended role of absorbing endogenous placement, I conduct a parallel analysis by regressing the Free Signal on the same set of socioeconomic variables, while controlling for the Real Signal. In contrast to the previous tests, many of these variables are significant predictors of Free Signal as shown in Table 2. Together, these findings supports the logic of the empirical design that Free Signal captures the non-random variation related to NHK radio signal, leaving the quasi-random topographical influence in Real Signal as variation to identify the causal effect of radio exposure on linguistic assimilation.

[Table 2 around here]

Table 3 presents the OLS estimates of the impact of NHK radio on linguistic assimilation. Across the first four columns, the dependent variable is the post-radio (1950) linguistic distance to the Tokyo dialect. Column (1) shows a negative correlation between Real Signal and linguistic distance with prefecture fixed effects included. In Column (2), I add Free Signal to implement my main identification strategy. The coefficient on Real Signal remains stable and significant, while the coefficient on Free Signal is near zero and statistically insignificant. My preferred specification in Column (4) includes the full set of geographical controls, economic conditions, and prefecture fixed effects. The coefficient on Real Signal is -1.731 and is statistically significant at the 1% level. This result indicates that one standard deviation increase of exposure to NHK radio significantly reduced a municipality's linguistic distance to Tokyo dialect by 1.73 points (approximately 3% of the mean).

[Table 3 around here]

Columns (5) and (6) in Table 3 present a placebo test to support a causal interpretation. This test addresses two concerns. First, it tests the parallel trends assumption by examining whether municipalities later receiving a strong radio signal were already linguistically closer to Tokyo before the radio era. Second, this test validates the apparent time construct. This assumption posits that an individual mainly acquires core linguistic features mainly

during the critical period of childhood, and these features remain stable throughout their life. This assumption allows for the use of atlas conducted after 1950 to reconstruct the pre-radio linguistic landscape.

I conduct this the placebo test by regressing pre-radio linguistic distance on the 1950 signal variables using the same specification as in Column (4) of Table 3. Column (5) uses the 1909 linguistic distance (from the LAJ) as the dependent variable, while Column (6) uses the 1926 linguistic distance (from the GAJ). In both columns, the coefficient on Real Signal is statistically insignificant. These null results support the absence of pre-existing trends, suggesting that the main finding is not driven by the strategic placement of radio stations in areas that were already converging with the Tokyo dialect. Besides, they validate the apparent time construct. A failure of this assumption would imply that post-1950 radio exposure altered the speech of older informants, generating a significant, negative coefficient on Real Signal.

4.2 Difference-in-Difference Estimation

To further address concerns about omitted variable bias, I employ a difference-in-differences (DiD) model. This approach allows me to control for any time-invariant unobserved characteristics at the municipality level. Constructing the required panel dataset first involves creating a consistent measure of linguistic distance over time. To achieve this, I identify and match 30 lexical items that were surveyed in both the pre-radio LAJ (1909) and the post-radio FPJD (1950). I exclude the GAJ atlas from this specific analysis because

its focus on grammatical data is incompatible with the lexical data. The LAJ and FPJD atlases directly overlap in 287 municipalities. I expand the sample by matching FPJD municipalities not surveyed in the LAJ to their geographically nearest LAJ counterparts. This process yields a two-period panel of linguistic distance to the Tokyo dialect, capturing the change in local dialect patterns from 1909 to 1950.

Table 4 reports the DiD estimates. I include the same set of control variables in the baseline model: geographic and economic controls, and prefecture fixed effects. But now I interact them with a post-period indicator to allow for time-varying impacts. With municipality and year fixed effects included, the coefficient on the Real Signal variable is statistically significant at the 10% level in Column (4) with a full set of controls. This result further supports the causal interpretation of my findings, suggesting that the NHK radio drove local dialect converging toward the Tokyo dialect.

[Table 4 around here]

4.3 Instrument Results using Radio Subscription Ratio

My previous results show that the NHK radio signal in 1950 reduced the linguistic distance to the Tokyo dialect. However, signal strength proxies for availability rather than actual consumption. To address this limitation and the potential endogeneity of radio subscription, I employ an instrumental variable (IV) strategy to isolate the causal effect of radio adoption on linguistic assimilation.

I measure actual exposure of NHK radio using the available 1947 radio subscription rate from the *Gyomu Tokei Yoran Showa 22 Nen* (Business Statistics Overview Showa Year 22) (Nippon Hoso Kyokai, 1947). The subscription rate is an equilibrium outcome determined by both supply and demand factors. For instance, household income or a pre-existing affinity for Tokyo culture can shape local demand. Such factors might independently influence linguistic assimilation and thus bias an LS estimate.

I instrument the subscription rate using the Real Signal and Free Signal in 1947. Table 5 presents the results. Column (1) reports the first-stage results. The coefficient on Real Signal is positive and significant at the 1% level, indicating that stronger radio signal led to higher radio subscription rate. Columns (2) and (3) provide OLS comparisons, and Columns (4) and (5) report counterpart IV second-stage results. My preferred specification is Column (5), which includes the full set of baseline controls. In this specification, the estimated coefficient on the radio subscription rate is negative and significant at the 5% level. This implies that higher radio subscription led to a reduction in linguistic distance to the Tokyo dialect, thereby accelerating national language standardization.

[Table 5 around here]

4.4 Robustness Tests

4.4.1. Additional Control Variables

Railway -- A concern is that the estimated effect of radio may be confounded by the influence of transportation networks. As suggested by Inoue (2019), the railway system played an important role in linguistic assimilation in Japan. By connecting cities and towns before the advent of radio, railways facilitated the movement of people and goods, which could have independently driven linguistic convergence toward the Tokyo dialect. If the radio signal was correlated with the existing railway network, my estimates might mistakenly attribute the historical effect of railways to radio.

To account for the historical influence of transportation infrastructure, I control for the duration of railway access. This variable represents the number of years a municipality with railway connection by 1926,¹⁰ which captures the accumulated exposure of a municipality to the integrating effects of the railway. As shown in Row (1) of Table 6, after including this railway control, the coefficient on Real Signal remains negative, statistically significant, and of a similar magnitude to the baseline estimate.

[Table 6 around here]

Migration -- Migration constitutes another potential driver of linguistic assimilation. The history of Hokkaido provides a compelling example of this channel. As illustrated in Figure 2, Hokkaido's dialect is close to the Tokyo dialect despite its significant geographical distance. Migrants from diverse regions settled the territory. These groups adopted standard Japanese to facilitate communication, rather than forming a distinct local dialect (Gottlieb, 2005). If radio signals were systematically stronger in areas with higher migrant populations, the baseline estimates could be biased.

To address this concern, I add the migrant ratio into the baseline regression. I define this as the share of a municipality's population that was not born locally using the data from the 1930 National Census.¹¹ Row (2) of Table 6 presents the results with additional control. The coefficient on Real Signal remains negative and significant, and its magnitude is consistent with the baseline result.

Education -- Government education policy presents another confounder. Compulsory schooling has historically been the important instrument for promoting a national language, as documented in France (Blanc and Kubo, 2025). Japan similarly concentrated early standardization efforts within the education system (Carroll, 1997). Therefore, the observed linguistic assimilation could be the result of schooling rather than radio exposure, especially if areas with better schooling also received stronger radio signals.

To isolate the effect of radio from the effect of education, I include my baseline model with a direct measure of the education system's success in language standardization. Specifically,

¹⁰ I obtain the railway data from the [National Land Data Download Site](#).

¹¹ I obtain the digitized data from the [Historical Geography Data](#).

I control for logarithm value of the share of conscripts who passed a standardized Japanese language test in 1931. The data is available at the district (*gun*) level from the *Sotei Kyoiku Chosa Gaikyo, Showa 6-nendo* (General Overview of the Education Survey of Conscription-Age Men, Year 1931) (Social Education Bureau (Ministry of Education), 1932). This variable provides a proxy of the local effectiveness of formal language education. Row (3) of Table 6 shows that after adding this control, the coefficient on Real Signal remains negative, statistically significant, and consistent in magnitude.

Radio Station Fixed Effects -- My baseline analysis assumes that the effect of NHK signal is uniform across all NHK transmitters. This assumption may not hold. Although NHK operated as a single national network, individual stations could vary in their specific programming, the accents of their announcers, or other characteristics. To address this, I introduce a set of radio station fixed effects to ensure the results are not driven by the influence of a few high-powered or particularly effective stations. Row (5) of Table 6 reports the results of this test. After including radio station fixed effects, the coefficient on the Real Signal remains negative, statistically significant, and nearly identical to the baseline result. This result shows that my findings capture an average impact of the NHK radio on linguistic assimilation, rather than the idiosyncratic effect of any single station.

Informants Characteristics -- The assumption of my measurement strategy, the apparent time construct, could be vulnerable to bias if the ages of atlas informants are not random. If municipalities with stronger radio signals systematically sampled younger informants, the estimates could mistakenly attribute a natural cohort effect to radio exposure. In such a scenario, younger generations might naturally adopt standardized dialect regardless of radio exposure. I address this by adding the average birth year of informants in each municipality as a control variable. The coefficient on Real Signal in Row (5) of Table 6 remains negative, statistically significant, and consistent in magnitude.

Finally, to ensure my main finding does not reflect some complex interaction between the various confounding factors, I estimate a specification that includes all additional controls simultaneously. This stringent test requires the Real Signal to maintain explanatory power while competing with the historical influence of the railway network, migration patterns, local educational efficacy, radio station fixed effects, and informant birth cohorts. Row (6) of Table 6 presents the results for this fully specified model. The coefficient on Real Signal remains negative, statistically significant, and stable in magnitude relative to the baseline estimate.

4.4.2 Sample

To ensure that my baseline results are not driven by unique idiosyncratic linguistic or historical characteristics of certain regions, I estimate the baseline model excluding several regions. Specifically, I conduct five sensitivity tests. Row (7) of Table 6 omits Okinawa where the Ryukyuan languages are distinct from mainland Japanese and so that the process of assimilation might have followed a different logic. Then, I remove Hokkaido (Row (8)).

This settlement frontier lacked a traditional dialect and naturally aligned with the standard language. Row (9) drops Tokyo, the linguistic source of the broadcast standard. Finally, I exclude Kyoto (Row (10)). As the former capital, Kyoto is the heart of the Kansai dialect, the only real cultural rival to Tokyo’s linguistic influence. Row (11) excludes all four regions simultaneously.

Across all these variations, the coefficient on Real Signal remains negative, statistically significant, and similar in magnitude to the baseline estimate. The stability across these sample modifications supports that the estimated effect of radio broadcasting is a general phenomenon, not driven by the inclusion of potentially unique region.

4.4.3. Other Methods to Measure Linguistic Distance

My main analysis relies on the Levenshtein distance to measure the linguistic distance between a local dialect and the Tokyo dialect. While recent literature widely adopts this approach (Ginsburgh and Weber, 2020; Dickens, 2021; Blanc and Kubo, 2025; Castiello, 2025), a valid concern is whether this string-editing distance accurately captures the real-world difficulty of communication. To address this concern, I demonstrate that my main result is robust to several alternative methods of constructing the linguistic distance.

First, instead of the Levenshtein distance, I construct a simple binary measure. This measure assigns a value of 1 if a local variant differs in any way from its Tokyo counterpart and 0 if they are identical. This tests whether the result is driven by the magnitude of the difference or by the presence of dialectal variation.

Second, I shift from written text to phonetic pronunciation, which better reflects the auditory nature of radio. I convert romaji inputs to IPA using the nearest matching and calculate two distinct distance measures: a phonetic Levenshtein distance and a PanPhon-based phonological distance (Mortensen et al., 2016). PanPhon provides a feature-based measure that quantifies the distance between sounds. Unlike standard Levenshtein distance, which treats all substitutions equally, PanPhon weights changes by articulatory similarity. PanPhon represents each phoneme as a vector of features defining place, manner, and voicing. For instance, the pair /p/ and /b/ yields a small distance because both are bilabial stops differentiated only by voicing. In contrast, /p/ and /f/ produce a large distance due to divergences in both place and manner. This feature-based approach constitutes the theoretically preferred measure. It directly tests whether local dialects evolved to sound like the Tokyo dialect.

Third, I refine the benchmark used for comparison. My main analysis uses the Tokyo dialect as the comparison because it serves as the basis for the broadcast standard. However, official standard Japanese (*hyojungo*) is a constructed norm. While it is heavily based on Tokyo dialect, it slightly differ from any single regional dialect, including the one spoken in Tokyo (Gottlieb, 2005). To account for this distinction, I recalculate the linguistic distance using this standard Japanese (*hyojungo*) as the benchmark instead of the Tokyo dialect.

Finally, I vary the aggregation method. My main analysis uses the average distance across all survey items. However, this average relies on a normalization procedure that could potentially smooth over important variations. As Ginsburgh and Weber (2016) notes, when comparing two dialects using the Levenshtein distance for multiple word pairs, there arises a necessity to calculate the aggregated distance. To ensure my results are not sensitive to this choice, I recalculate the sum of unnormalized distances. I then take the logarithmic transformation to address the right-skewed distribution of the aggregate distance.

The results from all five alternative measures from Row (12) to (16) in Table 6 show that the coefficient on Real Signal remains negative, statistically significant, and of a comparable magnitude to my main finding. This stability across a diverse set of measurements provides compelling evidence that the results are not driven by using a single definition of linguistic distance.

4.4.4. Standard Errors

My baseline model clusters standard errors at the prefecture level to account for unobserved factors common to municipalities within the same prefecture. However, since unobserved shocks may not follow political boundaries, I test the sensitivity of my inference using several alternative error structures. First, I compute simple heteroskedasticity-robust standard errors as a benchmark. Second, I account for spatial correlation by referring to Colella et al. (2023). I apply using three distance cutoffs: 50, 100, and 200 kilometers. Rows (17) through (20) of Table 6 report the results. The coefficient on Real Signal remains statistically significant across all specifications.

5. Heterogeneous Effects

The preceding analyses demonstrates that, on average NHK radio exposure reduced the linguistic distance to the Tokyo dialect. I am now investigating the mechanisms behind this effect by exploring its heterogeneity. I specifically examine whether mass media substitutes for alternative assimilation channels or complements them. Radio acts as a substitute if it generates a larger impact where alternative channels are weak. Conversely, it functions as a complement if it amplifies assimilation where alternative channels are strong. To distinguish between these possibilities, I estimate specifications that interact the Real Signal with specific municipal characteristics. These interaction terms test the pathways through which mass media shapes linguistic change.

Endowments -- Panel A of Table 7 show that radio's influence was greater where initial geographic and linguistic barriers to assimilation were higher. The interaction term between the Real Signal and the terrain ruggedness index is negative and statistically significant. This result indicates that the assimilation effect was stronger in more geographically isolated municipalities. Radio therefore acted as a substitute for physical isolation. Furthermore, the interaction with the initial 1909 linguistic distance to the Tokyo dialect

is negative, and statistically significant. This coefficient suggests that NHK radio had a more pronounced impact in municipalities where the local dialect was originally most distant from the Tokyo dialect.

Economic and Social Exchange -- Panel B of Table 7 shows that radio acted as a substitute for channels of economic and social exchange. The interaction term on the years of railway access by 1926 is positive and statistically significant. This indicates that the radio's assimilation effect was weaker in places with a longer history of established railway links. Similarly, the interaction with the share of the migrant population in 1930 is positive and significant. Radio exerted a smaller additional impact in areas already integrated through direct human contact. Together, these results provide evidence that mass media and direct human exchange are substitute pathways for linguistic assimilation.

Education -- In contrast to economic and social exchange, Panel C of Table 7 indicates that education and mass media are complements. The radio's assimilation effect was significantly stronger in municipalities with a higher share of conscripts who passed tests in standardized Japanese language and civilian knowledge. These results suggest that a curriculum focused on language and civic culture equipped people with the cognitive framework necessary to process and adopt the broadcast standard. Distinctively, the interaction with mathematics is statistically insignificant. This null result strengthens the finding that linguistically and culturally relevant education acted as a catalyst for media influence. While math skills may reflect general intelligence or economic development, they did not facilitate the adoption of the broadcast dialect.¹²

[Table 7 around here]

6 . Conclusions

This paper provides empirical evidence that mass media technology can drive cultural change by linguistic assimilation. I leverage linguistic atlases and the exogenous variation in radio signal propagation created by Japan's topological geography. I find that exposure to the NHK radio broadcasting significantly reduced the linguistic distance from local dialects to the Tokyo dialect between 1926 and 1950. Placebo tests using pre-radio data from 1909 and 1926 support that this convergence was not driven by pre-existing trends.

Beyond the average effect, this paper uncovers the specific mechanisms through which media shapes culture. The impact varied according to local endowments. First, radio acted as a substitute for physical infrastructure. The assimilation effect was stronger in rugged municipalities where railway access was limited. Airwaves effectively bridged cultural gaps where the transaction costs of physical travel remained high. Conversely, radio served as a

¹² These education measures represent the share of the population that passed specific subject tests during the 1931 conscription exam. The data are obtained from the *Sotei Kyoiku Chosa Gaikyo Showa 6-nendo* (General Overview of the Education Survey of Conscription-Age Men, Year 1931) (Social Education Bureau (Ministry of Education), 1932).

complement to human capital. Regions with higher education penetration experienced stronger linguistic convergence. While schools provided the formal rules of the standard language, radio provided the necessary daily exposure shock to solidify usage.

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Figures

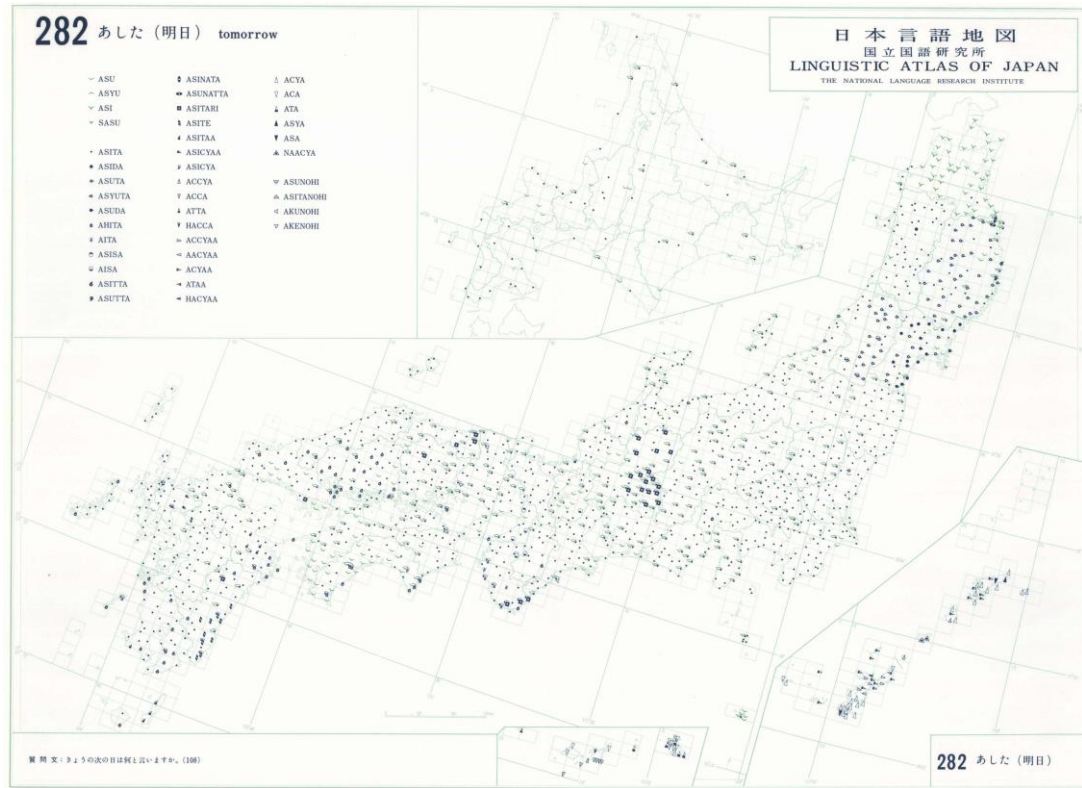


Figure 1. Map of ‘Tomorrow’ in the Linguistic Atlas of Japanese (LAJ)

Notes: This figure illustrates the geographic distribution of dialectal variants for the word ‘tomorrow’ (*asita* in the Tokyo dialect). The legend lists the phonetic variations recorded in Romaji. Each symbol on the map represents a specific survey location within Japan. The Linguistic Atlas of Japan (LAJ) sampled 2,209 municipalities, while the Field Research Project to Analyze the Formation Process of Japanese Dialects (FPJD) utilized a sparser sample of 543 municipalities.

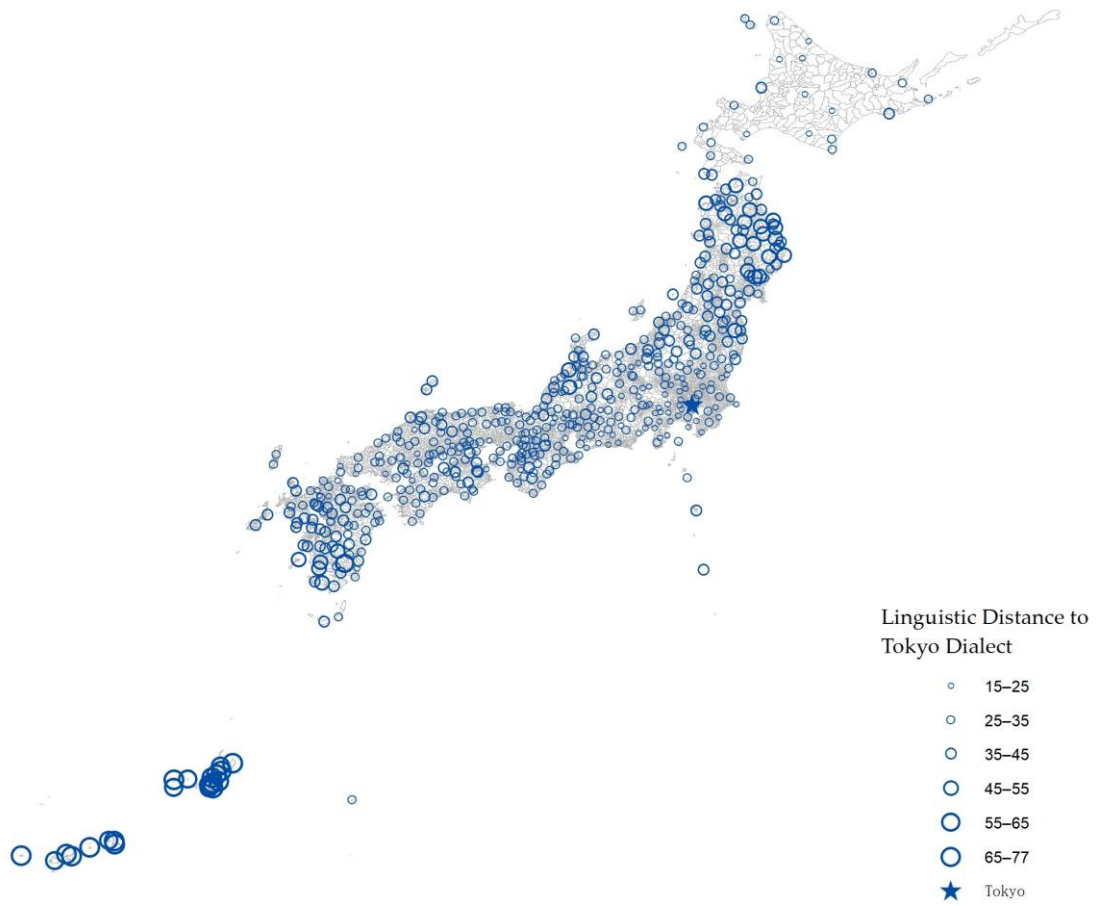


Figure 2. Linguistic Distance to the Tokyo Dialect in 1950

Notes: This graph illustrates linguistic distance to the Tokyo dialect in 1950 using the lexical items from Field Research Project to Analyze the Formation Process of Japanese Dialects (FPJD). A higher value represents the larger difference from the Tokyo dialect and vice versa. The blue star denotes the Tokyo region. The gray boundaries in the background show 10,467 municipalities in Japan in 1950. There are 543 municipalities in the FPJD sample.

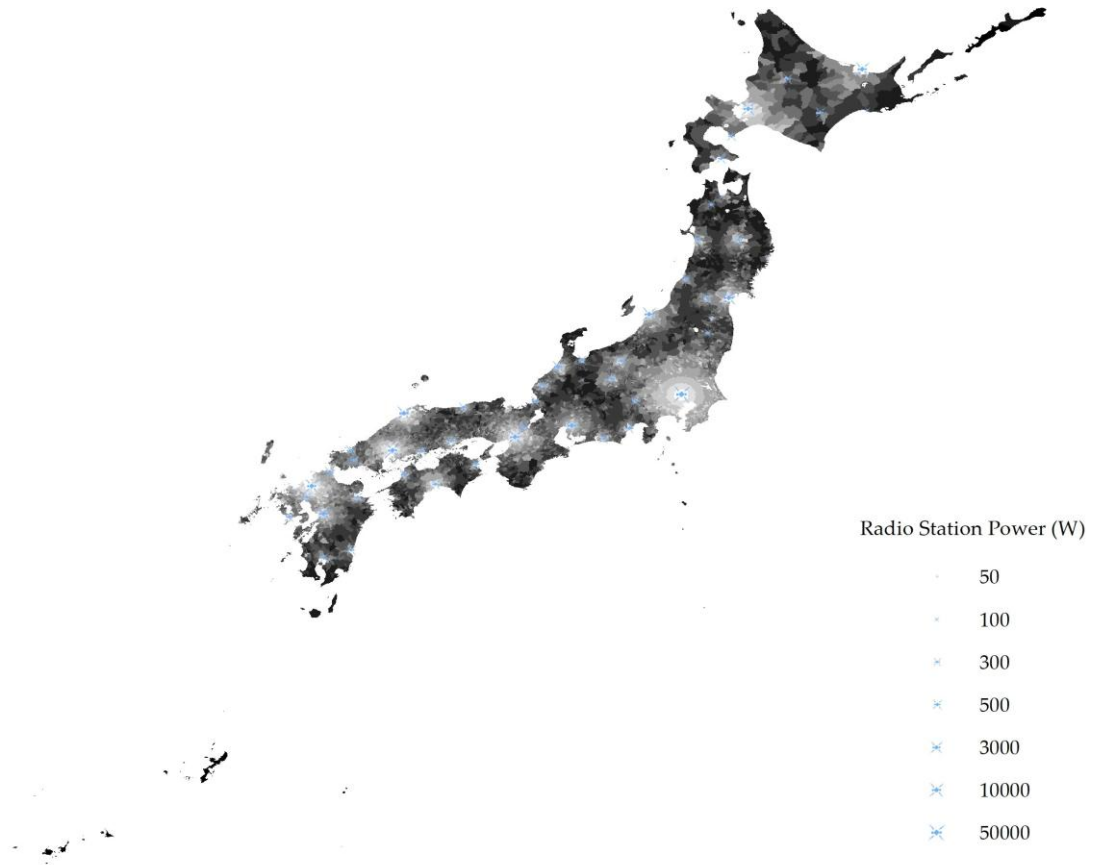


Figure 3: NHK Real Signal Distribution in 1950

Notes: This graph depicts the distribution of NHK Real Signal in 1950 for whole Japan. The light blue symbols denote radio stations, with larger symbols indicating greater radio power measured in watts (W). The background represents signal strength, with darker color indicating lower signal strength and lighter color indicating higher signal strength. The signal is calculated using the Irregular Terrain Model.

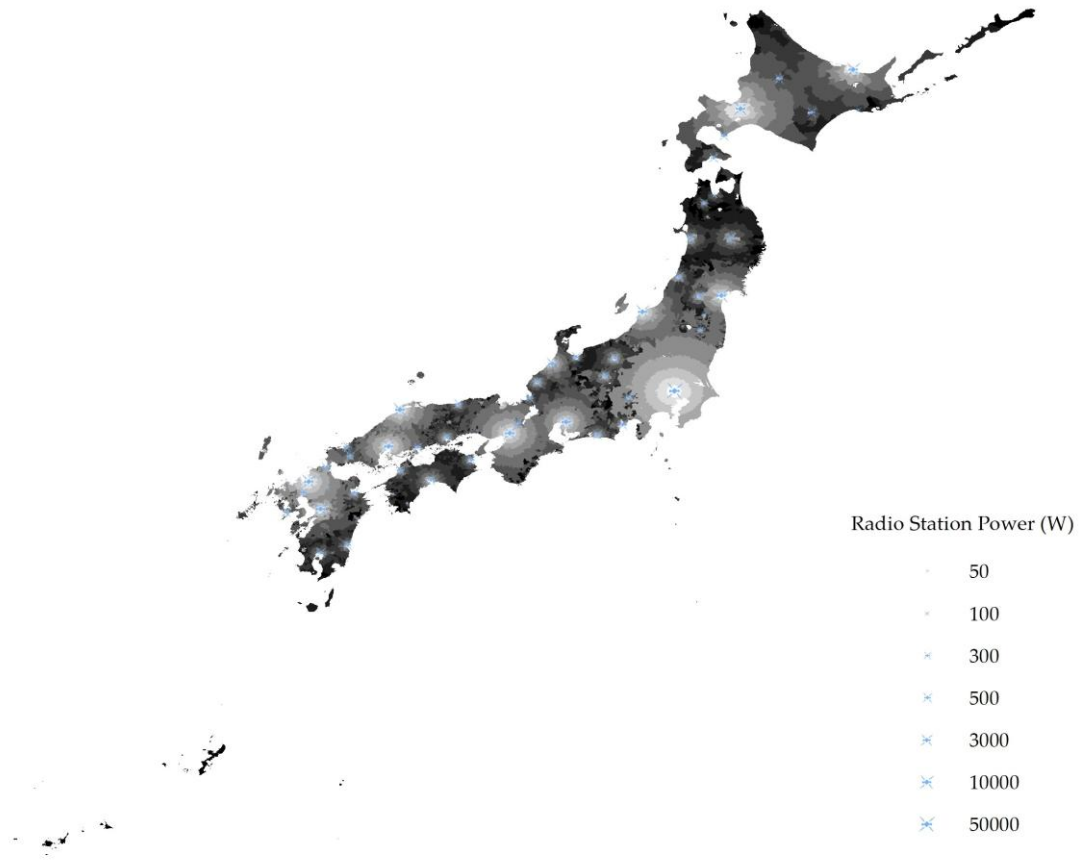


Figure 4: NHK Free Signal Distribution in 1950

Notes: This graph depicts the distribution of NHK Free Signal in 1950 for whole Japan. The light blue symbols denote radio stations, with larger symbols indicating greater radio power measured in watts (W). The background represents signal strength, with darker color indicating lower signal strength and lighter color indicating higher signal strength. The signal is calculated using the Irregular Terrain Model assuming propagation over flat terrain without geographical barriers.

Tables

Table 1. Summary statistics

	N	Mean	SD	Min	Max
Linguistic Distance to Tokyo Dialect 1950 (FPJD)	543	32.65	10.06	14.98	76.43
Linguistic Distance to Tokyo Dialect 1926 (GAJ)	543	43.37	8.95	19.08	75.03
Linguistic Distance to Tokyo Dialect 1909 (LAJ)	543	41.74	11.95	13.35	79.06
Real Signal (dBm)	543	-12.53	18.15	-103.79	34.71
Free Signal (dBm)	543	3.15	9.29	-19.13	37.81
Distance To Tokyo (km)	543	620.68	436.46	9.4	2355.11
Terrian Ruggedness Index	543	23.47	20.88	0	88.9
Elevation (m)	543	240.9	301.71	0	2344.19
Agriculture Share 1920 (%)	543	58.07	26.40	.42	95.9
Industry Share 1920 (%)	543	14.65	11.94	.78	71.56
Population Density 1920 (people/km2)	543	377.52	1529.01	.76	25812.74
Radio Subscription Rate 1947 (%)	543	30.99	16.34	0	88.58

Table 2: Correlation between NHK Signals and Pre-Existing Municipal Characteristics

	Real Signal (z-score)		Free Signal (z-score)	
	Coefficient	S.E.	Coefficient	S.E.
<i>Demographics (1920)</i>				
Population Density 1920 (logged)	-0.045	(0.018)**	0.123	(0.018)***
Population Growth Rate 1920–1930	0.000	(0.000)	-0.000	(0.000)
<i>Occupation Shares (1920)</i>				
Agriculture	-0.001	(0.001)	-0.002	(0.001)**
Fishery	0.004	(0.002)**	-0.009	(0.002)***
Mineral	-0.008	(0.008)	0.004	(0.005)
Transport	0.010	(0.007)	0.005	(0.007)
Industry	-0.001	(0.002)	0.009	(0.002)***
Business	0.002	(0.003)	0.012	(0.003)***
Public Service and Professionals	0.006	(0.005)	0.029	(0.007)***
Domestic Service	-0.000	(0.001)	0.003	(0.002)**
<i>Infrastructure</i>				
Years of Railway Access (by 1926)	0.001	(0.001)	0.012	(0.002)***

Notes: Each cell reports the coefficient from a separate OLS regression where the dependent variable is the signal strength measure indicated in the column header. The Real Signal specifications control for the Free Signal. The Free Signal specifications control for the Real Signal. Robust standard errors are in parenthesis for each separate regression. p<0.1, ** p<0.05, *** p<0.01

Table 3. Impact of NHK Radio on Linguistic Assimilation, OLS Estimates.

	Linguistic Distance to Tokyo Dialect					
	Post-Radio (1950)				Pre-Radio	
	(1)	(2)	(3)	(4)	(5)	(6)
Real Signal (z-score)	-2.110 (0.721)***	-2.113 (0.744)***	-1.784 (0.528)***	-1.731 (0.594)***	-0.408 (0.610)	-0.548 (0.772)
Free Signal (z-score)		0.003 (0.455)	0.606 (0.474)	0.658 (0.506)	0.012 (0.598)	0.647 (0.534)
Prefecture FEs	Yes	Yes	Yes	Yes	Yes	Yes
Geographical Controls			Yes	Yes	Yes	Yes
Economic Conditions				Yes	Yes	Yes
Observations	543	543	543	543	543	543
Adjusted R^2	0.723	0.722	0.735	0.735	0.834	0.832

Notes: The dependent variable, Linguistic Distance to Tokyo Dialect, is measured in 1950 (the post-period) using the Field Research Project to Analyze the Formation Process of Japanese Dialects (FPJD). Pre-period observations use data from the Linguistic Atlas of Japan (LAJ) for 1909 in Column (5) and the Grammatical Atlas of Japanese Dialects (GAJ) for 1926 in Column (6). Real Signal refers to the measured strength of the NHK radio signal in 1950, whereas Free Signal denotes a simulated signal strength in 1950 assuming propagation over flat terrain without topographical barriers. Geographical controls include a terrain ruggedness index, elevation and the logged distance to Tokyo. Initial economic conditions are measured in 1920 and include logged population density and the shares of the population in the agricultural and industrial sectors. Standard errors clustered at the prefecture level are reported in parentheses. There are 47 prefectures in Japan in 1950. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Impact of NHK Radio on Linguistic Assimilation, DiD Estimation.

	Linguistic Distance to Tokyo Dialect			
	(1)	(2)	(3)	(4)
Real Signal (z-score) $\times$ Post-period	-3.190 (0.827)***	-3.058 (1.404)**	-2.615 (1.372)*	-2.504 (1.431)*
Free Signal (z-score) $\times$ Post-period		0.258 (1.080)	1.024 (1.076)	1.101 (1.105)
Municipality FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Prefecture FEs $\times$ Post-period	Yes	Yes	Yes	Yes
Geographical Controls $\times$ Post-period			Yes	Yes
Economic Conditions $\times$ Post-period				Yes
Observations	1086	1086	1086	1086
Adjusted R^2	0.807	0.810	0.821	0.821

Notes: The sample is a panel of municipalities observed in 1909 and 1950. Post-period is an indicator variable equal to one for the year 1950, and zero for 1909. Linguistic Distance to Tokyo Dialect is measured by using the 30 lexical items common to both the Linguistic Atlas of Japan (LAJ) for 1909, and the Field Research Project to Analyze the Formation Process of Japanese Dialects (FPJD). Real Signal refers to the measured strength of the NHK radio signal in 1950, whereas Free Signal denotes a simulated signal strength in 1950 assuming propagation over flat terrain without topographical barriers. Geographical controls include a terrain ruggedness index, elevation and the logged distance to Tokyo. Initial economic conditions are measured in 1920 and include logged population density and the shares of the population in the agricultural and industrial sectors. All control sets are interacted with the Post-period indicator as specified in the table. Standard errors clustered at the municipality level are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Impact of NHK Radio on Linguistic Assimilation, Instrumented Results.

	Radio Subscription Rate	Linguistic Distance to Tokyo Dialect			
	(1)	(2)	(3)	(4)	(5)
Real Signal (z-score)	9.632 (2.497)***				
Free Signal (z-score)	-0.199 (1.632)				
Radio Subscription Rate		-0.095 (0.027)***	-0.046 (0.020)**	-0.164 (0.050)***	-0.106 (0.052)**
Prefecture FEs	Yes	Yes	Yes	Yes	Yes
Geographical Controls	Yes		Yes		Yes
Initial Economic Conditions	Yes		Yes		Yes
Observations	543	543	543	543	543
Adjusted R^2	0.676	0.724	0.734	0.717	0.731
Estimator	OLS	OLS	OLS	2SLS	2SLS
KP F-Stat.				59.94	42.64

Notes: Radio Subscription Ratio refers to the paid radio subscription rate in 1947. The instruments are the Real Signal and Free Signal in 1947. Real Signal refers to the measured strength of the NHK radio signal in 1947, whereas Free Signal denotes a simulated signal strength in 1947 assuming propagation over flat earth without topographical barriers. Geographical controls include a terrain ruggedness index, elevation and the logged distance to Tokyo. Initial economic conditions are measured in 1920 and include logged population density and the shares of the population in the agricultural and industrial sectors. Standard errors clustered at the prefecture level are reported in parentheses. There are 47 prefectures in Japan in 1950. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Robustness Tests of NHK Radio's Effect on Linguistic Assimilation

	Row	Coefficient	S.E.
<i>Panel A: Additional Controls</i>			
Years of Railway Access by 1926	(1)	-1.532	(0.646)**
Share of Migrant Population 1930	(2)	-1.669	(0.592)***
Share of Qualification in Standard Japanese 1931	(3)	-1.733	(0.673)**
Informants' Average Birth Year	(4)	-1.725	(0.619)***
Radio Station Fixed Effects	(5)	-2.574	(0.709)***
Include All Five Additional Controls	(6)	-2.576	(0.818)***
<i>Panel B: Sample Change</i>			
Exclude Tokyo	(7)	-1.496	(0.666)**
Exclude Okinawa	(8)	-1.576	(0.639)**
Exclude Hokkaido	(9)	-1.874	(0.596)***
Exclude Kyoto	(10)	-1.787	(0.602)***
Exclude All Four Prefectures	(11)	-1.530	(0.699)**
<i>Panel C: Linguistic Distance Calculation</i>			
Binary Distance	(12)	-2.502	(1.031)**
IPA Levenstein Distance	(13)	-1.752	(0.579)***
IPA Phanphone Distance	(14)	-0.983	(0.303)***
Standard Language as Comparison	(15)	-1.418	(0.696)**
Aggregate Levenstein Distance	(16)	-0.021	(0.010)**
<i>Panel D: Standard Error</i>			
Robust Standard Errors	(17)	-1.731	(0.940)*
Spatial Correlation (50km)	(18)	-1.731	(0.887)*
Spatial Correlation (100km)	(19)	-1.731	(0.812)**
Spatial Correlation (200km)	(20)	-1.731	(0.783)**

Notes: Each row represents a separate regression addressing the robustness check introduced in the main text. The reported coefficients and standard errors correspond to the Real Signal (z-score) variable. Each regression controls for: Free Signal, geographical controls, economics controls and prefectural fixed effects. Real Signal refers to the measured strength of the NHK radio signal in 1950, whereas Free Signal denotes a simulated signal strength in 1950 assuming propagation over flat terrain without topographical barriers. Geographical controls include a terrain ruggedness index, elevation and the logged distance to Tokyo. Initial economic conditions are measured in 1920 and include logged population density and the shares of the population in the agricultural and industrial sectors. Standard errors clustered at the prefecture level are reported in parentheses in Panel A, B, and C. There are 47 prefectures in Japan in 1950. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Heterogeneous Analyses of NHK Radio's Effect on Linguistic Assimilation

Interaction between Real Signal (z-score) and:	Row	Coefficient	S.E.
<i>Panel A: Endowments</i>			
Terrain Ruggedness Index	(1)	-0.026	(0.013)*
Linguistic Distance to Tokyo Dialect 1909	(2)	-4.766	(2.346)**
<i>Panel B: Economic and Social Exchange</i>			
Years of Railway Access by 1926	(3)	0.05	(0.028)*
Share of Migrant Population 1930	(4)	0.045	(0.013)***
<i>Panel C: Education</i>			
Standard Japanese Pass Rate 1931	(5)	-2.436	(1.363)*
Civilian Knowledge Pass Rate 1931	(6)	-1.648	(0.847)*
Math Pass Rate 1931	(7)	-0.68	-1.068

Notes: Each row represents a separate regression. The reported coefficients and standard errors correspond to the interaction term between the variable examined in that row. Each regression controls for the main effects of Real Signal (z-score) and the examined variable, as well as Free Signal, geographical controls, economics controls and prefectural fixed effects. Real Signal refers to the measured strength of the NHK radio signal in 1950, whereas Free Signal denotes a simulated signal strength in 1950 assuming propagation over flat terrain without topographical barriers. Geographical controls include a terrain ruggedness index, elevation and the logged distance to Tokyo. Initial economic conditions are measured in 1920 and include logged population density and the shares of the population in the agricultural and industrial sectors. Standard errors clustered at the prefecture level are reported in parentheses. There are 47 prefectures in Japan in 1950. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.