Spread the Word: Mass Media, Language and Propaganda in Fascist Italy*

Maxence Castiello†

Job Market Paper

Click here for the latest version

March 12, 2026

Abstract

This paper provides microeconomic evidence on the effect of radio exposure on language convergence and cultural homogenization. Building on archival data on radio station transmitters, I focus on the expansion of a politically-controlled radio network in fascist Italy. I combine predicted measures of radio signal strength with metrics of linguistic convergence computed using a unique collection of over one million linguistic entries. Exploiting quasi-random variation in radio exposure due to spatial differences in ground conductivity, I provide causal evidence on both signal strength and duration of coverage positively shaping the process of linguistic homogenization. Regarding possible mechanisms, I find that regions distant from the political capital, literacy rate and business-related occupations were key drivers of language convergence. Conversely, breaking down the linguistic metrics by word characteristics yields only slight differences when accounting for lexical frequency or restricting to politically-oriented words. Additionally, I explore the persuasive effects of propaganda on political attitudes and cultural norms, documenting a weakening of political opposition underlying radio exposure. Last, I providence evidence of positive effects of fascist radio coverage on fertility rates, with heterogeneous results suggesting that linguistic proximity to the broadcasting language plays a significant role in determining the effectiveness of propaganda absorption.

Keywords: Mass Media, Radio Exposure, Language Convergence, Propaganda, Fertility

JEL Classification: J13, L82, N34, N44, Z13.

*The Online Appendix of the paper can be found here. I am particularly grateful to Clément Bosquet for his continued support and dedicated supervision. This research has benefited from comments and suggestions by Guillaume Blanc, Julia Cagé, Mario Carillo, Antonio Ciccone, Elisabetta De Cao, Giuseppe De Feo, Sarah Flèche, Giacomo Gabbuti, Massimiliano Gaetano Onorato, Elona Harka, Sophie Hatte, Jean Lacroix, Sara Lazzaroni, Fabio Mariani, Nicola Mastrorocco, Andrea Matranga, Giuseppe Musillo, Jan Pierskalla, Giovanni Prarolo, Thomas Renault, Gianluca Russo, Hans-Joachim Voth and all the attendants of the CES Young Researcher Seminar, Bologna Economic History Reading Group, PSE Applied Economics Lunch Seminar, 8th Economics of Media Bias Workshop, 2025 ADRES Job Market Conference, 2025 EHS Annual Conference, 20th Doctorissimes Conference, 17th UniTo-CCA PhD Workshop, 2024 Junior Workshop ENS Lyon, 2024 ARiSE Conference, 2024 ASC Conference, the AYEW Political Economy Workshop and the Virtual Workshop on Virtual Authoritarian Regimes. Additionally, I am thankful to Sergio Buonomo, for sharing the CCRI shapefile; Goebl Hans, for sharing the Salzburg Dialectometry data; Matteo Rivoira and the Atlante Linguistico Italiano for giving me access to the ALI archives and data; and to Graziano Tisato, for sharing the AIS data. Funding from the AAP CES 2024 is gratefully acknowledged. All errors are my own.

†Université Paris-1 Panthéon-Sorbonne, Centre d'Économie de la Sorbonne, 106-112 boulevard de l'Hôpital, 75642 Paris. Email: maxence.castiello@univ-paris1.fr.

1 Introduction

"We have made Italy. Now we must make Italians." Massimo d'Azeglio, 1867[1]

Cultural homogenization is an important step towards the formation of a nation-state (Tilly et al. [1975]; Hobsbawm [1992]). To this end, mass media is an instrumental tool mobilized by governments and elite to bolster the assimilation process. This cultural transition occurred alongside the spread of new media technologies, which have substantially shaped political opinions and cultural values. History is replete with instances of mass media under the control of governments, intended to mold individual identities and steer them towards a unified narrative.[2] A primary effect of mass media exposure is the standardization of language, one of the fundamental elements of a common culture (Cantril and Allport [1935]; Arnheim [1936]; Adorno [1945]; Alesina and Reich [2015]).[3] While the political and cultural responses to media coverage have received consequential attention in the economic literature, little is known on the effect of mass media on language homogenization.[4]

This paper explores how mass media exposure shapes cultural homogenisation through language convergence. The fascist period in Italy (1922-1943) offers a privileged setting to study this question. Despite the adoption of a common language after the political unification in the 1860s, a multitude of local languages and dialects still coexisted in the country when Mussolini came to power (1922). Consequently, the regime engaged an intense *italianization* of society, actively fighting linguistic diversity and minorities. To this regard, the fascist authorities mobilized all the available mass media to promote the standard Italian, including the nascent radio technology (Thompson [1991]). Radio programs were exclusively broadcast in Italian, serving as a pervasive tool for disseminating the common language. Despite the significant role of radio as homogenizing force, there is no empirical assessment of radio exposure on linguistic convergence.

[1] Quote from the autobiography of Massimo d'Azeglio, one of the leading voices of the political unification of Italy.

[2] Recent examples illustrate the continued use of mass media as an instrument of linguistic nation-building. In China, official policy calls for the use of Mandarin (Putonghua) in "news and publications, radio, film and television", including in regions with significant linguistic minorities, as part of a broader national unity agenda (Los Angeles Times, December 1, 2021). Similarly, Ukraine introduced legislation mandating that at least 75% of television and radio broadcast time be in Ukrainian, as part of a broader ukrainization policy (Le Monde, September 27, 2017).

[3] [Arnheim, 1936] already noted that "*there is an unmistakable tendency towards greater unity of language. [...] Modern culture also necessarily tends to reduce provincial dialects to one unified language, generally artificially created. The reactions of various governments to this phenomenon are very mixed; while in Italy dialect is opposed to-day as a decentralising factor.*"

[4] See DellaVigna and La Ferrara [2015] and Enikolopov and Petrova [2017] for reviews of the economic, political and social effects of mass media.

The creation and expansion of a unique and politically-controlled radio network during this period provide an ideal experimental framework to document these effects. First, radio broadcast faced little competition from other mass media, as newspapers were exclusive to literate individuals and sound film slowly overtaking silent movie only from the mid-1930s. Second, the physics of radio wave propagation allows for deriving quasi-exogenous variation in radio coverage due to ground-based differences; a crucial feature for establishing causal radio effects. For this purpose, I have collected newly-available archival data on the annual location and technical specifications of radio station transmitters. I combine this information with geographic characteristics to model radio signal strength across time and space, which has been identified as a strong predictor for the actual audience size.

I complement the predicted measures of radio exposure with unique data on linguistic homogenization, available for a representative sample of Italian municipalities. Building on the time feature of two linguistic surveys, I construct a novel index of language convergence, which is defined as the difference in the local linguistic distances to Italian, measured before and after the expansion of radio broadcasting. Following a methodology akin to that of Blanc and Kubo [2023], the metrics of linguistic distance are computed using a rich collection of over one million phonetic entries, each one representing the dialectal equivalent of thousands of concepts and expressions.

My empirical strategy aims to derive the causal effects of exposure to the fascist radio on language convergence. Given the strategic placement of antenna transmitters to maximize audience, the reception of fascist broadcasts may have been correlated with other determinants of language convergence. To alleviate this concern, my identification strategy draws from previous research to leverage plausibly exogenous variation arising from the physics of radio propagation (Olken [2009]; Yanagizawa-Drott [2014]). Specifically, I build on the fact that the propagation of amplitude modulation (AM) ground waves is primarily influenced by ground conductivity, which widely varies across Italian municipalities. Controlling for the distance to the radio transmitter and the local ground characteristics, I exploit the quasi-random variation in radio exposure resulting from variations in the electrical characteristics along the signal transmission path. I provide empirical support to the key identification assumption that, conditional on the radio propaganda covariates and an extensive set of regional fixed-effects, the variation in radio exposure is as good as random. Precisely, results from a series of balance and placebo tests show that radio exposure is uncorrelated with a large

set of municipality characteristics and past measures of linguistic distance, after accounting for the radio controls and regional fixed-effects.[5]

The main result of the paper suggests that exposure to the fascist radio network spurred cultural homogenization through language convergence. Municipalities with greater access to radio broadcasts experienced higher levels of linguistic homogenization. Specifically, a 1 standard deviation increase in radio signal strength is associated with a 0.6 standard deviation rise in the index of language convergence, which is equivalent to a one-letter change in a word of twenty-three letters. Estimates from an alternative difference-in-different specification and an placebo exercise provide additional support to these baseline results. Additional results show that radio exposure had a substantial impact on all aspects of language, from wording to pronunciation, with effects observed both in the breadth of coverage and the duration of exposure. I further rule out findings' sensitivity to the estimation process, providing an extensive set of robustness checks.

Turning to the potential mechanisms, I present suggestive evidence that the convergence process primarily occurred in linguistic regions distant from the political capital and featured with low levels of national identity, even after accounting for the initial distance to Italian. Literacy rates and the share of business-related occupations also played a substantial role, shaping individuals' capabilities and incentives to acquire a new language. Building on the rich set of atlas words underlying the linguistic metrics, I examine language adoption through word-level characteristics. First, I test the role of everyday vocabulary—more likely to appear in broadcasts—by weighting atlas words according to their lexical frequency derived from a large Italian web corpus. Second, I assess the influence of propaganda-oriented content by restricting the analysis to words used in Mussolini's speeches. Across both approaches, results indicate that while common and politically charged words contribute to convergence, they cannot by themselves account for the overall effect.

Radio programs were exclusively broadcast in Italian, with a content largely politically-driven to the aim of diffusing the Fascist ideology. Consequently, the two final sections of the paper investigates the mass persuasion effects of propaganda to determine whether mass media can influence not only political opinions but also cultural behaviors and values. I first assess the effects on radio propaganda on political persuasion and activity using administrative records on political opponents

[5]Following Yanagizawa-Drott [2014], the radio propagation controls are: latitude, longitude, their interaction, and second-order polynomials in municipality mean conductivity, municipality conductivity variance, relative permittivity and distance to the nearest radio transmitter.

and individuals classified as subversive. Exploiting the staggered expansion of the radio network in an event-study fashion, I find that surveillance rates declined with radio coverage, a pattern driven by a reduction in the opening of new records. However, this short-run evidence of diminished observed opposition to Fascism does not translate into persistent differences in postwar electoral outcomes or long-run political preferences in municipalities more exposed to radio-diffused Fascist propaganda.

Second, I turn to the radio effects on social norms, focusing on a large and long-lasting media campaign which supported the national call for increasing natality, also known as the *Battle for Births*. Relying on annual measures of birth rates at the province level, I employ a dynamic differences-in-differences approach with heterogeneous-robust estimating methods to investigate population dynamics associated with radio exposure (Callaway and Sant'Anna [2021]; De Chaisemartin and d'Haultfoeuille [2024]). The coefficient estimates show a positive and cumulative effect of fascist radio coverage on fertility decisions and point to the absence of pre-trend prior to treatment. To explain the success of propaganda, I explore heterogeneity by the local linguistic proximity to Italian. Results appear to be driven by regions with a better initial understand of Italian, which suggests that the broadcasting language plays a significant role in determining the effectiveness of propaganda absorption and shaping individuals' behaviors and values.

Overall, this paper contributes to several strands of the literature. First, it provides new insights into the economics of language. If the origins and consequences of language diversity have recently received considerable attention (Falck et al. [2012]; Fenske and Kala [2021]; Blouin and Dyer [2021]), the process of language homogenisation remains largely overlook.[6] Notable work in this field includes [Blanc and Kubo, 2023], who provide evidence of the positive effects of state-sponsored education on the adoption of a common language in France. Building upon analogous data sources from a different country, I aim to demonstrate the concurrent impact of AM radio on the process of linguistic homogenization in Italy (Bracco et al. [2015]; Lecce et al. [2022]; Dominici et al. [2024]).

By shedding light on the role of radio on the linguistic homogenisation of Italy, this paper adds to a substantial body of literature exploring the political and cultural effects of media. Previous studies have demonstrated that media serves as a potent tool mobilised by governments and individuals to shape group opinions and attitudes. From the earliest form of mass media, newspapers, which played

[6] See the recent work from [Ginsburgh and Weber, 2020] for a complete review of this literature.

a significant role in the nascent nation-building process, to the advent of new technologies such as radio, cinema, television, and more recently, the internet, media has been widely employed across various contexts to exert over political and cultural influence.[7] To this regard, radio exposure has been identified as a substantial driver in the adoption of both regional (Lemoli [2023]) and foreign languages (Argan and Cheysson [2023]). Similarly, while the literature has considered a range of media technologies, a more recent strand focuses specifically on medium-wave (AM) radio transmission and the underlying variation in ground conductivity (Russo [2020]; Armand et al. [2023]). Building on idiosyncratic variation in radio exposure, I contribute to this literature by estimating the causal effect of media on the diffusion of a common language and the weakening of political opposition within a culturally-fragmented country.

Focusing on Mussolini's targeted priority to enhance fertility rates and position Italy as a demographic powerhouse, I provide novel evidence on the role of media in positively influencing fertility rates. This study builds upon prior research examining the impact of various media forms on fertility rates, including western television (Jensen and Oster [2009]; Bönisch and Hyll [2023]), entertainment shows (Ferrara et al. [2012]; Kearney and Levine [2015]), and newspaper trial coverage (Beach and Hanlon [2019]). Two related studies have specifically investigated the positive effects of massive radio-air radio broadcasts on shaping fertility behaviors, respectively in Japan and India (Okuyama [2021]; Rusche [2025]). Taken together, these studies emphasize the importance of integrating norms and cultural factors to enhance the comprehension of fertility dynamics.

Centering on the interwar era, this study contributes to the economic history of policies implemented by the Fascist regime. While previous economic literature has explored three of the four *Battles* targeted by the government (Carillo [2021]; Carillo [2022]; Dominici et al. [2024]), I provide novel evidence on the fertility-focused policies enacted by interwar-authoritarian regimes, complementing analogous work on this period [Baudin and Stelter, 2023].[8]

The remainder of this paper is organised as follows. Section 2 provides an overview on the

[7] Precisely, media have shown to be used to influence voting behaviors (Enikolopov et al. [2011]; Adena et al. [2015]; Garcia-Arenas [2016]; Wang [2021a]; Cannella and Magnaricotte [2024]), identity formation (DellaVigna et al. [2014]; Blouin and Mukand [2019]; Ang [2023]; Esposito et al. [2023]; Ahmed et al. [2025]), and cultural values (Russo [2020]; Khalifa [2022]; Armand et al. [2023]). Mass persuasion has been identified as a powerful determinant of herd instinct, whether in bolstering mass killings (Yanagizawa-Drott [2014]; Ou and Xiong [2021]), social movements (Gagliarducci et al. [2020]; Wang [2021b]) or rebel demobilization [Armand et al., 2020].

[8] Relevant papers also include those by [Acemoglu et al., 2022], who analyze the emergence of Italian Fascism, and [Gagliarducci et al., 2020], who investigate resistance to it.

historical radio development and cultural homogenisation process in post-unified Italy. Section 3 describes the data collection and construction processes. Section 4 details the empirical strategy. Section 5 presents the results on language convergence underlying radio exposure. Section 6 and Section 7 respectively document the propaganda effects on political activities and family outcomes. Section 8 concludes.

2 Background

2.1 The process of linguistic homogenisation in Italy

With the proclamation of the Kingdom of Italy in 1861, the Italian peninsula completed a large part of its political unification, which would not be achieved until the annexation of the Papal States in 1870. The political unification process had be followed by the cultural unification of a country composed of a multitude of regionalisms and languages. Local languages were still widely used, with significant variations both between and within regions. From a national perspective, the language had the task of overcoming the old regional particularisms and establishing the basis of a common cultural identity for the Italian people. In this regard, the Piedmontese elite instituted a commission in charge of defining the new unified and administrative language of the country [Raffaelli, 2006]. The work of the commission, chaired by Alessandro Manzoni, resulted in a report entitled *Dell'unità della lingua e dei mezzi di diffonderla* (1868), in which Manzoni identified a contemporary and simplified form of the Florentine as the linguistic model of reference.[9] This language was selected following the geographical centrality of Tuscany, the legacy of Tuscan authors in the Italian literature and its existing popularity among the elite. Alessandro Manzoni had already initiated the dissemination of a simplified version of this local language with his popular novel, *I promessi sposi*, published in 1842 (Duggan [2008]; Pécout and Balzani [1999]).[10]

While the Italian language was established during the Risorgimento, the language was yet very little spread throughout the territory. Despite the absence of official statistics, several historians have tried to quantify the number of Italian speakers at the time of the political unification. De Mauro's calculations point to a very limited number of *Italian-speaking* individuals (less than 2.5% of

[9] The report title can be translated as "On the Unity of Language and the Means of Spreading It".
[10] Manzoni's novel title can be translated as "The Betrothed".

Italians), widely due to low literacy rates (78% of illiterates nationally) [De Mauro, 2017]. According to Castellani's estimate [Castellani, 1982], however, the percentage of people capable of speaking Italian was at least 10%, with many to be found in Tuscany, but also in other central parts of the peninsula [Trifone et al., 2017].

The new Italian state promoted linguistic homogenization, first through schooling, with the Coppino law (1877), which introduced compulsory schooling in primary school and defined sanctions for parents of pupils who did not comply with this obligation, and the Orlando law (1904), which extended compulsory schooling up to the age of 12. Likewise, a combination of multiple factors supported the spread of the Italian language among the population, including the urbanisation and industrialisation processes, the introduction of compulsory military service, the strengthening of a centralized bureaucracy, and the advent of national mass media [De Mauro, 2017].

Mussolini's rise to power marked the onset of an era characterized by the enforced Italianization of society. This involved the promotion of standard Italian while actively fighting linguistic diversity, including linguistic minorities, dialects and foreign influences. The regime adopted repressive measures against speakers of minority languages in border areas (*alloglotti*), viewing regionalism as antithetical to the Fascist national ideology. Similarly, foreign words in use are systematically replaced with their Italian equivalents. To bolster the linguistic homogenization process, the emerging mass media, notably radio, became instrumental [Isola, 1998]. Government-controlled radio broadcasts were strictly conducted in Italian, serving as a pervasive means to disseminate the national language. Radio programs, such as *La lingua d'Italia* in 1938, not only addressed listeners' linguistic queries but also served as a model for non-dialectal pronunciation across various regions and social strata. The EIAR gradually came to recognize the predominant role of radio broadcasting as a decisive linguistic authority, shaping spoken Italian more effectively than newspapers, books, theater, or cinema, despite its relatively limited technical resources [Fochi, 1990]. Building on this awareness, the radio authority commissioned the linguists Giulio Bertoni and Francesco Ugolini to compile the "*Prontuario di pronunzia e di ortografia*", the first official manual designed to standardize radio diction for broadcasting professionals [Giulio and Francesco, 1939].[11] Though intended as a clear normative reference, the guide immediately provoked controversy for privileging Roman pronunci-

[11] Giulio Bertoni is also the lead author of the "*Atlante linguistico italiano (ALI)*", which serves as primary source to measure linguistic convergence in this study [Bertoni, 1925].

ation over the traditionally established Florentine model of standard Italian. This concerted effort ensured that radio exposure became a pivotal mechanism for language standardization throughout the Interwar period [De Mauro, 2017].

2.2 Radio during the fascist period

If Italy is one of the technological cradles of radio, the official commencement of radio history in the peninsula dates back to 1924, at the eve of Mussolini's regime. The Italian government established a radio monopoly by conferring exclusive control over the network infrastructure and broadcasting to a public entity, the *Unione Radiofonica Italiana (URI)*. Radio's narrative became intricately interwoven with that of Fascism, with URI inaugurating its broadcasts on October 6, 1924. Its sole source of information was the Stefani press agency, directly overseen by the government. In 1928, URI was succeeded by the *Ente Italiano Audizioni Radiofoniche (EIAR)*, entrusted with revitalizing radio as a paramount propaganda instrument [Maraschio, 2011].

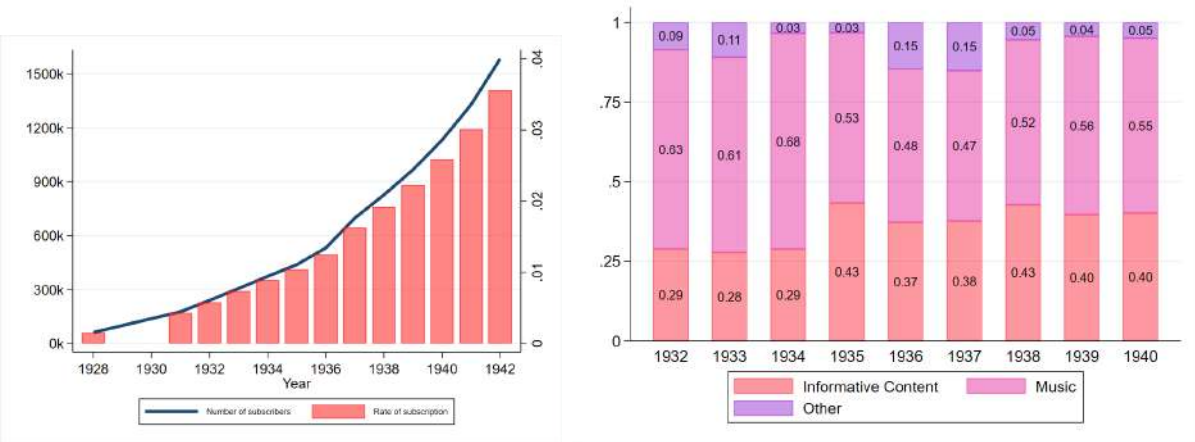
The EIAR became quickly popular, despite the fact that a large proportion of the population could not afford to have a radio in their homes.[12] Instead, public venues such as bars and communal spaces became hubs for collective listening. Fascist propaganda also encouraged the spread of loudspeakers linked to radio devices, broadcasting the *Duce*'s speeches to public squares across the country. With the *Radiorurale* project in 1933, radio was broadcast in all schools in Italy and allowed many students to deepen their knowledge of the Italian language. Concurrently, affordable radio sets began to be marketed at lower prices, available for purchase in installments, and without subscription fees. For instance, the Fascist regime launched in April 1937, a device known as *Radio Balilla* that was relatively affordable price and could be paid for in eighteen installments [Cannistraro, 1975].[13] Home listening became widespread, profoundly changing the habits of listeners, and consequently influencing their language, thanks to highly popular broadcasts [Monteleone, 2013]. Data from the Annual Statistical Yearbooks reveals the growing popularity of radio, as evidenced by the continuous rise in the national subscription rate and the number of the number of one million radio subscribers reached on the eve of World War II (Figure 1a).

[12] Radio was originally considered as a luxury product, mainly accessible to urban elite who only could afford the purchase of the radio device and the associated taxes for license fee.

[13] In 1925, the price of a radio receiver ranged from 2,000 to 10,000 liras, but by the mid-1930s, this cost had dropped to less than 400 liras [Galdi et al., 2010].

The combination of collective and private listening, with programs tailored for mass audiences, has elevated radio to a pivotal role in the lives of Italians. A post-World War II survey by the *DOXA* polling institute revealed that over 80% of respondents listened to radio daily, emphasizing its pervasive presence in Italian society [Luzzatto Fegiz, 1966].[14]

The Fascist regime swiftly identified radio as a preferred medium for disseminating its nationalist, anti-dialectic and xenophobic propaganda, progressively increasing its use of EIAR broadcasts for this purpose. In 1931, approximately 22% of EIAR radio programs were overtly propagandistic in nature. By 1938, this proportion had risen to 33% [Cannistraro, 1975]. Data from the Annual Statistical Yearbooks corroborates this trend towards increasingly politicized content in broadcasts (Figure 1b). As an example, the popular show *Cronache del Regime* was established in 1933, with the aim of shaping listeners' opinions on political and economic news.



(a) Radio Subscription Over Time in Italy

(b) Radio Programmation Over Time in Italy

Figure 1: Radio development during the Interwar period in Italy

Notes: Panel (a) shows the number of radio subscribers and the national subscription rate in Italy between 1928 and 1942. Panel (bl) shows the evolution of the radio content in Italy between 1932 and 1940. Informative content relates to the spoken-word programs including news, conferences, conversations, recitals, ceremonies or targeted programs (militaries, farmers, children). Music relates to all types of musical programs such as opera, orchestra, chamber music, music records, sacred music or choirs. Other includes advertisement and unspecified content. The source is the *Annuari Statistiche Italiani*.

[14]Similarly, a national-representative survey conducted by ISTAT in 1958 underscored the profound impact of radio on daily routines. With 72.3% of listeners, radio is the most-used medium in Italy in this period, still more popular than television or cinema. This figure shows little variations across social occupations and geographic regions, stating in favor of the "social revolution" brought by radio [De Mauro, 2017].

3 Data

3.1 Radio exposure

This paper aims at assessing the cultural effects of radio exposure during the fascist period in Italy. Because information on the number of radio ownerships or subscriptions is not available at a disaggregated level, I follow a common approach in the literature which relies on predicting radio signal strength to develop a local measure of radio exposure (Durante et al. [2019]; Wang [2021a]).[15] Radio signal strength can be modelled in several ways, but necessarily requires information on radio transmitter characteristics, receiver characteristics and local geophysical characteristics.

The first radio broadcasting technology in Italy used amplitude modulation (AM) transmissions, operating on short wave and medium wave frequencies. In this study, I solely focus on medium waves, which use ground waves for spatial propagation and are primarily responsible for local variations in signal quality (Levis et al. [2010]; Russo [2020]). Further details on the specificities of amplitude modulation (AM) transmissions are provided in Appendix B.

Transmitter characteristics. I collected information on radio transmitters characteristics using the historical archives of the *Radio Corriere*.[16] This was the official listings magazine of the EIAR, issued weekly from 1925, and publishing the schedules of broadcasting programs. Crucially, the magazine also contains information on the location, frequency and power of the Italian radio stations, which I gathered from the last publication of each year between 1925 and 1942. Information was further cross-checked using the yearly issues of the *Broadcasting Yearbook* and the Annual Statistical Yearbooks (*Annuario Statistico Italiano*), which enclose similar annual information on the characteristics of transmitting stations in Italy.[17] To complete the list of radio transmitter inputs required in radio propagation models, I predict antennas height relative to ground level, using the 1936 antenna regulations promulgated by the US Federal Communications Commission. This regulation imposes a minimum physical height of antenna proper as a function of power and frequency transmitter (Appendix Figure F1). Because these transmitter features are available in

[15] Previous studies use signal strength as an instrument to estimate the effect of listenership on various outcomes, as signal strength is a strong predictor for the actual audience size (Olken [2009]; Enikolopov et al. [2011]; Adena et al. [2015]). I explore the relationship between radio signal and radio subscription at the regional level in the Online Appendix.

[16] http://www.radiocorriere.teche.rai.it/

[17] https://www.worldradiohistory.com/Broadcasting-Yearbook.htm

the aforementioned sources, I am able to model antenna height using the FCC required minimum height function. In a robustness exercise, I consider several alternative values for transmitter height, ranging from 0 to 200 meters, to ensure that my results are not sensitive to this procedure.[18]

Receiver characteristics. Modelling radio signal requests defining a universe of transmitters - *radio stations* - and receivers. To derive the location of radio signal receivers, I consider the centroid of each municipality. I also set the receiver height relative to ground level at 10 meters.[19]

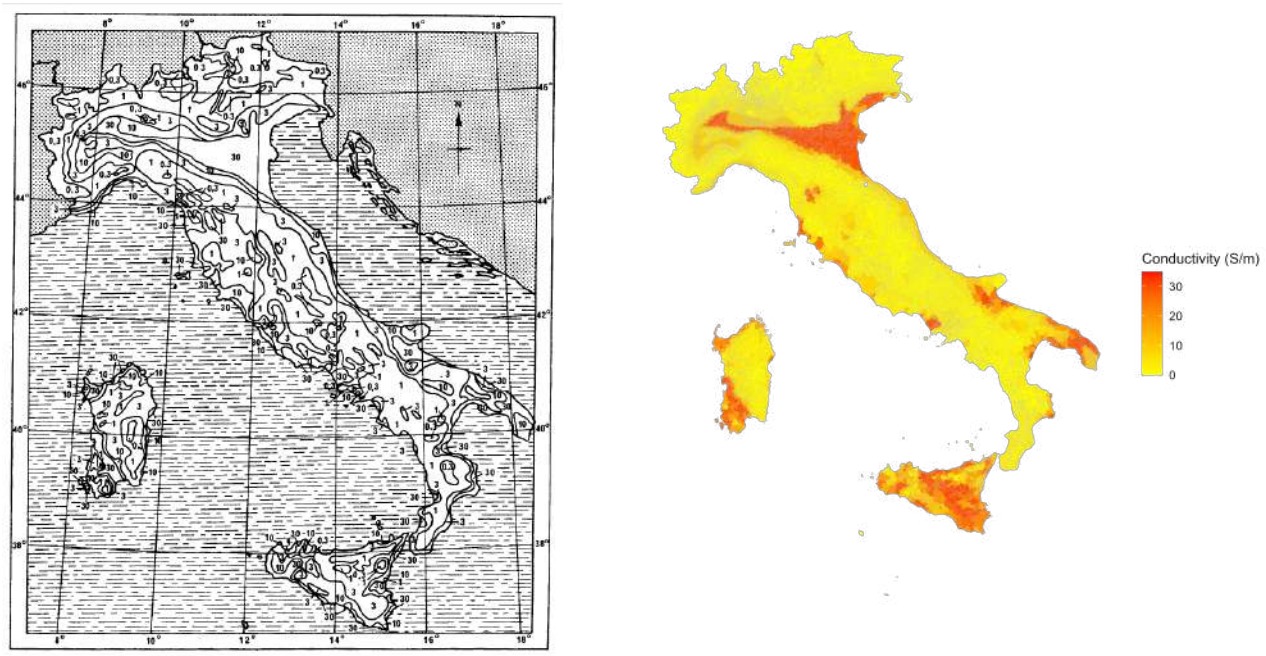
Geophysical characteristics. Similar to FM radio, the strength of AM signal is positively impacted by the power of the transmitting antenna and decreases with distance following the attenuation phenomena. However, the two radio technologies differ in the primary factors that naturally limit their coverage. While FM waves are influenced by topography, AM ground waves are predominantly affected by the conductivity of the soil. Ground conductivity refers as the ability of the soil to reflect and conduct electromagnetic waves. It is influenced by a wide range of factors, including soil composition, salinity, temperature, volcanic activity, and other geological characteristics. A higher ground conductivity indicates better AM propagation characteristics, with sea water being the best conductive surface while dry land and ice featuring limited conductivity. Ground conductivity also enables to derive measures of relative permittivity, which refers to the ability to polarize a material subjected to an electrical field. Ground conductivity and permittivity are positively associated, with higher permittivity hampering the wave attenuation phenomena [Levis et al., 2010].

I use information available in the *World Atlas of Ground Conductivity* [CCIR, 1992] to derive average measures of ground conductivity at the municipal level (Figure 2). Areas experiencing the highest levels of ground conductivity are located in the Po valley, Apulia and Sicily, while rugged areas in the Alps and Apennine Mountains exhibit the lowest average values. I use information from the same source to interpolate local measures of relative permittivity from the mean conductivity value. Finally, I use information from the *World Atlas Atmospheric of Radio Refractivity* [Bean, 1966] to derive a common measure of surface refractivity for all municipalities, using the average monthly statement taken in Rome.

AM Radio Propagation Model. I rely on the ground-wave propagation prediction method

[18]It is however to note that transmitter height plays a trivial role in the modelling process of radio propagation, compared to other model inputs (transmitter power and frequency, distance to transmitter and ground wave characteristics).

[19]Similar to transmitter height, receiver height only contributes marginally to the radio signal modelling process, as stated in Table 1 of the International Telecommunication Union (ITU) report [ITU, 2010].



(a) Original map (b) Digitised map

Figure 2: Ground Conductivity at the Municipality Level

Notes: Panel (a) presents the original map in the *World Atlas of Ground Conductivity* [CCIR, 1992]. Panel (b) displays the digitised version of the original map, with the average value for ground conductivity at the municipality level. Darker shades reflect a higher level of ground conductivity, and by extend better AM propagation characteristics.

for low- and medium-frequencies bands developed by the International Telecommunication Union (ITU) to compute local estimates of radio signal strength [ITU, 2014]. Precisely, the model returns a local measure of field strength using a set of inputs including transmitter characteristics (height, location, power, frequency), receiver characteristics (height, location, distance to transmitter) and local geophysical characteristics (ground conductivity, relative permittivity, surface refractivity). Field strength gives a continuous measure of radio signal strength at the local level, expressed in decibels relative to 1 microvolt per meter ($dB\mu V/m$). This measure can alternatively be converted into binary coverage indicators considering specific cutoffs. However, setting these cutoffs accurately requires detailed technical information about radio receivers. Due to limited information on audio broadcast formats (monophonic/stereophonic) and precise classification of municipalities as rural, urban, or large cities, I adopt a minimum threshold of 66 $dB\mu V/m$, following prior research.[20] Results remain consistent considering alternative cutoffs. Appendix B provides more details on the

[20]This threshold is used in Armand et al. [2023], which follows recommendations made by the European Telecommunications Standards Institute (ETSI) for the minimum sensitivity limit for AM broadcasting (ETSI [2021]).

computational exercise to predict radio field strength.

Figure 3 shows the expansion of radio exposure, measured as the electric field strengths in decibels relative to 1 microvolt per meter ($dB\mu V/m$).[21] Municipalities with stronger signal are represented in lighter shades, primarily clustered around radio station locations. Signal strength steadily decreases with distance to transmitter antenna, with more conductive areas mitigating this distance effect. Additionally, it is possible to model radio signal strength released of the ground conductivity constraints, setting the highest level of ground conductivity for each municipality. Plotting the radio signal strength in open ground aids to visualize the effect of conductivity constrains in AM radio signal propagation (Appendix Figure F2).[22]

3.2 Linguistic convergence

To assess the extent to which the local languages converged towards standard Italian, I rely on two linguistic surveys conducted in the first half of the twentieth century and presented in the form of atlases. Following the pioneer work of the French linguist Jules Gilliéron with the Atlas linguistique de la France (ALF), two similar projects of linguistic atlases were developed in Italy, following the same methodology: the *Atlante linguistico ed etnografico dell'Italia e della Svizzera meridionale (AIS)* and the *Atlante linguistico italiano (ALI)*.[23]

Atlante linguistico ed etnografico dell'Italia e della Svizzera meridionale (AIS). An initial endeavor was launched by two students of Jules Gilliéron, namely Karl Jaberg and Jacob Jud, who aimed to document the local dialects of Southern Switzerland and Italy [Jaberg et al., 1928]. They followed a methodology akin to the ALF, with the base survey consisting of over 2,000 inquiries intended to retrieve local translations of commonplace concepts and notions [Krefeld, 2005]. The questionnaire was designed to comprehensively cover all aspects of the local language, including vocabulary and pronunciation. The two linguists ensured that the captured language reflected the contemporary dialect of the locality rather than an idealized archaic form of the language. Although

[21] Alternatively, I use the aforementioned minimum signal strength cutoff to map out the expansion of radio coverage during the fascist period. Maps are available in the Online Appendix.

[22] The Online Appendix maps the residual radio signal for the same set of years, after 1) including the baseline set of propagation controls and fixed-effects; and 2) adding the free signal. The correlation coefficient between the two residual measures varies little over time and is approximately 0.65.

[23] The original German title of "Atlante linguistico ed etnografico dell'Italia e della Svizzera meridionale" (AIS) is "Sprach- und Sachatlas Italiens und der Südschweiz", which can be translated as "Linguistic and Ethnographic Atlas of Italy and Southern Switzerland". Similarly, an English translation of the "Atlante linguistico italiano (ALI)" is the "Italian Linguistic Atlas".

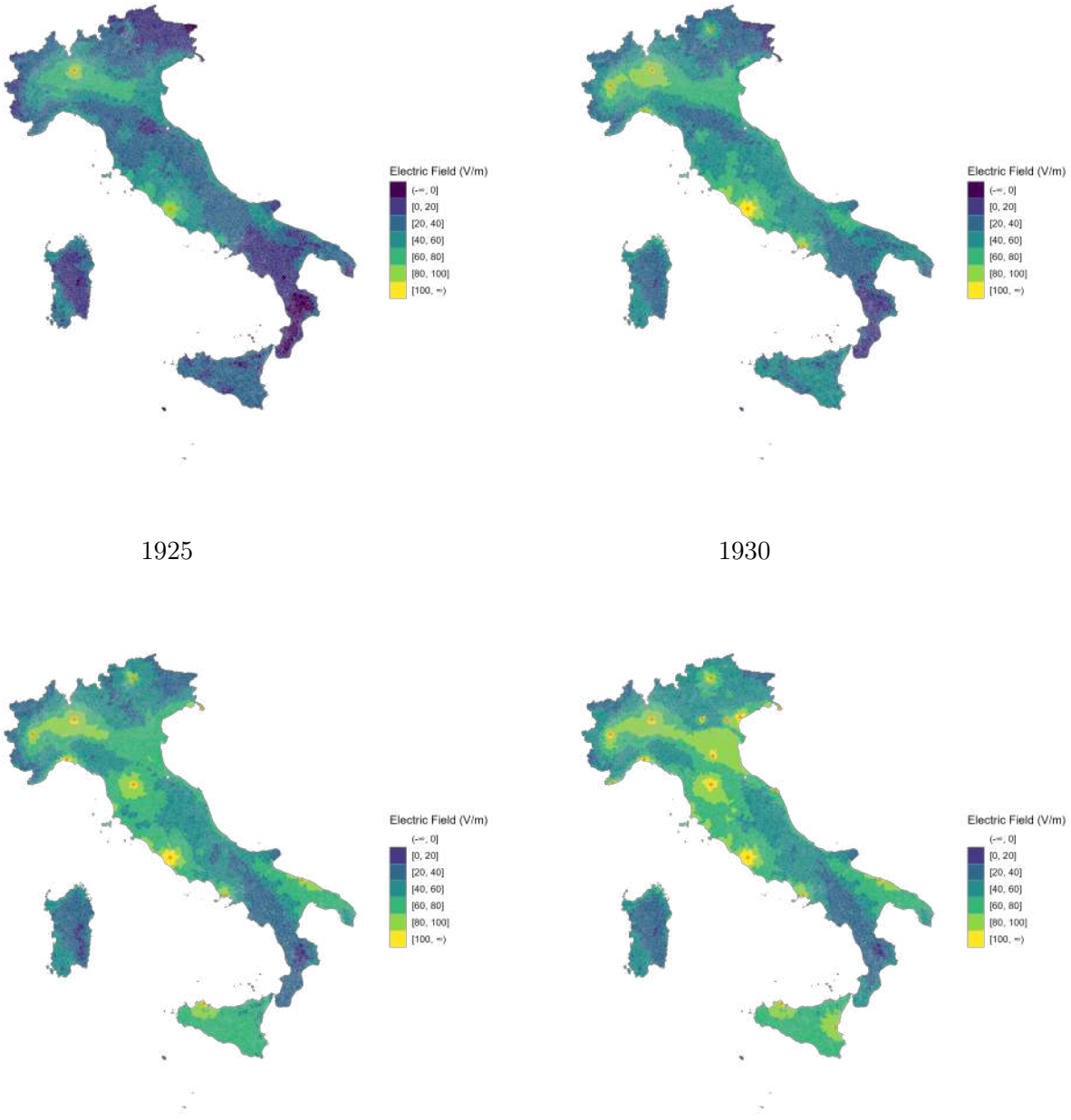


Figure 3: Radio Signal Strength Over Year

Notes: This figure shows the expansion of radio signal strength, measured in field strength, at four periods of time in Italy. The orange dots represent the radio stations and transmitter antennas.

each survey point usually relied on a single informant, the selection process sought to ensure local representativeness and to minimize the effects of migration. The collected content was compiled into 1,705 maps, which were published in the decade following the completion of the data collection phase. Nearly 400 locations in Italy were surveyed between 1919 and 1922, just prior to the advent of radio. The selected municipalities were intended to ensure consistent territorial coverage, with a slight overrepresentation of large cities and interior areas at the expense of rural and coastal zones.

The dialectal transcriptions displayed in the maps were digitized and made accessible online through the projects *AIS, reloaded (AISr)* and *AIS, the digital turn (AISdt)*.[24] This searchable digital tool consists in a dataset of 1,712 words with local translations from 365 municipalities located in nowadays Italy, for a total of nearly 650,000 entries [Loporcaro et al., 2021].[25]

Atlante linguistico italiano (ALI). Concurrently to the initiative by the two Swiss students, a national project for a linguistic atlas was orchestrated under the guidance of M.G. Bartoli [Bertoni, 1925]. The project materialized with field surveys conducted by Ugo Pellis, who single-handedly conducted 727 field surveys between 1925 and 1940. The remaining 282 surveys, mostly covering southern Italy, were carried out between 1952 and 1965. Out of the 999 surveyed locations, 680 were municipalities both situated in present-day Italy and with survey conducted before WWII. The selection process of these locations followed a geographical rationale, with an approximate distance range of 15 to 30 km between each point. The sample of selected points was intended to be representative of Italy, encompassing both major cultural centers and peripheral areas. Although different versions of the questionnaire existed, the most comprehensive one comprised of 7,000 entries. Similar to the AIS, the aim was to capture the respective linguistic transcription of numerous concepts or expressions.

The original records are preserved at the *Istituto dell'Atlante Linguistico Italiano*, who generously supplied me with the digitized entries used to produce maps of six Volumes (III, V, VI, VII, IX and X), amounting 1735 words and over 500,000 entries [Rivoira et al., 2016].

Atlases comparability. The two atlases, both rooted in the same rigorous scientific tradition inherited from the *Atlas Linguistique de la France*, are closely comparable in their overall conception, despite some differences in design. The ALI is characterized by a higher density of survey points

[24] https://www.ais-reloaded.uzh.ch/

[25] 371 localities were surveyed in total, but six of them are located outside the current State of Italy.

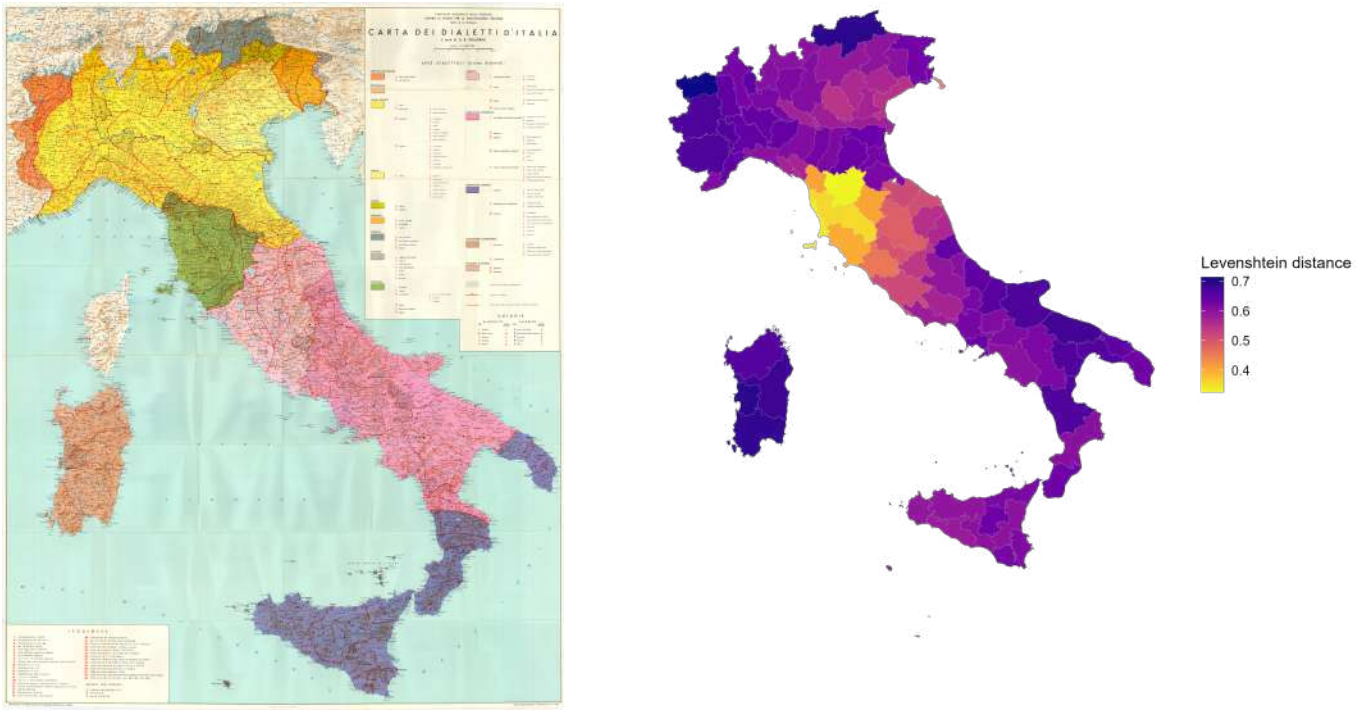
and a correspondingly stronger national representativeness, while its questionnaire is substantially more extensive and structured into general and specialized sections [Rivoira, 2019]. Beyond these differences, the two atlases share a set of methodological limitations that have been widely discussed in the literature. In particular, despite the methodological rigor of the time, the reliance on a single informant per surveyed locality does not allow for the inclusion of differences arising from social, gender, or generational variation [Sanga et al., 2017]. Similarly, the use of a questionnaire has been questioned to shape speakers' responses [Canobbio, 2002].

Despite their aforementioned methodological limitations, the AIS and ALI have gradually acquired the status of canonical empirical references for the historiography of the Italian language. Their collection of local entries have been used extensively by linguistic historians as a direct source of historical evidence to study multiple linguistic domains, including phonetics, syntax, and lexicon (Rohlfs and Franceschi [1968]; Loporcaro [2013]). Aggregate patterns from the atlases have also been used in broader historical syntheses to support macro-historical accounts of dialectal stratification and the development of standard Italian (Serianni and Trifone [1993]; De Mauro [2017]). Although their reliability as a data source has been debated, the prevailing view in the literature treats the AIS and ALI as providing a representative record of local dialect usage at the respective moment of each survey, rather than as a socially exhaustive description of linguistic variation (Loporcaro [2013]; (Sanga et al. [2015]).

Matching procedure. Measuring language convergence requires comparing linguistic measures at two distinct time periods. Hence, I take advantage of the differential timing in the data collection process of the two Italian atlases to build a sample of municipalities with information on language convergence. Specifically, I match the 365 municipalities surveyed in the AIS with the 680 municipalities surveyed prior WWII in the ALI, using the closest geographic proximity as the basis for the match. Consequently, two ALI municipalities can be matched with the same AIS municipality.[26] While my primary approach involves matching municipalities based on the geographically closest-match rationale, I further restrict matches to municipalities located within the same linguistic family. Precisely, I rely on the historical map and classification built by the linguist Battista Pellegrini [Pellegrini, 1977]. The classification is composed of 14 linguistic areas, which in turn

[26] In a robustness check, I impose only one ALI municipality matched with an AIS locality, restricting to the closest match in distance

can be divided into 33 linguistic subareas. My preferred matching method strictly confines links to municipalities within the same linguistic area (Figure 4). To rule out results' sensitivity to this matching procedure, I also consider alternative samples where matching links are subject to stricter constraints (within the same linguistic subarea) or no constraints additionally to the geographical proximity rationale. The three procedures yield very similar sets of matches, with the median distance between matches ranging between 11.3 and 11.6 kilometers (Appendix Figure F3).[27] It is to worth noting that there are 106 municipalities that perfectly match between the two atlases.



(a) Historical linguistic regions

(b) Linguistic Proximity to Florence Dialect

Figure 4: Map of Italian Dialects

Notes: Panel (a) shows the spatial distribution of the historical dialectal areas in Italy. The map was produced by the linguist Battista Pellegrini, following a classification built by the same author [Pellegrini, 1977]. Panel (b) displays the linguistic distance to Florence dialect, at the province-level, computed using Levenshtein distance.

Linguistic distance. The first step in building an index of linguistic convergence consists in measuring the linguistic distance between the local language and standard Italian, independently for each municipality surveyed in one of the atlases. I follow the same approach as in Blanc and Kubo

[27] The first and third quartiles respectively span between 6.3 and 6.4 km and 16 and 16.4 km, while the average distance ranges between 11.7 and 12.9 kilometers. Detailed statistics on the matching samples can be found in the Online Appendix.

[2023]. Precisely, I compute municipality-averages of Levenshtein distance to standard Italian, using the linguistic entries of each atlas.[28] The Levenshtein distance is a metric measuring the difference between two strings, commonly found in the linguistic literature [Kessler, 1995]. It is defined as the minimum number of single-character edits (insertions, deletions or substitutions) needed to transform one sequence into the other. One attracting feature of this metric is the possibility to normalize the outcome to the unit interval, dividing the score by the number of letters of the longest of the two strings. Hence, a Levenshtein distance score of 0 indicates perfect similarity between two languages, and by opposition, a score of 1 denotes perfect dissimilarity.

The number of local entries used to compute the metrics of linguistic distance varies across municipalities and atlases. The average (and standard deviation) number amounts to 1115 (167) for the AIS (pre-radio atlas) and 383 (208) for the ALI (post-radio atlas). The detailed kernel densities are displayed in Appendix Figure F4. The minimum number of words used to compute the linguistic distance measures is 464 for the AIS and 15 for the ALI, with only four municipalities in the latter falling below the threshold of 30.

Each atlas employs its own phonetic system to precisely transcribe the large array of nuances in the pronunciation. Consequently, I am constrained to rely on the available phonetic entries from each atlas to set a benchmark point for the string distance computation procedure. Unfortunately, neither atlas provides phonetic translations in standard Italian of the surveyed words. By extend, I use the Florence point as the reference, as the common language was derived from a contemporary and simplified form of the Florentine dialect. However, it is worth noting that a translated version of the AIS entries in the International Phonetic Alphabet (IPA) was made available by the Zurich team [Loporcaro et al., 2021]. The translated entries enable to use phonetic transcriptions of standard Italian words as benchmark, without losing the phonetic component. The IPA phonetic transcriptions of the 899 Italian words and concepts used in the AIS were collected using online Italian dictionaries.[29] This feature enables to derive local measures of linguistic distance to standard Italian, that is further used in the Section 7 which explores the heterogeneous effect of mass media on family outcomes. Panel (b) of Figure 4 shows the province-level score of the linguistic proximity

[28] The densities of the linguistic distance metrics are available in the Online Appendix.

[29] Precisely, I used two dictionaries and cross-checked the phonetic entries: https://www.dizionario-italiano.it/ and https://www.wiktionary.org/.

to Italian.[30]

I assess the reliability of the own-computed linguistic distance metrics by comparing the obtained outcomes with alternative measures. I first replicate the linguistic distance procedure, considering alternative string distance computation method that slightly diverged from the Levenshtein distance, namely the Damerau-Levenshtein (DL) and the Optimal Sting Alignment (OSA) distances. Next, I leverage from the fact that the Salzburg dialectometry team used the same digitized words database from the AIS to compare my distances measures with their own proximity metrics, namely the Relative Identity Value (RIW) and the Weighted Identity Value (GIW) (Goebl [2007]; Goebl [2008]). Appendix Table G1 displays the unconditional correlation coefficients between the linguistic distance metrics I derived and the proximity measures computed by the Salzburg team. The table includes the normalized Levenshtein distance - my preferred metric - along with alternative measures derived by myself, as well as the proximity measures computed by the Salzburg team. The estimated coefficients reveal a nearly perfect association between all linguistic distance measures computed using different string distance methods. Reassuringly, these metrics exhibit high levels of correlation with the dialectometric proximity measures derived by the Salzburg team, with correlation coefficients reaching 0.97.

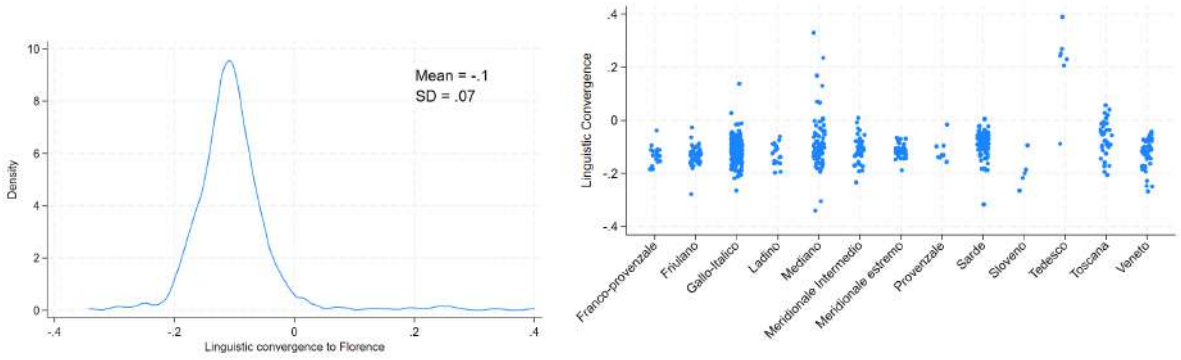
Linguistic convergence. Last, I derived the final metric of language convergence to Italian for each pair of matched municipalities, computing the difference between the average linguistic distance for the AIS and the ALI. Precisely, the index of linguistic convergence is defined as follows:

$$LC_i = LD_i^{pre-radio} - LD_i^{post-radio} \tag{1}$$

where LC_i is the index of linguistic convergence of municipality i, computed as the difference between the linguistic distance from Italian $LD_i^{pre-radio}$ of municipality i in the AIS, and the linguistic distance from Italian $LD_i^{post-radio}$ of municipality i in the ALI. By construction, the LC_i index ranges between [-1;1], with -1 denoting the highest level of linguistic divergence, and 1, the highest level of linguistic convergence. The procedure to stepwise build the linguistic convergence index is detailed in the Appendix C, which also provides illustrative examples to facilitate interpretation of the index.

[30] Analogous maps displaying province-level linguistic similarity to Italian using alternative linguistic metrics are available in the Online Appendix.

Figure 5 summarizes the distribution and regional variation of the baseline linguistic convergence index. Panel (a) shows that the index is centered at a mean of -0.10, which mechanically reflects differences in the richness of phonetic transcription between the ALI and the AIS (925 special characters in the former versus 734 in the latter) rather than systematic linguistic divergence. Panel (b) documents substantial dispersion in convergence across municipalities, with no pronounced differences across linguistic regions. This absence of strong regional clustering is consistent with the spatial distribution shown in Appendix Figure F5. Finally, convergence is only weakly related to geographic distance from Florence, the reference dialect location, and from Rome, the political capital, with correlation coefficients of -0.03 and -0.14, respectively.[31]



(a) Sample Distribution

(b) By Linguistic Region

Figure 5: Linguistic Convergence to Florence

Notes: Panel (a) shows the density of linguistic convergence to Florence dialect for the full sample over the period, measured at the municipality level. Panel (b) groups observations by linguistic region.

3.3 Additional covariates

I supplement the aforedescribed information on language and radio with additional data to derive a large array of controls, with supplementary details in Appendix A. I obtain geographical information from external sources and governmental agencies, including municipality coordinates, land area, average and maximum elevation, terrain ruggedness, distance to Rome, distance to Florence, distance to the closest river and maritime access. Census-year population figures are obtained by digitizing data from Sistema Statistico Nazionale (Sistema Statistico Nazionale [1994]), which retrieves the decennial number of inhabitants for the 1991 municipalities. I derive the intercensal

[31]The correlation coefficient distributions municipality are available in the Online Appendix.

population estimates using a linear interpolation approach. I use the same data source to construct a municipality-level measure of market access.[32] The rest of the socioeconomic covariates which consists of the share of population working in agriculture, in the industry, in transport and communications, in trade, in banking, in liberal professions, in public administration, in private administration, in domestic economy, the active population rate and the literacy rate are derived from the 1931 official Italian Census.

I supplement the dataset with variables addressing for potential cofounders described in Section 2. Precisely, I control for the distance to the closest railroad of the 1913 network and to the closest post office of the 1918 network, respectively taken from Ciccarelli and Groote [2017] and from Martinez et al. [2024]. I further use provincial information on the average annual expenditure per inhabitant in cinema in 1937, collected from the 1937 annual report of the Italian Society of Authors and Publishers (SIAE). Last, I derive an estimated measure of the regime's presence at the municipality level using the photographic archive of fascist activities collected by the official media of the regime [De Pirro, 2024].[33]

Finally, I ensure a consistent geography over the period, setting the 1991 administrative geography as reference units. To do so, I follow the geographical crosswalk procedure from Eckert et al. [2018] and used the administrative boundaries files made available by ISTAT.

3.4 Sample

The matching procedure yields a final sample of 624 municipalities of the 1991 geography. Out of the 882 municipalities from the 1991 geography, 258 were surveyed post-WWII, and excluded from the sample.[34] Panel (b) of Appendix Figure F6 displays these localities (in orange) that were dropped due to a different type of treatment in radio exposure. Most of them are located in the

[32] I follow an approach akin to Bonfatti et al. [2021], where for each municipality i, I compute $MA_i = \sum_{j \neq i} P_j D_{ij}^{-1}$ with P being the population of municipality j, and D_{ij} the geodesic distance between municipalities i and j. In the calculation of MA_i, I employ the population of all municipalities, with the exception of municipality i's own population.

[33] I used the information from the photo descriptions to geolocalize all major activities and events attended by Mussolini between 1927 and 1942 (openings of new establishments, cultural events, public speeches). I am grateful to Amanda De Pirro for providing the data extracted from the photographic archives.

[34] Out of the initial 371 municipalities included in the AIS survey, 30 to 40 of them – depending on the matching criteria – were excluded from the matching process because they are now located outside of present-day Italy or were too far from any municipalities surveyed in the ALI. Similarly, from the original 999 localities in the ALI survey, 43 were excluded for being outside of Italy, 258 were removed for being surveyed after World War II, and 74 were merged with their main municipality, as they were hamlets of a 1991 municipality.

southern region of the country, with a few also found in the Apennines and the central portion of Sicily. Although linguistic atlases designers and surveyors aimed to ensure a representative coverage of the geographical diversity, the selected municipalities were not chosen through a random process. Consequently, important cities tend to be overly represented, even when restricting the sample to rural municipalities (less than 2,500 inhabitants) or zooming within regions. While the series of t-tests reported in the Online Appendix reveals differences in observable characteristics between the full universe of Italian municipalities and the estimation sample, these characteristics are either directly controlled for in the regressions or absorbed by geographic fixed effects. Consequently, residual selection on observables is unlikely to bias the estimated coefficients.

4 Empirical strategy

My empirical strategy aims to derive the causal effects of exposure to the fascist radio on language convergence. A major concern stems from the strategic placement of antenna transmitters, with governmental authorities targeting populated area in order to reach the maximum audience. Hence, reception of fascist broadcast might have been correlated with other determinants of language convergence. To address this concern, my empirical strategy builds on previous works to exploit plausibly exogenous variation stemming from the physics of radio propagation (Olken [2009]; Yanagizawa-Drott [2014]).

Given transmitter height and power, AM radio propagation by ground waves is primarily determined by the distance to the transmitter, and the geophysical characteristics locally and alongside the transmission path. Freed of natural obstacles, radio signal electric strength decreases in the square distance from the transmitter. Hence, I follow [Yanagizawa-Drott, 2014]'s strategy to include in the regression model a second-order polynomial in the distance to the transmitter to account for the endogenous placement of radio stations. The other constituting factors of the attenuation phenomena are the geophysical characteristics of both the receiving location and the areas traversed along the route. As detailed in Section 3.1 this set of geophysical characteristics primarily includes ground conductivity and the underlying relative permittivity for ground waves propagation.[35] Consequently, I include second-order polynomials in the average permittivity, mean

[35] Most of the existing papers on radio focus on the FM technology, for which topography is the major determinant of radio coverage Olken [2009]; Durante et al. [2019]; Wang [2021a].

and variance conductivity of the municipality to control for the endogenous ground-based characteristics of receiving municipalities. Conditional on the distance to the transmitter and the local geophysical features, the remaining variation in signal strength solely stems from the variations in geophysical characteristics of the areas located between the transmitter and the receiver. Following the strategic placement of transmitters, potentially correlated with local geophysical characteristics, I include both province and linguistic region fixed-effects to account for regional differences. The residual variation in radio exposure is thus the local variation across municipalities within the same province and linguistic region, arguably more orthogonal to other determinants of language convergence. Identification of the coefficient of interest results in variation in diffraction patterns caused by ground electrical characteristics along the signal transmission route, across similar municipalities.

Precisely, I estimate the following econometric model:

$$LC_{iprt} = \beta Signal_{iprt} + RadioControls_{iprt} + X'_{iprt}\gamma + \delta_{p,(i)} + \zeta_{r,(i)} + \eta_{t,(i)} + \epsilon_{(i),p} \tag{2}$$

where LC_{iprt} is the index of linguistic convergence, as defined in equation (1), of municipality i located in province p and linguistic region r, and surveyed in year t. The main variable of interest is $Signal_{iprt}$, computed as the predicted radio signal strength of municipality i located in province p and linguistic region r, and surveyed in year t. $RadioControls_{iprt}$ includes the set of radio-propagation controls as defined above, namely second-order polynomials in the distance to the nearest radio transmitter, average permittivity, mean and variance of conductivity, geographic coordinates and their interactions. I include the vectors $\delta_{p,(i)}$ and $\zeta_{r,(i)}$ as province and linguistic region fixed effects, respectively, for controlling for any differences across provinces and linguistic regions that might influence the unification process of language. I also account for differential years in data collection for the ALI with the inclusion of vectors $\eta_{t,(i)}$ as ALI year fixed-effects.[36] X'_{iprt} is a set of geographical and socioeconomic cofounders, defined at municipality level. The standard errors are clustered at the province level to account for spatial correlation.[37] To ease the interpretation of the results, I standardize the linguistic indices and radio signal strength measure, such that they

[36] ALI year of collection fixed-effects account for the evolution of language, restricting the comparison between municipalities where the survey was conducted in the same year.

[37] I show that results remained unchanged when clustering at the region level or accounting for spatial autocorrelation using a kernel adjustment procedure [Conley, 1999] or a semiparametric regression that incorporates a spatial smoothing term [Kelly et al., 2023]. Results are available in the Online Appendix.

have a mean of zero and a standard deviation of one. Finally, observations are weighted by the inverse matching distance between AIS and ALI municipalities, in order to give more importance on the closest matches in the estimation procedure.[38]

In the absence of information on the actual listenership, the coefficient of interest, β, seizes the reduced-form estimates of the impact of exposure to the fascist radio broadcast. I expect $\beta > 0$, as large values of $Signal_i$ stands for better radio reception, and high values for LC_i implies an increase in linguistic proximity to Italian. The identification strategy of estimating the causal effects of radio exposure relies on the assumption that, conditional on the vectors of covariates, *Signal* is orthogonal to the error term. While this assumption is inherently untestable, I provide support to this conditional independence assumption, running both a balance test on municipalities characteristics and a placebo exercise on linguistic outcomes.

Balance test. Table 1 reports the estimated coefficients and R^2 of the arrays of correlation regressions between *Signal* and the array of municipality characteristics.[39] The first set of correlation coefficients reports the unconditional radio effect, showing that *Signal* is significantly associated with a consequential number of the characteristics in the univariate regressions. This is unsurprising considering that fascist stations were strategically placed in major cities to maximize audience. The second array of coefficients shows the effect for radio exposure on the list of municipality characteristics, controlling the radio propagation covariates and the set of fixed effects.[40] Most the coefficients for radio exposure become statistically indistinguishable from zero across all covariates (except distance to Rome, the active population rate and the cumulative number of propaganda events), once implementing the identification strategy. Consequently, conditional on the set of fixed effects and the radio propagation controls, radio signal strength at the municipal level shows to be be as good as randomly distributed with regard to municipal characteristics, giving extensive support to the identification strategy. To remain conservative, I still control for all the geographical and socioeconomic characteristics displayed in Table 1, when estimating the effects of radio exposure.

[38] For the perfect matches, I set the distance to be 1 kilometer. In a robustness exercise, I set this distance to 0.5km, giving *de facto* more weight to the perfect matches in the estimation process. I also ensure that the estimates are not driven by the weighting procedure, replicating the results without including weights in the estimation process.

[39] A supplementary figure in the Online Appendix plots the two regression coefficients for each municipality characteristics.

[40] The set of radio propagation controls includes latitude, longitude, their interaction, and second-order polynomials in municipality mean conductivity, municipality conductivity variance, relative permittivity and distance to the nearest radio transmitter, while the set of regional fixed-effects account for province, linguistic region and ALI survey year of collection fixed-effects.

Table 1: Radio Exposure and Municipalities Characteristics (Balance Tests)

		Univariate		Controls & FEs	
	Mean (SD)	Coefficient	R^2	Coefficient	R^2
	(1)	(2)	(3)	(4)	(5)
Elevation	544.8	-216.870***	0.15	-113.549	0.90
	(601.1)	(44.815)		(70.311)	
Land Area	91.3	22.568	0.02	57.921	0.67
	(102.8)	(16.929)		(40.031)	
Terrain Ruggedness	1,576,325	-5.43e+05***	0.16	-2.39e+05	0.86
	(1,460,418)	(1.18e+05)		(1.87e+05)	
Population (log)	8.6	0.633***	0.15	-0.002	0.78
	(1.3)	(0.130)		(0.439)	
Market Access (log)	5.1	0.159***	0.28	0.021	0.98
	(0.3)	(0.053)		(0.022)	
Dist. to River	14.0	-0.481	0.00	-0.356	0.78
	(13.9)	(0.830)		(1.726)	
Maritime Access	0.256	0.051	0.02	-0.032	0.73
	(0.437)	(0.033)		(0.057)	
Dist. to Rome	363.1	-30.696*	0.05	-7.058**	1.00
	(151.8)	(15.561)		(2.732)	
Dist. to Florence	295.1	-37.428**	0.08	-1.334	1.00
	(162.2)	(14.460)		(3.878)	
Agriculture	0.596	-0.050**	0.05	0.020	0.52
	(0.221)	(0.021)		(0.041)	
Industry	0.225	0.031**	0.05	-0.007	0.25
	(0.148)	(0.013)		(0.020)	
Transport & Com.	0.028	0.005**	0.03	-0.005	0.67
	(0.028)	(0.003)		(0.008)	
Trade	0.066	0.005	0.01	-0.007	0.74
	(0.041)	(0.005)		(0.010)	
Banking	0.003	0.001**	0.05	0.000	0.70
	(0.005)	(0.001)		(0.002)	
Liberal Profession	0.010	0.003***	0.01	0.000	0.68
	(0.009)	(0.001)		(0.003)	
Public Administration	0.037	0.003	0.05	-0.007	0.62
	(0.027)	(0.003)		(0.007)	
Private Administration	0.031	0.001***	0.03	-0.001	0.58
	(0.004)	(0.000)		(0.001)	
Domestic Economy	0.003	0.001	0.00	0.007	0.65
	(0.004)	(0.002)		(0.008)	
Active Population	0.448	0.009	0.10	0.030**	0.82
	(0.082)	(0.010)		(0.011)	
Literacy rate	0.800	0.015	0.01	-0.005	0.92
	(0.152)	(0.017)		(0.014)	
Railroad Access	0.468	0.173***	0.53	0.016	0.67
	(0.499)	(0.027)		(0.102)	
Dist. to Post	6388.9	-1039.021***	0.05	-686.717	0.70
	(5625.3)	(330.759)		(698.119)	
Propaganda Events	0.282	2.252	0.03	10.309**	0.62
	(7.005)	(2.125)		(4.961)	

Notes: The sample is comprised of 624 observations. This table shows the summary statistics of municipalities characteristics (column 1). Columns 2 and 3 respectively report the correlation coefficient and the R^2 of the univariate ordinary least squares (OLS) regression of each variable on exposure to Fascist radio. Columns 4 and 5 supplement the regression model with radio controls (latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity) and the set of fixed-effects. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Placebo test. Table 2 reports the estimates of a placebo exercise that tests whether radio station placement is related to local linguistic characteristics. Although I cannot explore the association between radio signal strength with past linguistic convergence locally, I examine the potential endogeneity of radio exposure with regard to local linguistic prxomity to Italian. Precisely, I estimate Equation (2) using the pre-radio indices of linguistic distance to Italian as outcome. Conditional on the full set of baseline controls, the coefficient for radio exposure is not significantly correlated with any metrics of linguistics distance, measured before radio was developed over the territory. These results lend additional credibility to the conditional exogeneity assumption underlying the identification strategy.

Table 2: Radio Exposure and Original Linguistic Characteristics (Placebo Tests)

	(1) AIS Linguistic dist.	(2) RIW Linguistic prox.	(3) GIW Linguistic prox.
Radio Exposure	-0.007	-0.048	1.575
	(0.015)	(0.703)	(1.543)
Mean outcome	0.59	62.08	26.26
Province FE	✓	✓	✓
ALI Year FE	✓	✓	✓
Ling. Reg. FE	✓	✓	✓
Radio Controls	✓	✓	✓
Additional Controls	✓	✓	✓
Dist. Weight	✓	✓	✓
Observations	616	577	577
R-squared	0.96	0.98	0.98

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Difference-in-Difference Strategy. I consider an alternative empirical strategy setting a classic Difference-in-Difference (DiD) design using the pre- and post-radio periods. Specifically, I run the following regression:

$$LD_{it} = \beta Signal_i \times Post_t + X_{it}\,\gamma_1 + X_i\,\gamma_{2t} + \delta_i + \eta_{pt} + \epsilon_{it} \tag{3}$$

where LD_{it} is the index of linguistic distance from Italian of municipality i in period t. The main variable of interest is the interaction term between $Signal_i$, computed as the standardized predicted

radio signal strength of municipality i measured at the collection year of the post-radio survey (ALI), and a time dummy $Post_t$ which equals to zero for pre-radio survey year (AIS) and one for post-radio survey year (ALI). X_{it} is a set of time-varying population controls which comprises the (log-transformed) population and (log-transformed) measure of market-access. X_i further accounts for radio propagation characteristics, including the radio signal released of the ground conductivity constraints and the set of radio propagation covariates as defined above, interacted with the time dummy. Additionally, I address the design limitation that the post-radio survey was conducted in different years across municipalities by including a second-order polynomial of the time gap between the years in which the two surveys were conducted, interacted with the time dummy. I also include the vectors δ_i and η_{pt} as municipality and province-by-year fixed effects, respectively, for controlling for any time invariant municipality characteristics and for provincewide shocks to all municipalities in each province. The standard errors are clustered at the municipality level to account for spatial autocorrelation. Same as above, observations are weighted by the inverse matching distance between AIS and ALI municipalities.

5 Radio effects on language convergence

5.1 Main results

Baseline results. Table 3 presents the main results of the empirical analysis, where I examine the effect of fascist radio signal strength on linguistic convergence. In column (1), I merely implement the identification strategy, by controlling for the radio propagation covariates and the set of fixed-effects.[41] The coefficient for *Signal* is positive and statistically significant, suggesting for a large positive effect of radio exposure on linguistic convergence. The estimates remain robust and increase in magnitude when including municipality geographic and socioeconomic characteristics (columns 2 and 3). Precisely, Column (3), which is my preferred specification that includes all baseline controls, suggests that one standard deviation increase in *Signal* is associated with a 0.6 standard deviation increase in the linguistic convergence index. This coefficient can be alternatively interpreted as changes in diacriticized letter (the base letter along with its pronunciation symbols). Precisely,

[41] The set of radio propagation variables includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity.

coefficient of column (3) is equivalent to one additional change of a diacriticized letter, within a linguistic entry composed of 23 diacriticized letters. This figure needs to be considered in relation to the time period between the years of collection of the two linguistic survey, which averages 11.5 years.[42] The two last columns of the table impose further restrictions in the identification strategy. Column (4) restraints the residual variation to stem from municipalities from the same province and linguistic region and surveyed in the same year, by interacting all the sets of fixed-effects. The coefficient of interest of this highly-demanding specification remains statistically significant, albeit decreasing in size. Last, column (5) addresses the hypothesis that radio stations could have differential effects due to distinct broadcasting programs, by adding radio transmitter fixed-effects.[43] The point estimate remains virtually unaffected. Taken as a whole, Table 3 suggests that exposure to fascist radio broadcast had a sizeable positive effect on the process of language convergence.

Table 3: Radio Exposure and Linguistic Convergence

	Linguistic Convergence				
	(1)	(2)	(3)	(4)	(5)
Radio Exposure	0.509***	0.653**	0.623***	0.387**	0.597***
	(0.176)	(0.252)	(0.204)	(0.189)	(0.199)
Controls					
Radio Controls	✓	✓	✓	✓	✓
Local Geography		✓	✓	✓	✓
Socioeconomics			✓	✓	✓
Fixed-effects					
Province FE	✓	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓	✓
Province × Year × Ling. Reg. FE				✓	
Radio Transmitter FE					✓
Dist. Weight	✓	✓	✓	✓	✓
Observations	612	612	612	532	612
R-squared	0.51	0.55	0.60	0.71	0.61

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of local geographic controls is comprised of the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to Florence and maritime access. The set of socioeconomic controls includes the log-transformed population and market access, a dummy for railroad access, distance to post office, the cumulative number of propaganda events, the proportion of active population and the occupational shares of agriculture, industry, transport and communication, trade, banking, liberal professions, public administration, private administration and domestic economy. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[42] This figure is derived from the regression coefficient of the non-standardized measure of radio exposure on the linguistic outcome (equal to 0.043). It should be considered in relation to the range of the linguistic convergence index [-1;1]. Hence, the positive coefficient corresponds to a converging change of 0.043 in the convergence index, which approximately equals to $1/23$.

[43] The associated radio station for each municipality is selected using the closest radio transmitter in distance.

A natural concern regarding the identification strategy designed to causally isolate the effect of radio exposure on language is that the extensive inclusion of fixed effects and radio propagation controls may potentially absorb all the variation in the linguistic convergence index. In order to ensure that the coefficient of the baseline specification, displayed in column (3) of Table 3, still captures substantial variation in the outcome, I plot the residuals of increasingly-restricting regressions of the radio exposure measure on the linguistic convergence index against the main variable of interest (Appendix Figure F7). Precisely, I start plotting the univariate correlation between radio exposure and linguistic convergence (model 1), then add the fixed effects (model 2), followed by the radio propagation controls (model 3), and finally, the additional controls to reproduce the baseline regression model (model 4). The procedure shows that none of the components of the identification strategy fully captures the initial variation between the outcome and variable of interest. In Appendix D, I perform a large array of robustness tests to support the validity of the results.

Persuasion rate. A widely used approach in media literature to interpret the effects of media exposure is to express them in terms of persuasion rates [DellaVigna and Gentzkow, 2010]. The persuasion rate represents the proportion of individuals who change their behavior in response to the treatment, relative to those who were potentially susceptible to change. The treatment I consider is binary exposure to radio coverage using the cutoff of 66 $dB\mu V/m$, which is considered as the minimum sensitivity limit for AM broadcasting (ETSI [2021]). The outcome variable is the rate of similarity between the local language and standard Italian, with similarity defined as a Levenstein distance of 0.2 at maximum. Following the methodologies of Fujiwara et al. [2024] and Boken et al. [2023], the persuasion rate for marginal changes in exposure can be approximated as:

$$f \equiv \beta * e * \frac{y}{(1-y)},$$

where β is the estimated effect of radio coverage on the word similarity rate, with estimates derived from equation (2) and reported in Appendix Table G2; e represents the proportion of the population with good radio coverage; and y denotes the average similarity rate of words. By setting $\beta = 0.025$, $e = 0.046$, and $y = 0.224$, the persuasion rate is estimated to be approximately 15.7%. This value falls within the typical range of persuasion rates reported in previous studies (DellaVigna and

Gentzkow [2010]; Wang [2021a]).

Difference-in-Difference Estimates. Table G3 presents the coefficients from the difference-in-difference specification, which substantially corroborate with the baseline results. Column (1), which only controls for municipality fixed effects and period fixed effects, points to a positive effect of exposure to Fascist broadcasts on linguistic convergence. The point estimates increase in magnitude and precision as additional controls are introduced. Specifically, column (2) incorporates the fictive signal computed without geophysical constraints, column (3) adds population covariates, column (4) includes radio propagation controls interacted with the time dummy, and column (5) accounts for the time gap between the two surveys. Finally, column (6) supplements the specification with province-by-year fixed effects, with little change in the estimates. Overall, the estimated coefficients suggest a reduction in the linguistic distance index to Italian by 0.01 to 0.04 following a 1 standard deviation increase in radio exposure. These figures are comparable in size with the coefficients derived using equation (2), highlighting the significant contribution of radio to the process of linguistic convergence.

Placebo Exercise. Unlike cinema, where regional languages were occasionally used to enhance authenticity, radio programs were exclusively broadcast in standard Italian. Consequently, while radio exposure may have eased linguistic convergence towards standard Italian, it likely had little impact on linguistic homogenization within individual regions. To confirm that the observed effects on linguistic convergence are not artifacts of a broader linguistic homogenization across the territory, I conduct a placebo analysis. Specifically, I replicate the estimates from equation (2), using the 20 regional capitals as reference points for computing the linguistic metrics. Since regional languages and dialects were absent from radio broadcasts, I expect no significant effect of radio exposure on convergence to regional languages. The results, presented in Table G4, support this hypothesis, even after excluding regional capitals from the sample (column (2)). The estimated coefficients are small and statistically indistinguishable from zero. These findings indicate that radio exposure specifically promoted convergence towards Standard Italian rather than fostering a general linguistic homogenization process.

5.2 Additional results

Years of Radio Exposure. My baseline econometric framework solely investigates the extent to which better radio signal strength influences the local process of language convergence. Because radio stations were launched at different points in time and the second survey was conducted across multiple years, the potential effects of radio may not depend solely on its presence at the time of data collection, but also on the number of years of exposure. In this section, I hence move beyond mere access to radio and focus instead on the number of years of exposure to fascist broadcasts.

I first construct a measure of exposure duration equal to the number of years in which a municipality received a radio signal of sufficient quality, defined as field strength exceeding $66 dB\mu V/m$. While this measure only relies on the strongest radio signal received by each municipality, it does not account for the possibility that municipalities may have been simultaneously exposed to broadcasts from multiple radio stations. To address this limitation, I construct an additional measure which captures the intensity of exposure, following an approach similar to Armand et al. [2020] and Rusche [2025]. Precisely, I build a cumulative measure that accounts for the gradual spatial and temporal expansion of the radio network and exploits the random overlap of signals from different transmitters. For each municipality i, radio station r, and year t, I start converting signal strength into a probability of coverage using a smooth logistic transformation,

$$p_{irt} = \left(1 + \exp\left(-\frac{E_{irt} - S}{\sigma}\right)\right)^{-1},$$

where E_{irt} denotes the predicted field strength, $S = 66$ dBμV/m is a standard threshold for reliable reception, and σ governs the smoothness of the transition around the threshold.[44] This transformation accounts for within-municipality heterogeneity and measurement error inherent in using centroid-based signal predictions. For each municipality–year, I then combine station-specific coverage probabilities to construct the cumulative probability that the municipality is exposed to radio broadcasting:

$$\text{CoveredProb}_{it} = \sum_{r=1}^{R_t} \text{AddedCoverageProbability}_{irt},$$

where $\text{AddedCoverageProbability}_{irt}$ measures the marginal increase in the probability that munici-

[44] I set the smoothness parameter to $\sigma = 5$, but results are robust to alternative values of σ.

pality i is covered by radio station r in year t, after accounting for coverage provided by all closer stations. By construction, this sum corresponds to the probability that at least one radio signal reaches the municipality in a given year. This aggregation avoids double-counting overlapping signals and corresponds to the union probability of radio coverage.[45] Last, I measure the intensity of radio exposure as the cumulative sum of annual coverage probabilities from 1924 up to the year in which the second survey was conducted::

$$\text{Intensity}_i = \sum_{t=1924}^{T} \text{CoveredProb}_{it}.$$

The resulting exposure index can be interpreted as the equivalent number of fully covered years experienced by a municipality over the period of radio diffusion, allowing for partial coverage in individual years.[46]

Table 4 presents the results, substituting radio signal strength in equation (2) with measures of the duration and intensity of exposure. Consistently with the observed pattern using signal strength, the coefficient for the *Duration* of exposure is positive and statistically significant (column 1). Precisely, the point estimate suggests that an additional year of exposure correlates with a 0.1 standard deviation increase in the linguistic convergence index. Additionally, the quadratic term presents a negative coefficient, implying that the positive impact of radio exposure on linguistic convergence fades over time. Reassuringly, the maximum of the function is reached at 8 years of radio exposure, with 83% of observations lying below this point.[47] These results remain stable after accounting for the hypothetical exposure duration when radio wave propagation is modeled without natural constraints (column 2). Results point to the same direction using the radio intensity of exposure instead of the mere duration of exposure. The coefficient of *Intensity* is positive and statistically significant, albeit smaller and less precise compared to *Duration* (column 3). The inclusion of a second-order polynomial to explore the non-linear marginal returns to exposure intensity suggests for a linear relationship between intensity of exposure and linguistic convergence (column 4). Similar to Armand et al. [2020], I additionally control for the median distance from all active

[45] This equation is equivalent to:

$$\text{CoveredProb}_{it} = 1 - \prod_{r} (1 - p_{irt}).$$

[46] Naturally, *Intensity* and *Duration* are highly associated with a correlation coefficient of 0.96.

[47] The detailed distributions of the duration and intensity of radio exposure are available in the Online Appendix.

transmitters and its square in the specification using the intensity of exposure, as multiple antennas might cover a single municipality.

Wording and pronunciation. Aforedescribed findings suggests a positive effect of radio exposure on language convergence. However, these results do not provide insights into which components of language were impacted by radio expansion. Radio exposure may have driven the full adoption of a new language, including both vocabulary and pronunciation, or it could have resulted in changes limited only to pronunciation. One attractive feature of the chosen encoding procedure of the linguistic entries is the possibility to derive an index of linguistic convergence purged of the phonetic component.[48] I present the findings of radio exposure on linguistic convergence, measured both including and excluding accents in Table 5. Column (1) shows the baseline results, with the index of linguistic convergence including both wording and pronunciation. Column (2) reproduces the coefficient estimate using as outcome the index of linguistic convergence with the accents excluding, which captures only convergence in vocabulary. The point estimate remains positive and significantly different from zero, albeit smaller in magnitude, suggesting that radio exposure propagated not only the Florentine pronunciation but, more prominently, Italian vocabulary.

Origins of Italian. In this part, I assess the hypothesis that the standard version of Italian established as the common language in country derives from a contemporary and simplified form of the dialect spoken in Florence. To do so, I reproduce estimate from equation 2 considering alternative reference points when computing the linguistic indices. Precisely, I selected localities within the Tuscany linguistic region, at a different distance from Florence, and the political capital of the country, Rome.[49] I systematically exclude the municipality used as reference point from the estimation process. Results reported in Appendix Table G5 suggest that coefficient for all Tuscany municipality used as reference point are positive, albeit not all statistically different from zero. The point coefficient seems to shrink towards zero when getting further from Florence, supporting the hypothesis that standard Italian emerged from the Florentine dialect. Interestingly, the coefficient for Rome is small and not statistically significant, ruling out the capital as being the linguistic reference in the convergence process.

[48] Precisely, I follow the approach proposed by Blanc and Kubo [2023] to remove the phonetic diacritics in the encoded linguistic entries and only retain the alphabetic letters, which capture the wording component of the convergence index. Next, I repeat the string distance computation using entries with accents removed, in order to produce measures of linguistic convergence that exclude the phonetic component.

[49] Only perfect matches were considered in the replication process.

Table 4: Radio Exposure and Linguistic Convergence, Years of Exposure

	Linguistic Convergence			
	(1)	(2)	(3)	(4)
Duration	0.099***	0.092**		
	(0.035)	(0.035)		
Duration (Second order)	-0.006**	-0.006**		
	(0.003)	(0.003)		
Intensity			0.040*	0.053*
			(0.021)	(0.032)
Intensity (Second order)				-0.001
				(0.002)
Average Years of Exposure	2.03	2.03		
Average Years of Full Coverage			2.32	2.32
Max of Parabola	7.93	7.98		19.13
Pct. Below Max	89.7%	94.4%		100%
Province FE	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓
Open Ground		✓		
Additional Controls	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓
Observations	612	612	612	612
R-squared	0.70	0.70	0.62	0.62

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Duration is computed as the number of years of radio exposure at the municipality level. Intensity is computed as the number of years of full radio coverage at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Radio Exposure and Linguistic Convergence, Wording and Pronunciation

	Wording & Pronunciation	Wording only
	(1)	(2)
Radio Exposure	0.623***	0.442**
	(0.204)	(0.217)
Province FE	✓	✓
ALI Year FE	✓	✓
Ling. Reg. FE	✓	✓
Radio Controls	✓	✓
Additional Controls	✓	✓
Dist. Weight	✓	✓
Observations	612	612
R-squared	0.60	0.55

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.3 Mechanisms

This section explores the local drivers and regional differences in linguistic convergence, considering the heterogeneous effects of the radio exposure treatment, which shed light on the potential underlying mechanisms.

Word adoption. Drawing on the rich set of atlas words underlying the linguistic metrics, I investigate features of language adoption by examining on the subset of words that may be driving the overall positive impact of radio exposure on linguistic convergence. First, I focus on daily-life or commonly used words, given their greater likelihood of appearing in radio broadcasts. To this end, I assign lexical frequency values to the atlas words using frequency distributions derived from the Italian web corpus [Baroni et al., 2009]).[50] Second, I examine whether the effect of radio exposure on language can be attributed to propaganda-oriented programs, given their growing prominence over time (see Figure 1b). Because transcripts and audio records of radio shows have not been preserved in sufficient quantity, I instead use the complete corpus of Mussolini's speeches as a proxy. These political speeches were widely broadcast, received substantial attention by a large audience. I collected all speeches delivered by Benito Mussolini between 1914 and 1942, amounting to 934 in

[50]The Italian web corpus (itWaC) is an Italian corpus made up of texts collected from the Internet and containing around 1.5 billion words.

total.[51] After preprocessing the texts (tokenization, removal of stop words, and lemmatization), the corpus yields approximately 20,000 unique words and 140,000 lemmatized tokens. The most frequently used terms include verbs such as "be", "can", and "must", as well as political concepts such as "italian, "people", "government", and "fascist". I subsequently match Mussolini's vocabulary with the itWaC corpus to compute an index of relative frequency, which measures the extent to which a given word was overused in his speeches compared to its standard use in Italian. This metric is derived from the comparison of the two frequency values and is defined as follows:

$$RFI_{fpmw} \equiv \frac{f_m}{F_m} \times \left(\frac{w_{fpmw}}{1{,}000{,}000} \right)^{-1},$$

where RFI_{fpmw} is the Relative Frequency Index for word w in propaganda-oriented Mussolini speeches, with f_m being the frequency of word w in Mussolini's speeches; F_m being the total number of words (tokens) in Mussolini's corpus and w_{fpmw} being the frequency of the same word w in the background corpus (itWaC), expressed per million words. The words with the highest RFI values, i.e. the most overused words in Mussolini's speeches are typically adverbs or numbers.

Results based on refined versions of the index of linguistic convergence are reported in Appendix Table G6. Column (1) reproduces the baseline estimates using the standard index. Column (2) employs a lexical-frequency–weighted version, constructed with the same set of words but weighting each by its frequency in itWaC (per million words). This approach assigns greater importance to common words. The estimated coefficient remains highly significant and slightly larger than the baseline, although the difference is too small to be statistically meaningful, suggesting that everyday words contribute to the overall effect but cannot fully account for it. Columns (3) and (4) use lexical frequencies from Mussolini's speeches. Column (3) restricts the analysis to atlas words that also appear in the speeches, while Column (4) further narrows the sample to words with an RFI score greater than 1, i.e., words overused by Mussolini relative to standard Italian.[52] The resulting coefficients are similar in magnitude and significance to the baseline, indicating that these subsets of words alone do not explain the overall findings.

Regional adoption of Italian. This part examines the differential effect of radio exposure

[51] The speeches are available on this website: https://www.adamoli.org/benito-mussolini/index.htm.

[52] The set of words used to construct the Mussolini frequency and Mussolini RFI indices are respectively reduced to 127 and 124 observations for the AIS and 135 and 130 observations for the ALI.

on the linguistic convergence process in regards to regional disparities. Columns (2) and (5) of Table G7 report the coefficients of equation (2) supplemented with an interaction term between radio exposure and the (mean-centered) log-transformed distance to Rome. The point estimate of radio exposure remains positive, albeit smaller in magnitude, for observations located at the average log distance to Rome (column 2). However, the radio effect on linguistic convergence becomes larger for municipalities situated further away from the capital. Additionally, the effect at the average fades away while the interaction term coefficient increases in magnitude, when restricting the linguistic convergence metric to its vocabulary component (column 5). These results suggest that the distance to Rome seems to be a significant factor in language convergence, especially the vocabulary component. In columns (3) and (6), I investigate heterogeneous effect in regards to the geographic distance to Florence. The interaction terms are positive but not statistically distinguishable from zero, suggesting that remoteness to the political capital city was the key factor in explaining regional differences. I extend this exercise, by interacting the array of historical linguistic region fixed-effects with the baseline radio exposure metrics, to derive a set of unique coefficients for each linguistic area (Figure 6).[53] Regions driving the average effect of radio exposure on language convergence are all distant from the capital and border foreign countries. These areas are home to speakers of local languages that are distinct from the Tuscan dialects (e.g., Friulano, Veneto) or belong to a different linguistic family altogether (e.g., Ladino, Provenzale, Sloveno, Tedesco). Interestingly, all regional coefficients remain positive and statistically significant when focusing solely on the wording aspect of the language, except the coefficient for Gallo-Italico. This makes sense, as speakers in this linguistic area use a local language closely related to standard Italian, so mainly pronunciation was primarily affected. For other impacted regions, the persistence of positive coefficients after excluding accents from the convergence measure indicates that the entire language, not just pronunciation, was affected. These findings are consistent with results reported in [Blanc and Kubo, 2023], which show that the effects of language were more pronounced in less integrated regions, where state capacity and national identity were originally weak.

Economic structure. I investigate the influence of the occupational structure and returns to human capital accumulation in explaining the adoption of the common language. If radio exposure provided a unique means of learning standard Italian, economic opportunities could have shaped

[53] The linguistic regions are mapped in Figure 4.

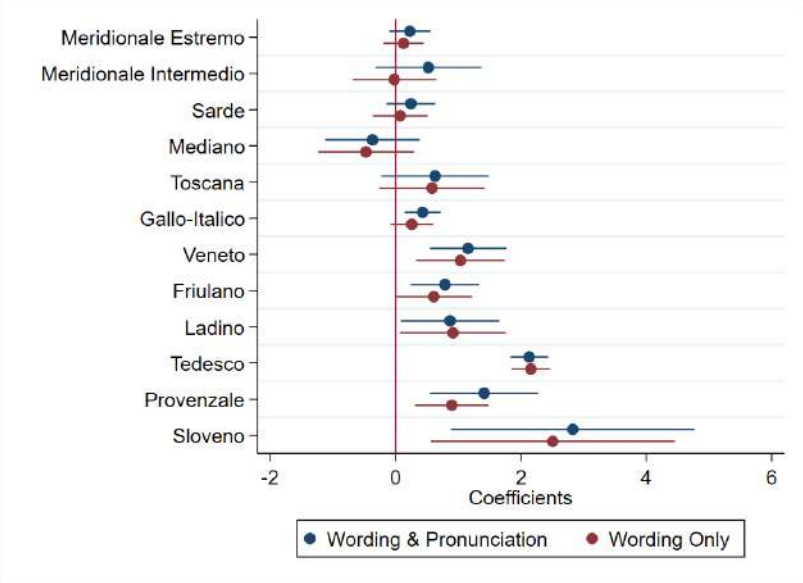


Figure 6: Heterogeneity by historical linguistic regions

Notes: This figure shows the results of radio exposure on language convergence, differentiated by historical linguistic regions. These regions are mapped in Appendix Figure 4. Coefficients for historical linguistic regions are plotted in descending order of distance from Italy's northern border.

the individuals' motivations during the adoption process. The political unification of the country throughout the late nineteenth century established a common market by removing trade barriers, suggesting that trade- and investment-related activities could have played a key role in the process of language homogenisation. Figure 7 shows the heterogeneous effects of radio coverage on linguistic convergence using a set of two dummies based on the median value for the shares of occupational categories, as defined in the 1931 national census. The effect of radio exposure appears to be larger in municipalities with higher shares of trade-, banking- and industry-related professions. These occupations involve more communication and connections between regions, suggesting for beneficial effects in adopting a common language. Appendix table G8 introduces the interaction terms using indicators based on the median threshold value for occupational categories in equation (2), in order to ensure that the observed differences are statistically significant at conventional levels.[54]

If the occupational structure shapes individuals' incentives to learn a new language, additional local characteristics could have facilitated the linguistic adoption process. Precisely, educational at-

[54]I further examine the influential role of business-related occupations, exploring the heterogeneous effects in relation to transportation networks and connectivity metrics. Additional findings indicate that the results are primarily driven by municipalities with better market access and proximity to river and postal networks, as shown in the Online Appendix.

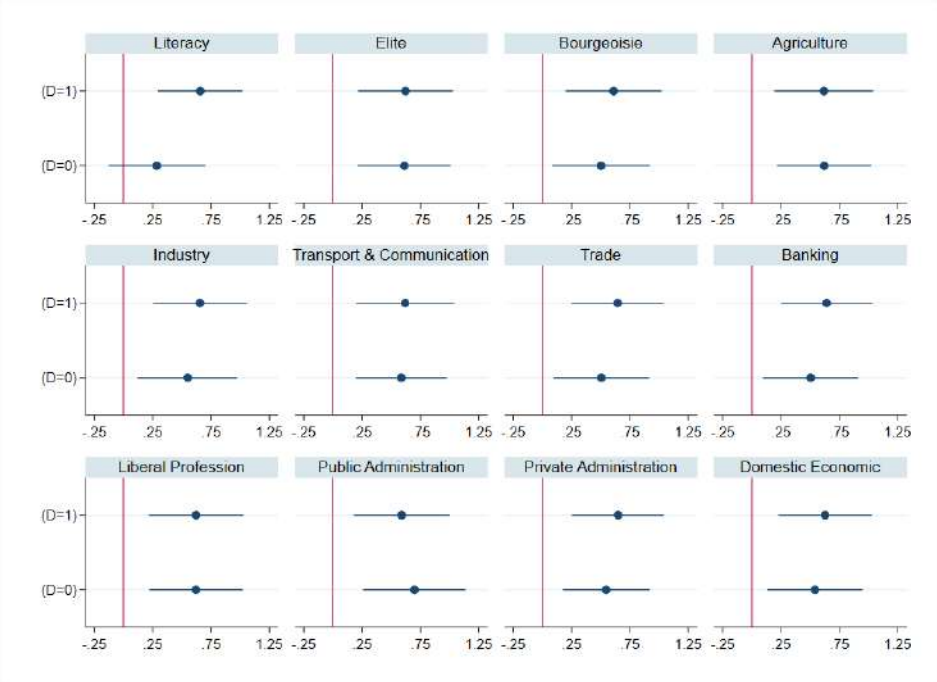


Figure 7: Heterogeneity by literacy and occupations rates

Notes: This figure shows the results of radio exposure on language convergence, differentiated by literacy and occupations rates. Each rate has been transformed into a dummy variable using the median as cutoff. "D=1" stands for the effect for municipalities situated above the median, and "D=0' stands for the effect for municipalities situated below the median. The figure shows the point estimates and the 95% confidence intervals.

tainment could play a substantial role in the homogenization process, providing individuals with the required cognitive and learning skills to acquire a new language. I test this assumption, by exploring the heterogeneous effect of radio exposure in regards to local levels of educational attainment, using literacy rate as proxy. Results presented in Appendix Table G9 suggest that the convergence process undermined by radio exposure occurred primarily in more literate locations. As schooling provision generally results from a top-down approach, one could be concerned that literacy rate may not be capturing the assimilation effect underlying educational attainment but rather that of elites. To investigate the latter hypothesis, I collected information on the shares of elite and bourgeoisie from the 1921 national census, using data from [Acemoglu et al., 2022]. This data being available for only 62% of the municipalities sample, I implemented a dummy variable adjustment procedure in order to retain the same number of observations.[55] However, the interaction terms for both elite and bourgeoisie only show little divergences across two groups, supporting the assimilation assumption (Figure 7).

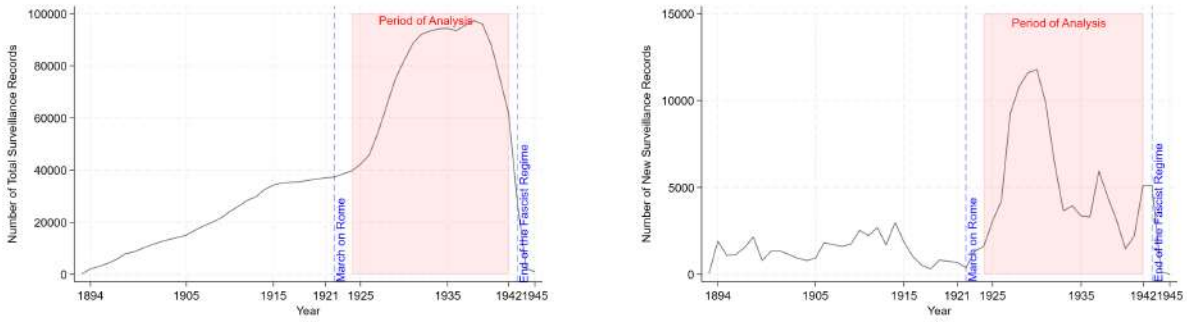
[55][Acemoglu et al., 2022] assembled information for a sample of approximately 5,775 Italian municipalities, out of the roughly 8,100 existing ones at this time.

6 Mass Media Propaganda and Political Persuasion

As propaganda content increasingly occupied radio airtime (see Section 2), this section examines the mass persuasion effects of a politically-controlled media in an autocratic state. The expected effects are theoretically ambiguous: exposure to fascist broadcasts could have strengthened support for the regime but may also have intensified opposition. A key challenge in addressing this question is the identification of an appropriate political outcome for this period, since competitive elections were no longer held after 1924 and access to the Fascist Party was tightly regulated from 1926 onward to curb opportunistic membership.

6.1 Political Attitudes Data from the Central Political Record

To measure political attitudes during the Fascist period, I use information on political opponents and subversive individuals recorded in the Central Political Registry (*Casellario Politico Centrale*, hereafter CPR). The CPR was a confidential archive administered by the Central Office of the State Police to monitor citizens deemed potential threats to the regime [Tosatti, 1990]. Established in 1894, it was initially used to track political dissidents but became a key instrument of mass surveillance following the consolidation of Mussolini's dictatorship. As displayed in Figure 8, 152,176 individuals were recorded in total in the CPR between 1894 and 1943: 40,532 entries before 1922 (about 1,400 per year on average) and 111,644 between 1923 and 1943 (about 5,300 per year on average). The CPR contains detailed personal files on individuals classified as political opponents, with information on the name, birth date, birthplace, residence, political affiliation, occupation, and the period of surveillance. This source has recently attracted growing attention in the economic literature. Specifically, it has been used to study the individual determinants of state surveillance [Dipoppa and Pezone, 2025], to analyze the causes and consequences of political repression (Panza et al. [2023]; Grau-Vilalta et al. [2025]; Fontana et al. [2025]), to document dissident behavior in the aftermath of World War I [Cervellati et al., 2025], and to measure political activity during the Fascist period in long-run analyses (Fontana et al. [2023]; Caprettini et al. [2025]).



(a) Total Records

(b) New Records

Figure 8: Surveillance Records in Italy, 1894-1945

Notes: Panel (a) shows the total number of surveilled individuals by the state between 1894 and 1945. Panel (b) shows the number of newly surveilled individuals by the state between 1894 and 1945. Data are from the Central Political Registry.

6.2 Difference-in-differences design

To causally investigate the effects of media-diffused propaganda on political attitudes, I rely on dynamic a difference-in-difference setting combining radio exposure and the surveillance activity at the municipality level. Precisely, I estimate the following equation of levels on changes in treatment:

$$Y_{i,t} = \sum_{\ell=-a}^{a} \beta_\ell T_{i,t}^{\ell} + X'_{i,t}\gamma + \delta_i + \zeta_t + \epsilon_{i,t} \tag{4}$$

where $Y_{i,t}$ is the standardized either total or newly identified regime opponents in municipality i at time t. $T_{p,t}^{\ell}$ are event time dummy variables taking the value of 1 when $t = y_i + \ell$, with y_i representing the year when radio exposure in the municipality a decent coverage level of $66 dB\mu V/m$. The periods correspond to one-year intervals, spanning from 1924 to 1942. I include the vectors δ_i and ζ_t as municipality and period fixed effects, respectively, to control for unobserved municipality characteristics with time-invariant effects on political attitude and time-varying factors affecting political activism homogeneously within the country. Although I first explore the unconditional effects, I additionally add a set of potential municipality-level confounders $X'_{i,t}$.[56] The standard errors are clustered at the municipality level to account for serial correlation.

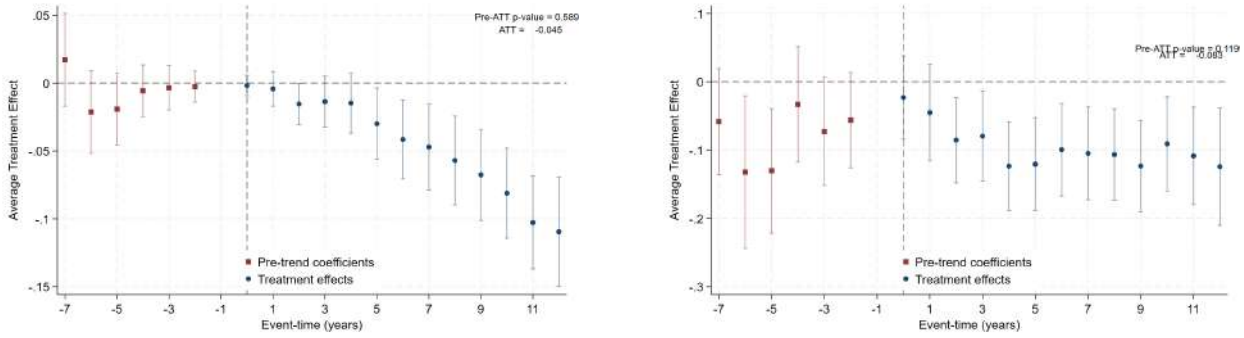
To account for the staggered treatment design due to the progressive opening of new radio stations over the period, I estimate equation (4) using the heterogeneity-robust estimator developed

[56]The vector of controls includes baseline time-varying characteristics (log market access and the number of propaganda events) as well as radio-related controls (free radio signal strength, a dummy for the presence of a radio station, and a quadratic term in the distance to the nearest radio transmitter).

by Callaway and Sant'Anna [2021].[57]

6.3 Main Results

Figure 9 reports the estimated event-time coefficients from equation (6), which capture the dynamic effects of radio exposure on the share of total surveilled individuals (panel (a)) and newly surveilled individuals (panel (b)), measured relative to the first year of radio coverage. Since the outcome variables are expressed as z-scores, the estimates can be interpreted in standard deviation units. Importantly, the estimates are presented without additional controls beyond year and province fixed effects, so as to assess the unconditional parallel trends assumption. For each year, the control group consists of municipalities that are either never treated or not yet treated.



Total Records (a) New Records (b)

Figure 9: Dynamic effect of radio coverage on the share of surveilled individuals

Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from Equation 4, representing the dynamic cumulative effect of radio coverage on the share of surveilled individuals. The period prior to radio exposure is normalized to zero. The dummy treatment is defined following threshold of $66 dB\mu V/m$ field strength in province radio signal, which is considered as the minimum sensitivity limit for AM broadcasting. Panel (a) shows the estimates for share of total surveilled individuals; Panel (a) shows the estimates for the share of newly surveilled individuals. Estimates are produced using the procedure developed by Callaway and Sant'Anna [2021]. Standard errors are corrected for clustering at the municipality level.

Surveillance rates appear to decline steadily after several years of exposure (panel (a)). If the coefficient for the first year of radio coverage is not statistically significant, the magnitude of the point estimates grows over time and becomes larger toward the end of the event window, pointing to persistent and long-lasting effects of radio exposure. The average treatment effect on the treated (ATT) corresponds to a 0.045 standard deviation reduction in the surveillance rate and is statistically significant at the 1% level (p-value < 0.001). Turning to the pre-treatment dynamics, the coefficients for the placebo periods are not statistically distinguishable from zero. This pattern

[57] Alternatively, I use the estimator proposed by De Chaisemartin and d'Haultfoeuille [2024] for robustness purposes.

supports the key assumption of flat pre-treatment trends, a conclusion reinforced by the large p-value associated with the pre-treatment ATT. The reduction in overall surveillance appears to be driven by a decline in newly surveilled individuals (panel (b)). The effect emerges quickly following the expansion of coverage and plateaus in subsequent years at a negative level.[58] One interpretation is that the regime's consolidation of media control reduced observable political opposition by shaping citizens' beliefs. Consistent with the theory of informational autocracy [Treisman and Guriev, 2023], centralized control over mass communication may have enabled the Fascist regime to monopolize narratives and project competence and legitimacy, hence dampening incentives for dissent behaviors.

I assess the robustness of the results to alternative estimation choices. Appendix Figure F9 re-estimates equation (4) under several specifications: restricting the control group to never-treated municipalities only (panel (a)); adding time-varying baseline and radio-propagation controls (panel (b)); employing the estimator proposed by De Chaisemartin and d'Haultfoeuille [2024] (panel (c)); and aggregating outcomes by municipality of birth rather than municipality of residence. Overall, the results remain largely unchanged across specifications. Appendix Figure F10 conducts the same set of robustness checks using the share of newly surveilled individuals as the outcome variable. Last, I replicate the analysis using the conventional two-way fixed effects (TWFE) estimator, which may nevertheless yield biased estimates in the presence of heterogeneous treatment effects. Results are available in the Online Appendix.

6.4 Long-term effects

This subsection examines the long-term effects of radio-diffused propaganda on political behaviors and preferences. To this end, I use electoral and survey data from Carillo's (2022) replication package.[59]

I consider electoral outcomes for nearly all Italian municipalities across eleven parliamentary elections held between 1948 and 1992. The year 1948 corresponds to the first election in which a neo-fascist party was allowed to compete following the end of the dictatorship, while 1992 marks the onset of political scandals that led to the collapse of most established political parties. Specifically,

[58] The evidence in support of the parallel trends assumption is weaker for this outcome, warranting a more cautious interpretation.

[59] Many thanks to Mario Carillo for sharing the data. The original electoral data are drawn from Corbetta et al. [2009].

I consider two outcomes: (i) the vote share of the neo-fascist party (MSI) and (ii) voter turnout. In addition to electoral outcomes, I zoom on political attitudes and cultural values using individual-level survey data from the Italian National Election Studies (ITANES) for 2001, 2004, and 2008.

To causally investigate the long-term effects of fascist radio exposure on political attitudes, I estimate the following econometric model:

$$y_{ipt} = \beta Signal_{ip} + RadioControls_{ip}\alpha + X_{ip}^{'}\gamma + \delta_{p,(i)} + \epsilon_{(i),p} \tag{5}$$

where y_{ipt} is the electoral outcome of municipality i located in province p in electoral round t. The main variable of interest is $Signal_{ip}$ measures radio exposure in municipality i in province p captured either by the duration of exposure (the number of years of radio access) or its intensity (the number of years of full radio coverage). For identification purpose, $RadioControls_{ip}$ includes the same set of radio-propagation controls as in equation (2).[60] $X_{ip}^{'}$ is a vector of municipality-level controls, including geographic characteristics similar to equation (2), and adds the log population in 1991, and population growth between 1951 and 1991. Province fixed effects $\delta_{p,(i)}$ ensure comparisons across municipalities within the same province. Standard errors are clustered at the province level to account for spatial correlation.

Results are presented in Appendix Figure F8 with panel (a) using the vote share of the neo-fascist party (MSI) as the outcome, while panel (b) considering voter turnout. Each coefficient corresponds to a separate election year. The specification includes a quadratic term in radio exposure intensity to capture potential nonlinear effects and account for the right-skewed distribution of exposure. Overall, the estimates point to limited political effects of radio exposure. Exposure has essentially no effect on the vote share of the neo-fascist party and is associated with higher turnout, although the marginal effect declines with exposure intensity. This relationship does not persist when exposure is measured by duration rather than intensity.[61] Estimates based on individual-level survey data using equation (5) similarly indicate no evidence of long-term effects on political preferences.[62]

[60] In addition, following Armand et al. [2020], I include a second-order polynomial in the median distance to all active antennas when using exposure intensity, as this measure of radio exposure depends on the full network of transmitters.

[61] In addition, I report results with specifications excluding the quadratic term to examine purely linear effects of radio exposure. Details are in the Online Appendix.

[62] The surveys include measures capturing the extent to which individual preferences align with elements of Fascist ideology, including nationalism, support for a strong leader, attitudes toward Fascism, and views on immigrants and minority groups. Detailed tables are available in the Online Appendix.

7 Mass Media Propaganda and Social Norms

This section examines the mass-persuasion effects of radio-diffused propaganda on cultural norms and social practices. Specifically, I assess how exposure to fascist radio broadcast affected fertility, the main objective underlying the regime's pronatalist campaign known as the *Battle for Births*.

Battle for Births. The *Battle for Births* was one of four economic battles - main targeted priorities - undertaken by Benito Mussolini's Fascist regime in Italy during the 1920s and 1930s. This major campaign aimed to increase the country's population through encouraging higher birth rates among Italian families (De Grazia [1992]). Mussolini outlined his views on demographics in his famous speech of the 1927 Feast of the Ascension (26th May), where he emphasized that a growing population was crucial for strengthening Italy's military and economic power ("The destiny of nations depends on their demographic potential"). He established a direct link between population growth and national interests, praising for large families and framing childbirth as a patriotic duty ("Italians must multiply and multiply rapidly" and "Large families are the greatest blessing for the nation"). Consequently, the regime implemented several fiscal measures, including financial support for large families and needy mothers, taxes on unmarried men, or restrictions on contraception and abortion [Duggan, 2008]. These legal measures were complemented with an intense propaganda campaign, glorifying the role of "authentic woman" [Forcucci, 2010]. Mass-media were intensely mobilized to promote increased birth rates and encouraged maternity as a form of female patriotism. Slogans and speeches were regularly broadcast on the radio, alongside programs specifically designed to promote motherhood and family values, such as "L'Ora della Famiglia" [De Grazia, 1992].[63] Ultimately, despite these massive efforts, the Battle for births only showed little success in curbing the steadily declining birth rates overall (Appendix Figure F11).

7.1 Sample

To assess the effects of the propaganda campaign underlying the *Battle for Births* on population dynamics, I collected yearly data on fertility and marriage rates between 1921 and 1940, using governmental annual reports.[64] Because annual series of these outcomes at the municipality level

[63] Translated as "The Family Hour".

[64] The reports are originally entitled *Movimento' della popolazione secondo gli atti dello' stato' civile*. Although they were produced under the Fascist administration, systematic manipulation of the reported figures is considered unlikely. The data derive from decentralized civil registration records used for legal and administrative purposes,

are lacking, I rely on aggregated data at the provincial level, which is the intermediate administrative division between municipalities and regions. My final sample includes all 95 Italian provinces over a span of 20 years, resulting in a total of 1,900 observations.[65]

7.2 Dynamic difference-in-differences design

I consider a dynamic difference-in-differences (DiD) approach to causally estimate the effects of radio coverage on fertility decisions. One limitation of the static dynamic (DiD) approach relies on its assumption of constant treatment effects over time. While this assumption may hold in some contexts, it is unlikely to be valid in the case of propaganda disseminated through mass media, as its impact on fertility decisions could vary over the years.[66] Consequently, I adopt an event study design to examine the dynamic effects of radio treatment over time. Precisely, I estimate the following equation of levels on changes in treatment:

$$Y_{p,t+1} = \sum_{\ell=-a}^{a} \beta_\ell T_{p,t}^{\ell} + X'_{p,t}\gamma + \delta_p + \zeta_t + \epsilon_{p,t} \tag{6}$$

where $Y_{p,t+1}$ is the fertility rate of province p at time $t+1$, defined as crude birth rate following the annual number of live births per 1,000 population and standardized for interpretation purpose. To account for the lagging feature of fertility underlying the 9-months long pregnancy period, I consider the outcome in the subsequent year. $T_{p,t}^{\ell}$ are event time dummy variables taking the value of 1 when $t = y_p + \ell$, with y_p representing the year when radio exposure in the province reaches a satisfactory coverage level of $66 dB\mu V/m$. The periods correspond to one-year intervals, spanning from 1921 to 1940. I include the vectors δ_p and ζ_t as province and period fixed effects, respectively, to control for unobserved province characteristics with time-invariant effects on fertility and time-varying factors affecting fertility rates homogeneously within the country. $X'_{p,t}$ is a set of potential province-level cofounders, which is the same as above. The standard errors are clustered at the province level to account for serial correlation.

Staggered Treatment Design. With the progressive opening of new radio stations over

making large-scale falsification costly and readily detectable. Accordingly, historical demographers generally regard these statistics as a primary and reliable source, and they are widely used in studies of Italian demographic change, including analyses of Fascist population policy [Ipsen, 1992].

[65] I use the 1991 administrative borders as reference units in order to ensure consistent geography over the period.

[66] Although the estimated coefficients will likely be biased, I derive results using a static design in Appendix E.

the period, radio coverage was achieved in different year across provinces, in a staggered treatment introduction fashion (Appendix Figure F12). In this case, the use of conventional two-way fixed-effects (TWFE) estimation could produce biased results in the presence of heterogeneous treatment effects (see Appendix E for additional explanations). Hence, I estimate equation (6) using the heterogeneity-robust estimator developed by Callaway and Sant'Anna [2021]. This method is specifically suitable for settings with the staggered adoption of a binary and absorbing treatment. Absorbing treatment implies that once a province achieves sufficiently strong radio coverage, it is assumed to maintain good coverage for the remainder of the observed period. This assumption is reasonable, as radio transmitters were never dismantled or abandoned after their construction but were instead upgraded to enhance their power and reach. The baseline estimation method uses the never-treated provinces as control group and relies on the 'long-differences" in the computation of both the pre- and post-treatment coefficients in order to interpret the event-study outcomes in a traditional manner [Roth, 2024].[67] Alternatively, I use the estimator proposed by De Chaisemartin and d'Haultfoeuille [2024] for robustness purposes.

Identification. The validity of difference-in-difference estimates relies on two key identifying assumptions. First, in the absence of radio treatment, the average fertility outcomes among the treated and comparison groups would have followed the same trend (parallel trend assumption). Second, treatment has no causal effect prior to its implementation (no anticipation assumption). This latter assumption could be violated if radio transmitters were installed in response to significant local shocks affecting fertility decisions. These assumptions together enable the identification of the average treatment effect on the treated (ATT). While it is not possible to directly test these assumptions, I perform the sensitivity analysis proposed by Rambachan and Roth [2023] to gauge the potential violations of the parallel trends assumption, as discussed in Appendix E.

7.3 Main Results

Figure 10 shows the estimated event-time dummy coefficients from equation (6) and the respective 95% confidence intervals, using the estimation process from Callaway and Sant'Anna [2021]. These coefficients capture the dynamic effect of radio exposure on birth rate for each period relative to the first year of radio coverage. As the fertility rate is expressed in z-score, the estimates can be

[67] Precisely, I ensure using the option "long2" from the `csdid` Stata package.

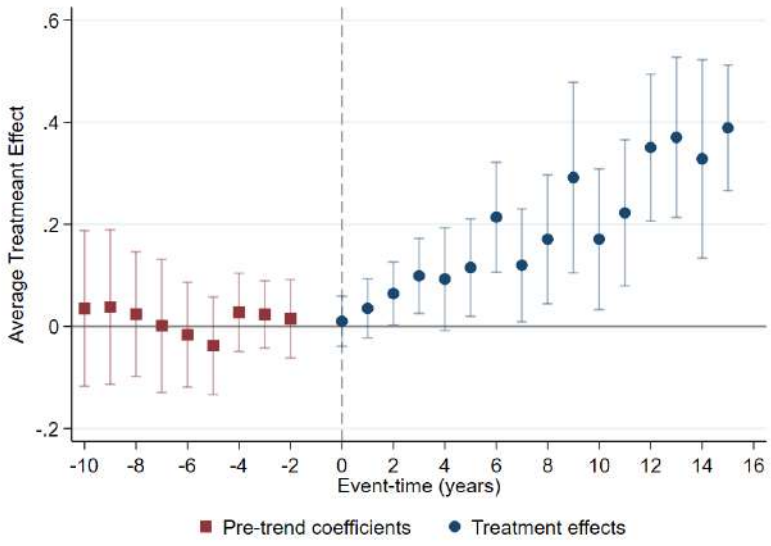


Figure 10: Dynamic effect of radio coverage on fertility rate

Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from Equation 6, representing the dynamic effect of radio coverage on fertility rate. The period prior to radio exposure is normalized to zero. The dummy treatment is defined following threshold of $66 dB\mu V/m$ field strength in province radio signal, which is considered as the minimum sensitivity limit for AM broadcasting. Standard errors are corrected for clustering at the province level.

interpreted in terms of standard deviations. Additionally, the design enables to explore the effect for nine periods prior to the first year of radio coverage and extends up to sixteen periods afterward.

The estimates are presented without the inclusion of any controls other than the set of year and provinces fixed-effects, in order to assess the unconditional parallel trend assumption. The coefficients for the placebo periods before treatment are not significantly different from zero, suggesting for flat pre-treatment trends. This supports the assumption that the placement of radio transmitters was orthogonal to local changes in fertility rates and that, in the absence of treatment, fertility rates would have followed similar trends across provinces that attained good radio coverage at different times. More empirical tests supporting this assumption are presented in Appendix E.

The coefficient for the first year of radio coverage is not statistically different from zero, indicating that fertility decisions are not immediately influenced by radio-diffused propaganda. However, there is a clear and steady rise in birth rates after a few years of radio coverage. The point estimates increase over time and become larger towards the end of the event window, suggesting for long-lasting effects of radio exposure. The reported average treatment effects on the treated (ATT) is equal to 0.11 standard deviation increase in the fertility rate and statistically significant at the 1% level (P-value$<$0.001).

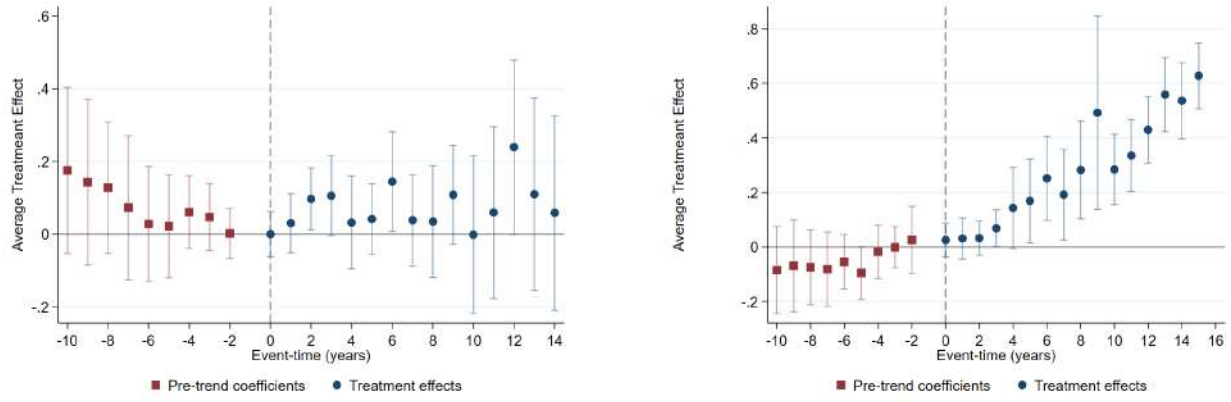
To ensure that the reported coefficients are not sensitive to any choices related to the estimation procedure, I reproduce estimates from equation (6) using alternative specifications. Appendix Figure F13 shows the dynamic effect of radio coverage on fertility decisions using four alternative regression models. Precisely, panel (a) uses the non-treated yet instead of the never-treated provinces as control group; panel (b) controls for the province population and artificial signal strength; panel (c) considers another treatment dummy based on a cutoff of $60 dB\mu V/m$ for minimum radio coverage; and panel (d) implements an alternative binary treatment on a 50% population-threshold of individuals featured with good coverage. Reassuringly, all these alternative event-studies point to a similar pattern regarding the effect of radio coverage on fertility decisions. Similarly, I ensure findings's robustness to estimation method selection, by replicating the results using the procedure outlined by De Chaisemartin and d'Haultfoeuille [2024]. Appendix Figure F14 plots the estimates, which yield to an analogous picture.[68]

7.4 Heterogeneity by linguistic proximity

I explore the role of understanding the broadcasting language used in mass media to evaluate how language influences the absorption of propaganda. Specifically, I test the hypothesis that propaganda content was better understood and integrated in areas where the local language was more closely related to standard Italian. To do this, I divide the provinces into two groups based on the median value of their initial linguistic proximity to standard Italian and reproduce the estimates from equation (6) for each group.

Appendix Figure 11 illustrates the differentiated effects over time for these two groups, showing no evidence of pre-treatment trends in either group. The positive and cumulative effect of radio coverage on fertility rates appears to be primarily driven by provinces with a local language more closely aligned to standard Italian (panel (b)). In contrast, provinces where the local language ranks lower in linguistic proximity to Italian show limited effects from radio exposure (panel (a)). Examining the ATTs, the ATT for the far-linguistic group is positive (0.06) but not statistically distinguishable from zero (p-value > 0.168). In contrast, the ATT for the close-linguistic group is higher (0.16) and achieves conventional levels of statistical significance (p-value < 0.002).

[68] Additionally, I reproduce all event-studies showed in the robustness check using the method proposed by De Chaisemartin and d'Haultfoeuille [2024]. Results are available in the Online Appendix.



Below the Median (a) Above the Median (b)

Figure 11: Dynamic effect of radio coverage on fertility rate, heterogeneity by linguistic proximity to Italian

Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from Equation 6, representing the dynamic cumulative effect of radio coverage on fertility rate. The period prior to radio exposure is normalized to zero. The dummy treatment is defined following threshold of $66 dB\mu V/m$ field strength in province radio signal, which is considered as the minimum sensitivity limit for AM broadcasting. Panel (a) shows the estimates for the subsample of province group below the median value of linguistic proximity to Italian; Panel (a) shows the estimates for the subsample of province group above the median value of linguistic proximity to Italian. Estimates are produced using the procedure developed by Callaway and Sant'Anna [2021]. Standard errors are corrected for clustering at the province level.

These findings are robust to the choice of estimation method, as the differential estimates obtained using the approach of De Chaisemartin and d'Haultfoeuille [2024] yield quantitatively similar results (Appendix Figure F15). Overall, these results suggest that linguistic proximity to the broadcasting language plays a significant role in enhancing the effectiveness of propaganda and shaping individuals' behaviors and values.

8 Conclusion

This paper investigates the causal effects of exposure to radio broadcasts on cultural homogenization and language convergence in Italy. The estimation process relies on the original use of linguistic surveys conducted during the Interwar period to build novel measures of linguistic convergence at the municipality level. The language metrics are combined with predicted measures of radio signal strength to assess the effects of radio coverage on the linguistic homogenization process. Results point to radio exposure as a prime driver of linguistic convergence, accounting for over 60% of the variation in this measure. Additionally, radio coverage is shown to be a significant tool employed by the Fascist government, not only to promote a common language but also to disseminate regime ideology, as reflected in declining political opposition and rising fertility rates.

These findings suggest that mass media serves as a powerful instrument for autocratic regimes to strengthen their control over society, with long-lasting effects on individual behavior that extend beyond political opinions. The present study calls for future research to explore other factors identified in the literature that contributed to language convergence in both autocratic and democratic contexts, such as compulsory military service or the development of transport infrastructure.

References

Acemoglu, Daron, Giuseppe De Feo, Giacomo De Luca, and Gianluca Russo, "War, socialism, and the rise of fascism: An empirical exploration," *The Quarterly Journal of Economics*, 2022, *137* (2), 1233–1296.

Adena, Maja, Ruben Enikolopov, Maria Petrova, Veronica Santarosa, and Ekaterina Zhuravskaya, "Radio and the Rise of the Nazis in Prewar Germany," *The Quarterly Journal of Economics*, 2015, *130* (4), 1885–1939.

Adorno, Theodor W, "A social critique of radio music," *The Kenyon Review*, 1945, *7* (2), 208–217.

Ahmed, Resuf, Paul Brimble, Akhila Kovvuri, Alessandro Saia, and Dean Yang, "Ancient Epics in the Television Age: Religious Identity and the Rise of Hindu Nationalism in India," *NBER Working Paper*, 2025, (w33417).

Alesina, Alberto Francesco and Bryony Reich, "Nation building," 2015.

Ang, Desmond, "The birth of a nation: Media and racial hate," *American Economic Review*, 2023, *113* (6), 1424–1460.

Argan, Damiano and Anatole Cheysson, "Plurilingualism and Brain Drain: Unexpected Consequences of Access to Foreign TV," *Available at SSRN 4395413*, 2023.

Armand, Alex, Paul Atwell, and Joseph F Gomes, "The reach of radio: Ending civil conflict through rebel demobilization," *American economic review*, 2020, *110* (5), 1395–1429.

_ , _ , Joseph Gomes, and Yannik Schenk, "It's a Bird, It's a Plane, It's Superman!: Using Mass Media to Fight Intolerance," Technical Report, Centre for Economic Policy Research 2023.

Arnheim, Rudolf, "Radio: An art of sound.," 1936.

Bacci, Massimo Livi, "A history of Italian fertility during the last two centuries," 2015.

Baroni, Marco, Silvia Bernardini, Adriano Ferraresi, and Eros Zanchetta, "The WaCky wide web: a collection of very large linguistically processed web-crawled corpora," *Language resources and evaluation*, 2009, *43* (3), 209–226.

Baudin, Thomas and Robert Stelter, "Kinder, Küche und Kirche, Family policies and fertility in the Third Reich," 2023.

Beach, Brian and W Walker Hanlon, "Censorship, family planning, and the historical fertility transition," Technical Report, National Bureau of Economic Research 2019.

Bean, Bradford R, *A world atlas of atmospheric radio refractivity*, Vol. 52, US Government Printing Office, 1966.

Bertoni, Giulio, *L'Atlante linguistico italiano*, Società Filologica Friulana, 1925.

Blanc, Guillaume and Masahiro Kubo, "HAL Id: hal-04292485," 2023.

Blouin, Arthur and Julian Dyer, *How cultures converge: An empirical investigation of trade and linguistic exchange*, University of Toronto, Department of Economics, 2021.

_ **and Sharun W Mukand**, "Erasing ethnicity? Propaganda, nation building, and identity in Rwanda," *Journal of Political Economy*, 2019, *127* (3), 1008–1062.

Boken, Johannes, Mirko Draca, Nicola Mastrorocco, and Arianna Ornaghi, "The returns to viral media: the case of US campaign contributions," 2023.

Bonfatti, Roberto, Giovanni Facchini, Alexander Tarasov, Gian Luca Tedeschi, and Cecilia Testa, "Pork, infrastructure and growth: Evidence from the Italian railway expansion," 2021.

Bönisch, Peter and Walter Hyll, "Television and fertility: Evidence from a natural experiment," *Empirical Economics*, 2023, *64* (3), 1025–1066.

Bracco, Emanuele, Maria De Paola, and Colin P Green, "Long lasting differences in civic capital: Evidence from a unique immigration event in Italy," *Journal of Economic Behavior & Organization*, 2015, *120*, 160–173.

Callaway, Brantly and Pedro HC Sant'Anna, "Difference-in-differences with multiple time periods," *Journal of econometrics*, 2021, *225* (2), 200–230.

Cannella, Mario and Matteo Magnaricotte, "Electoral effects of U.S. Soft Power: Evidence from Hollywood movies in Cold war Italy," Technical Report 2024.

Cannistraro, Philip V, "La fabbrica del consenso: fascismo e mass media," *(No Title)*, 1975.

Canobbio, Sabina, "L'Atlante linguistico corne strumento di ricerca? A proposito di alcune esperienze italiane," *Revue belge de philologie et d'histoire*, 2002, *80* (3), 905–929.

Cantril, Hadley and Gordon Willard Allport, "The psychology of radio.," 1935.

Caprettini, Bruno, Lorenzo Casaburi, and Miriam Venturini, "Harvesting votes: the electoral effects of the Italian land reform," *Available at SSRN 5404214*, 2025.

Carillo, Mario F, "Agricultural policy and long-run development: evidence from Mussolini's Battle for Grain," *The Economic Journal*, 2021, *131* (634), 566–597.

_ , "Fascistville: Mussolini's new towns and the persistence of neo-fascism," *Journal of Economic Growth*, 2022, *27* (4), 527–567.

Castellani, Arrigo Ettore, *Quanti erano gl'italofoni nel 1861?*, Salerno, 1982.

CCIR, "Recommendation 832: World Atlas of Ground Conductivity, Technical Report," 1992.

Cervellati, Matteo, Eleonora Esposito, Giacomo Plevani, and Alessandro Saia, "When We Rebel: Clashing Narratives and the Making of Subversive Identities," Discussion Paper 20808, CEPR, Paris and London 2025.

Chaisemartin, Clément De and Xavier d'Haultfoeuille, "Difference-in-differences estimators of intertemporal treatment effects," *Review of Economics and Statistics*, 2024, pp. 1–45.

Ciccarelli, Carlo and Peter Groote, "Railway endowment in Italy's provinces, 1839-1913," *Rivista di storia economica*, 2017, *33* (1), 45–88.

Conley, Timothy G, "GMM estimation with cross sectional dependence," *Journal of econometrics*, 1999, *92* (1), 1–45.

Corbetta, Piergiorgio, Maria Serena Piretti et al., *Atlante storico elettorale d'Italia: 1861-2008*, Zanichelli, 2009.

Crabtree, Charles and Holger L Kern, "Using electromagnetic signal propagation models for radio and television broadcasts: An introduction," *Political Analysis*, 2018, *26* (3), 348–355.

D'Amico, G, M Patti et al., "Introduzione, in [Meridiana: rivista di storia e scienze sociali: 92, 2, 2018].," *MERIDIANA*, 2018, *92* (92), 9–23.

DellaVigna, Stefano and Eliana La Ferrara, "Economic and social impacts of the media," in "Handbook of media economics," Vol. 1, Elsevier, 2015, pp. 723–768.

_ **and Matthew Gentzkow**, "Persuasion: empirical evidence," *Annu. Rev. Econ.*, 2010, *2* (1), 643–669.

_ **, Ruben Enikolopov, Vera Mironova, Maria Petrova, and Ekaterina Zhuravskaya**, "Cross-border media and nationalism: Evidence from Serbian radio in Croatia," *American Economic Journal: Applied Economics*, 2014, *6* (3), 103–132.

DeMinco, Nicholas, "Medium frequency propagation prediction techniques and antenna modeling for intelligent transportation systems (its) broadcast applications," Technical Report, Institute for Telecommunication Sciences 1999.

der Pol, Balth Van and H Bremmer, "XIII. The diffraction of electromagnetic waves from an

electrical point source round a finitely conducting sphere, with applications to badiotelegraphy and the theory of the rainbow.—Part I," *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 1937, *24* (159), 141–176.

Dipoppa, Gemma and Annalisa Pezone, "The Logic of State Surveillance," Technical Report, National Bureau of Economic Research 2025.

Dominici, Alice, Frederic Docquier, Fabio Mariani, and Martin Fernandez Sanchez, "Networks, Diversity, and Migrants' Success: Evidence from the Pontine Marshes, 1932-1941," *Working Version*, 2024.

Duggan, Christopher, *The force of destiny: A history of Italy since 1796*, Houghton Mifflin Harcourt, 2008.

Durante, Ruben, Paolo Pinotti, and Andrea Tesei, "The political legacy of entertainment TV," *American Economic Review*, 2019, *109* (7), 2497–2530.

Eckert, Fabian, Andrés Gvirtz, J Liang, and M Peters, "A consistent county-level crosswalk for us spatial data since 1790," *NBER Working Paper*, 2018, (26632).

Enikolopov, Ruben and Maria Petrova, *Mass media and its influence on behaviour*, CREI, Centre de Recerca en Economia Internacional, 2017.

_ , _ , and Ekaterina Zhuravskaya, "Media and political persuasion: Evidence from Russia," *American economic review*, 2011, *101* (7), 3253–3285.

Esposito, Elena, Tiziano Rotesi, Alessandro Saia, and Mathias Thoenig, "Reconciliation narratives: The birth of a nation after the us civil war," *American Economic Review*, 2023, *113* (6), 1461–1504.

ETSI, "Broadcast Sound Receivers; Part 2: AM broadcast sound service; Harmonised Standard for access to radio spectrum," 2021.

Falck, Oliver, Stephan Heblich, Alfred Lameli, and Jens Südekum, "Dialects, cultural identity, and economic exchange," *Journal of urban economics*, 2012, *72* (2-3), 225–239.

Fegiz, Pierpaolo Luzzatto, *Il volto sconosciuto dell'Italia: seconda serie, 1956-1965* 1966.

Fenske, James and Namrata Kala, "Linguistic distance and market integration in india," *The Journal of Economic History*, 2021, *81* (1), 1–39.

Ferrara, Eliana La, Alberto Chong, and Suzanne Duryea, "Soap operas and fertility: Evidence from Brazil," *American Economic Journal: Applied Economics*, 2012, *4* (4), 1–31.

Fochi, Franco, "L'EIAR, IL «PRONTUARIO», LA RAI E IL DOP," *Italianistica: Rivista di letteratura italiana*, 1990, pp. 417–420.

Fontana, Nicola, Francesco Barilari, and Nicola Mastrorocco, "When the Dictator Is in Town," 2025. Working paper.

_ , Tommaso Nannicini, and Guido Tabellini, "Historical roots of political extremism: The effects of Nazi occupation of Italy," *Journal of Comparative Economics*, 2023, *51* (3), 723–743.

Forcucci, Lauren E, "Battle for births: The fascist pronatalist campaign in Italy 1925 to 1938," *Journal of the Society for the Anthropology of Europe*, 2010, *10* (1), 4–13.

Fujiwara, Thomas, Karsten Müller, and Carlo Schwarz, "The effect of social media on elections: Evidence from the united states," *Journal of the European Economic Association*, 2024, *22* (3), 1495–1539.

Gagliarducci, Stefano, Massimiliano Gaetano Onorato, Francesco Sobbrio, and Guido Tabellini, "War of the waves: Radio and resistance during World War II," *American Economic Journal: Applied Economics*, 2020, *12* (4), 1–38.

Galdi, Roberto, Francesco Pietra, and Antonio Savini, "Radio broadcasting and its political use in Italy between the two world wars," in "2010 Second Region 8 IEEE Conference on the History of Communications" IEEE 2010, pp. 1–6.

Garcia-Arenas, Javier, "The impact of free media on regime change: Evidence from Russia," *The Quarterly Journal of Economics*, 2016, *128*, 105–164.

Ginsburgh, Victor and Shlomo Weber, "The economics of language," *Journal of Economic Literature*, 2020, *58* (2), 348–404.

Giulio, Bertoni and Ugolini Francesco, "Prontuario di pronunzia e di ortografia," 1939.

Goebl, Hans, "Dialektometrische Streifzüge durch das Netz des Sprachatlasses AIS," *Ladinia-Revista scientifica dl Istitut Ladin Micurà de Rü*, 2007, pp. 187–271.

_ , "La dialettometrizzazione integrale dell'AIS. Presentazione di primi risultati," *Revue de linguistique romane*, 2008, pp. 25–113.

Goodman-Bacon, Andrew, "Difference-in-differences with variation in treatment timing," *Journal of econometrics*, 2021, *225* (2), 254–277.

Grau-Vilalta, Pau, Lorenzo Vicari, and Andrea Xamo, "Feather-Handed Fascists: Surveillance as a Signal of Bureaucratic Alignment," 2025.

Grazia, Victoria De, *How fascism ruled women: Italy, 1922-1945*, Univ of California Press, 1992.

Hobsbawm, Eric J, *Nations and nationalism since 1780: Programme, myth, reality*, Cambridge university press, 1992.

International Telecommunications Union, "Recommendation ITU-R BS.412-9," Recommendation ITU-R BS.412-9, International Telecommunications Union 2008. Geneva, Switzerland.

Ipsen, Carl David, *Dictating Demography: The Problem of Population in Fascist Italy*, University of California, Berkeley, 1992.

Isola, Gianni, *L'ha scritto la radio: storia e testi della radio durante il fascismo (1924-1944)*, Mondadori Bruno, 1998.

ITU, "Compatibility of amateur service stations with existing services in the range 415-526.5 kHz. Report ITU-R M.2203," 2010.

_ , "Handbook On Ground Wave Propagation. Radiocommunication Bureau," 2014.

Jaberg, Karl, Jakob Jud, Paul Scheuermeier, Gerhard Rohlfs, and Max Leopold Wagner, "Sprach-und sachatlas Italiens und der Südschweiz," *(No Title)*, 1928.

Jakiela, Pamela, "Simple diagnostics for two-way fixed effects," *arXiv preprint arXiv:2103.13229*, 2021.

Jensen, Robert and Emily Oster, "The power of TV: Cable television and women's status in India," *The Quarterly Journal of Economics*, 2009, *124* (3), 1057–1094.

Kearney, Melissa S and Phillip B Levine, "Media influences on social outcomes: The impact of MTV's 16 and pregnant on teen childbearing," *American Economic Review*, 2015, *105* (12), 3597–3632.

Kelly, Morgan, Joel Mokyr, and Cormac Ó Gráda, "The mechanics of the Industrial Revolution," *Journal of Political Economy*, 2023, *131* (1), 59–94.

Kessler, Brett, "Computational dialectology in irish gaelic," in "Seventh conference of the European Chapter of the Association for Computational Linguistics" 1995.

Khalifa, Suzanna, "Female genital cutting and bride price," 2022.

Krefeld, Thomas, "Dialetto, variazione linguistica–e l'AIS," *Romanistisches Jahrbuch*, 2005, *55*, 83.

Lecce, Giampaolo, Laura Ogliari, and Tommaso Orlando, "State formation, social unrest and cultural distance: Brigandage in post-unification Italy," *Journal of Economic Growth*, 2022,

27 (3), 453–483.

Lemoli, Giacomo, "Ethnic Media and the Mobilization of Identity," *Comparative Political Studies*, 2023, p. 00104140241252076.

Levis, Curt, Joel T Johnson, and Fernando L Teixeira, *Radiowave propagation: physics and applications*, John Wiley & Sons, 2010.

Loporcaro, Michele, *Profilo linguistico dei dialetti italiani*, Vol. 275, Laterza, 2013.

_ , Stephan Schmid, Chiara Zanini, Diego Pescarini, Giulia Donzelli, Stefano Negrinelli, Graziano Tisato et al., "AIS, reloaded: a digital dialect atlas of Italy and Southern Switzerland," *TRAVAUX DE LINGUISTIQUE ROMANE*, 2021, pp. 111–136.

Maraschio, Nicoletta, "Le nuove fonti della lingua: radio e televisione," *V. Coletti (a cura di), L'italiano dalla nazione allo Stato, Le Lettere, Firenze*, 2011, pp. 161–171.

Martinez, Marco, Alessandro Nuvolari, and Michelangelo Vasta, "Railways and Innovation in Italian Municipalities: Evidence from a New Patent Data-set, 1855-1914," 2024.

Mauro, Tullio De, *Storia linguistica dell'Italia unita*, Gius. Laterza & Figli Spa, 2017.

Monteleone, Franco, *Storia della radio e della televisione in Italia: costume, società e politica*, Marsilio Editori spa, 2013.

Norton, KA, "The propagation of radio waves over the surface of the earth and in the upper atmosphere," *Proceedings of the Institute of Radio Engineers*, 1936, *24* (10), 1367–1387.

Nunn, Nathan and Diego Puga, "Ruggedness: The blessing of bad geography in Africa," *Review of Economics and Statistics*, 2012, *94* (1), 20–36.

Okuyama, Yoko, "Empowering women through radio: evidence from occupied japan," *Unpublished, Uppsala University*, 2021.

Olken, Benjamin A, "Do television and radio destroy social capital? Evidence from Indonesian villages," *American Economic Journal: Applied Economics*, 2009, *1* (4), 1–33.

Ou, Susan and Heyu Xiong, "Mass persuasion and the ideological origins of the Chinese Cultural Revolution," *Journal of Development Economics*, 2021, *153*, 102732.

Panza, Laura, Marco Lecci, Eik Swee, and Giulio Zanella, "Historical anti-fascism and right-wing voting in Italy," *Available at SSRN 4465117*, 2023.

Pécout, Gilles and Roberto Balzani, *Il lungo Risorgimento: la nascita dell'Italia contemporanea (1770-1922)*, Pearson Italia Spa, 1999.

Pellegrini, Giovan Battista, "Carta dei dialetti d'Italia," *(No Title)*, 1977.

Pennacchi, Antonio, "Fascio e martello: viaggio per le città del duce," *(No Title)*, 2008.

Pirro, Amanda De, "With a Little Help From My Enemy: Intellectual Property Rights in Fascist Italy," 2024. Working Paper.

Raffaelli, Sergio, "Normalizzazione, pianificazione e tutela istituzionalizzata della lingua: italiano e sardo," *Gerhard Ernst et al*, 2006, pp. 1463–1472.

Rambachan, Ashesh and Jonathan Roth, "A more credible approach to parallel trends," *Review of Economic Studies*, 2023, *90* (5), 2555–2591.

Rivoira, Matteo, "L'Atlante Linguistico Italiano: stato dell'arte," *Estudis Romànics*, 2019, *41*, 391–399.

_ et al., "L'archivio dell'ALI: informatizzazione dei dati e prospettive di sviluppo," *QUADERNO... MUSEO DELLE GENTI D'ABRUZZO*, 2016, *41*, 41–61.

Rohlfs, Gerhard and Temistocle Franceschi, "Grammatica storica della lingua italiana e dei suoi dialetti: Morfologia," *(No Title)*, 1968.

Romano, Antonio, Matteo Rivoira, Federica Cugno, Giovanni Ronco, Valentina De Iacovo, and Valentina Colonna, "Atlanti linguistici e archivi vocali di lingue locali e minoritarie in Italia," *Géolinguistique*, 2018, (18).

Roth, Jonathan, "Interpreting Event-Studies from Recent Difference-in-Differences Methods," *arXiv preprint arXiv:2401.12309*, 2024.

_ , Pedro HC Sant'Anna, Alyssa Bilinski, and John Poe, "What's trending in difference-in-differences? A synthesis of the recent econometrics literature," *Journal of Econometrics*, 2023, *235* (2), 2218–2244.

Rusche, Felix, "Broadcasting change: India's community radio policy and women's empowerment," Technical Report, Discussion Papers of the Max Planck Institute for Research on Collective Goods 2025.

Russo, Gianluca, "Mass Media and Cultural Assimilation: Broadcasting the American Dream on the Radio Job Market Paper," 2020.

Sanga, Glauco et al., "Un dibattito sulla geografia linguistica tra Jaberg, Jud, Scheuermeier e Gilliéron," *ORBIS*, 2015, pp. 125–135.

_ and _ , "La metodologia dell'AIS: teoria e pratica," in "La romanística svizzera della prima metà

del Novecento e l'Italia. Atti del Convegno, Firenze, Villa Medicea di Castello, 9-10 novembre 2016," Accademia della Crusca, 2017, pp. 107–120.

Serianni, Luca and Pietro Trifone, *Storia della lingua italiana: Le altre lingue*, Vol. 3, G. Einaudi, 1993.

Sistema Statistico Nazionale, *Popolazione Residente dei Comuni: Censimenti dal 1861 al 1991*, Rome, Italy: ISTAT, 1994.

Sommerfeld, AN, "Propagation of waves in wireless telegraphy," *Ann. Phys.(Leipzig)*, 1909, *28*, 665–737.

Swadesh, Morris, "Lexico-statistic dating of prehistoric ethnic contacts: with special reference to North American Indians and Eskimos," *Proceedings of the American philosophical society*, 1952, *96* (4), 452–463.

Thompson, Doug, *State control in fascist Italy: culture and conformity, 1925-43*, Manchester University Press, 1991.

Tilly, Charles, Gabriel Ardant et al., "The formation of national states in Western Europe," *(No Title)*, 1975.

Tosatti, Giovanna, "Il Ministero degli Interni. Le origini del Casellario politico centrale," *Le riforme crispine*, 1990, pp. 447–485.

Trainotti, Valentin, "Simplified calculation of coverage area for MF AM broadcast stations," *IEEE Antennas and Propagation Magazine*, 1990, *32* (3), 41–44.

Treisman, Daniel and Sergei Guriev, "Spin dictators: The changing face of tyranny in the 21st century," 2023.

Treves, Anna, "The anti-urban policy of fascism and a century of resistance to industrial urbanization in Italy.," *International Journal of Urban & Regional Research*, 1980, *4* (4).

Trifone, Pietro et al., *Pocoinchiostro. Storia dell'italiano comune*, Il mulino, 2017.

Wang, Tianyi, "Media, pulpit, and populist persuasion: Evidence from Father Coughlin," *American Economic Review*, 2021, *111* (9), 3064–3092.

_ , "Waves of empowerment: Black radio and the civil rights movement," Technical Report, Working paper 2021.

Yanagizawa-Drott, David, "Propaganda and conflict: Evidence from the Rwandan genocide," *The Quarterly Journal of Economics*, 2014, *129* (4), 1947–1994.

A Appendix - data sources

Variable	Observation Unit	Source	Observed Years
Panel A. Language			
Distance to Italian (pre-radio)	Municipality	Loporcaro et al. [2021]	1919–1922
Proximity to Italian (pre-radio)	Municipality	Goebl [2007]	1919–1922
Distance to Italian (post-radio)	Municipality	Romano et al. [2018]	1925–1940
Convergence to Italian	Municipality	Loporcaro et al. [2021]; Romano et al. [2018]	1919–1940
Panel B. Radio			
Transmitter inputs	Municipality	Radio Corriere	1925–1940
Conductivity	Municipality	CCIR [1992]	1992
Relative Permittivity	Municipality	CCIR [1992]	1992
Surface Refractivity	Municipality	Bean [1966]	1966
Panel C. Geographic controls			
Coordinates	Municipality	Istat shapefile	1991
Land area	Municipality	Istat shapefile	1991
Distance to Rome	Municipality	Istat shapefile	1991
Distance to Florence	Municipality	Istat shapefile	1991
Mean elevation	Municipality	GMTED	2010
Terrain Ruggedness	Municipality	Nunn and Puga [2012]	2012
Distance to the closest river	Municipality	ISPRA	2013
Maritime Access	Municipality	WDBII	2017
Panel D. Socioeconomic controls			
Population	Municipality	Sistema Statistico Nazionale [1994]	1994
Market Access	Municipality	Sistema Statistico Nazionale [1994]	1994
Occupations	Municipality	National Census	1931
Active Population	Municipality	National Census	1931
Literacy	Municipality	National Census	1931
Panel E. Cofounders			
Railroad access	Municipality	Ciccarelli and Groote [2017]	1913
Distance to Post Office	Municipality	Martinez et al. [2024]	1918
Propaganda Events	Municipality	De Pirro [2024]	1927-1942
Cinema consumption	Province	SIAE	1937
Panel G. Political outcomes			
Surveilled Individuals	Municipality	Central Political Registry	1924–1942
General elections	Municipality	[Corbetta et al., 2009] taken from [Carillo, 2022]	1948–1992
Political preferences	Municipality	ITANES taken from [Carillo, 2022]	2001, 2004, 2008
Panel G. Family outcomes			
Fertility rate	Province	Istat	1922–1939
Marriage rate	Province	Istat	1922–1939

B Appendix - Additional details on the ground wave signal transmission phenomena and prediction methodology

In this Appendix, I provide details on amplitude modulation (AM) transmissions and the computation procedure to predict ground-wave signal strength.

Radio propagation modeling implies to carefully consider the radio technology that was developed during the interwar period in Italy. The method of transmitting electromagnetic waves from one location to another thus varies depending on the radio frequency employed for broadcasting. The first radio broadcasting technology in Italy used amplitude modulation (AM) transmissions, operating on short wave and medium wave frequencies. Short waves are typically associated with high frequency band (HF), which extends from 3 to 30 MHz, and rely on the sky wave propagation phenomena. Sky waves can propagate at great distances, using refraction from the ionosphere, making it particularly suitable for international broadcasting. Conversely, medium wave range usually includes frequencies from 530 to 1700 kHz, and is commonly used for local AM (Amplitude Modulation) radio broadcasting. Wavelengths in this band use diffraction to bend over hills and other obstacles to spread along the surface; a phenomenon also known as ground wave (Levis et al. [2010]; Russo [2020]).

In this study, I solely focus on ground waves, as sky waves exhibit much less reliability over short distance ranges, especially with the *skip zone* effect.[69] Consequently, most of the spatial variations underlying AM radio signal strength stems from ground waves propagation. Additionally, most of radio programs at this time were scheduled during the day, while daytime transmission of AM radio signal is exclusively dependent on ground waves due to solar activity hindering sky waves refraction.[70]

Ground waves, also called *surface waves*, propagate along the Earth's surface similarly to electromagnetic waves. Their propagation is primarily attenuated with distance, due to the energy

[69] A skip zone is an area where a radio transmission can not be received due to the bouncing feature of sky wave.

[70] It is to note that short wave broadcasts began in 1930, with a short wave radio station operating in Rome from the end of this year. It means that technically, a large part of the Italian territory could hypothetically receive radio signal from this year. However, due to the nature of sky wave propagation, reception of this short wave signal remained widely uncertain if not impossible due to the *skip zone* effect. Similarly, a concurrent radio reaching most of the country started to operate in 1931, with Radio Vatican being established in the city-state. Although the radio programs were deemed to be multilingual, standard Italian was primarily used in the broadcast. However, Radio Vatican solely relied on short wave broadcasting in order to target an international audience, limiting the reception possibilities in adjacent regions.

absorbed by the Earth. The attenuation phenomena is also affected by the ground constants of the Earth along which it travels (conductivity and relative permittivity), which is also known as the lossy feature of Earth. Additionally, surface waves predominantly vertically polarized, as ground conductivity effectively neutralizes most of the horizontal electric field component (ITU [2014]).

The modelling of ground wave propagation was pioneered by Sommerfeld [1909] who solved the problem of radiation over a flat lossy Earth. In 1936, Norton [1936] built on Sommerfeld's theoretical foundations to ultimately provide the first practical method for calculations of field strength. For simplicity purposes, the model imposes flatness of Earth, constant values for ground conductivity and relative permittivity, and antenna height set at ground level. In practice, Norton [1936] derived a simple form to compute the electrical field strength E, as follows:

$$E = \frac{AE_0}{d} \tag{7}$$

with E_0 being a measure electric field strength of the surface wave for small distance; d being the distance between the transmitter and receiver, and A being the flat-Earth attenuation function, derived by Norton [1936]. The exact latter equation can be further simplified in the following form:

For $p_o < 4.5$ and all b:

$$A = e^{-43p_o \cdot 0.1p_o^2\left(\sqrt{p/2}\sin(b)\right)}e^{-5/8p_o} \tag{8}$$

For $p_o > 4.5$ and all b:

$$A = \frac{1}{2p_o \cdot 3.7}\left(-\sqrt{p/2}\sin(b)\right)e^{-5/8p_o} \tag{9}$$

where for vertical polarization:

$$\begin{gathered} P_o = \frac{\pi R(km)[f(MHz)]^2\cosh(b)}{54\times 10^2\sigma(\varepsilon+1)f(MHz)} \\ b = \tan^{-1}\left(\frac{(\varepsilon+1)f(MHz)}{18\times 10^3\sigma}\right) \end{gathered} \tag{10}$$

Hence, the flat-Earth attenuation function A is dependent upon frequency f (measured in mega-

hertz (MHz)), distance R (measured in kilometers), and the ground constants of the Earth (conductivity σ and relative permittivity ϵ), along which the wave is traveling.

Building on these simplified forms, Van der Pol and Bremmer [1937] incorporated the Earth's spherical shape into the model using a residue series. Later works expanded the theoretical model to include variations in ground conductivity and relative permittivity along the transmission route, as well as elevated antennas. DeMinco [1999] combined several types of mixed-path models − when the path is a mixture of land and sea − with both ground-based variations and elevated antennas feature, for practical application and computational purposes (ITU [2014]).

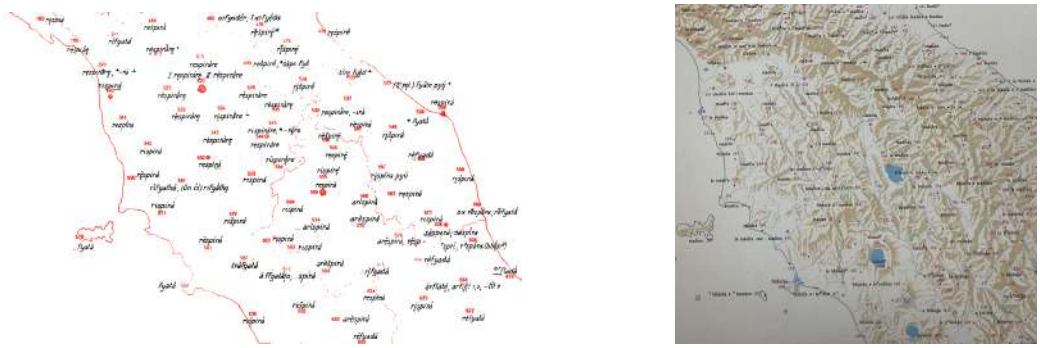
Practically, the National Telecommunications and Information Administration (NTIA) developed a coding implementation of the Low Frequency / Medium Frequency (LF/MF) Propagation Model based on the practical procedure implemented by DeMinco [1999]. The python package *PyLFMF* that I used to produce the local measure of electrical signal strengh, is a wrapping tool of the original programming procedure written in C++.

C Appendix - Additional details on the linguistic metrics

In this Appendix, I provide all the details in the step-wise procedure that ultimately led to the construction of the linguistic convergence index.

Data collection

For each atlas, I rely on a digitized sample of words collected during surveys. For the AIS, 1,712 original maps were digitized and assembled in a online database with the initial and IPA-transcribed entries [Loporcaro et al., 2021].[71] Local translations are available for a sample of 365 municipalities located in nowadays Italy, for a total of nearly 650,000 entries. For the ALI, I use the collection of words mapped in six Volumes (III, V, VI, VII, IX and X). Precisely, I was endowed by the *Istituto dell'Atlante Linguistico Italiano* with the digitized and encoded entries that were produced for the publication process of the volumes, amounting 1735 words and over 500,000 entries [Rivoira et al., 2016].



(a) AIS map - n°166 "respirare" (b) ALI map - n°959 "stadera"

Figure: Linguistic Atlases

Notes: Panel (a) shows the AIS map n°166 that shows local translation of the italian word "respirare". all the municipalities surveyed by at least one of the two atlases. Panel (b) shows the ALI map n°959 that shows local translation of the italian word "stadera".

Linguistic distance

The linguistic convergence index as defined in equation 1 relies on the computation of measures of linguistic distance for both atlases. The procedure to derive the distance metrics is implemented similarly for both atlases. The first step involves a simplification and encoding of the linguistic

[71] https://www.ais-reloaded.uzh.ch/

entry. Each entry is defined as a series of characters ("ɛ gràni"), some of them being supplemented with a diacritic ("à" is composed of the character "a" and the diacritic " ' "). Building on [Blanc and Kubo, 2023], I recoded each character and the associated diacritic as a letter with an association number. The simplest form of "a" is encoded "a01", while "à" is encoded "a12". In total, I document respectively 734 and 925 characters and their derivatives in the AIS and the ALI. Once the encoding is completed, the next step consisted in computing a measure of string distance for each entry using a reference point. As detailed in Section 3, my preferred method is the normalized Levenshtein distance and my preferred reference point is Florence. The Levenshtein distance is a measure of the difference between two sequences, defined as the minimum number of single-character edits (insertions, deletions, or substitutions) required to change one word into the other. Here is a generalized example using the Italian word "insegnare" (equivalent to "to teach"), transcribed "insɛnarɛ" in municipality point 374 and "insenare" in Florentine dialect.

Levenshtein distance (LD) procedure

Original transcription

1. "insɛnarɛ" → "insenarɛ": substitution of "ɛ" for "e"
2. "insenarɛ" → "insenare": substitution of "ɛ" for "e"

Encoded transcription

1. i01/n01/s01/e55/n05/a01/r01/e55 → i01/n01/s01/e01/n05/a01/r01/e55: substitution of e55 for e01
2. i01/n01/s01/e01/n05/a01/r01/e55 → i01/n01/s01/e01/n05/a01/r01/e01: substitution of e55 for e01

The number of changes amounts to 2, which divided by 8 (the number of character of the longest string), results to a normalized LD score of 2/8. The attracted feature of recoded the original transcription with a base letter and an associated figure is to decompose the character between the language component (the letter) and the phonetic aspect (the figure). Hence, it is possible to remove the figures to obtain a score purged of the phonetic component. In the above example, the

language score is 0, as the two entries share the same base letters which are positioned in the same order. Finally, I compute municipality-average scores using the entire universe of available entries, for each atlas.

Linguistic convergence

Once the average scores were computed for each universe of municipalities in the two atlases, I constructed the final measure of linguistic convergence to Italian for each matched municipality pair by taking the difference between the average linguistic distance in the AIS and that in the ALI, as defined in equation (1). Below, I provide an illustrative example for the municipality pair corresponding to Borgomanero, which appears in both atlases, using the Italian word *farina* ("flour"), also recorded in both sources. However, it is important to emphasize that the convergence index is constructed by differencing municipality-level average distance scores rather than computing differences at the word level, since most of the words recorded in the two atlases do not overlap.

1. *AIS (pre-radio atlas)*: "farinɑ" in Borgomanero; and "farina" in Florence.
   $\rightarrow LD^{pre-radio}$ score: $\frac{1}{6}$ (1 substitution in a 6 letters long word).

2. *ALI (post-radio atlas)*: "fari|na" in Borgomanero; and "fari|na" in Florence.
   $\rightarrow LD^{post-radio}$ score: $\frac{0}{6}$ (0 substitution in a 6 letters long word).

3. Linguistic Convergence (LC) index computed as:

$$LC_{Borgomanero} = LD^{pre-radio} - LD^{post-radio} = \frac{1}{6} - \frac{0}{6} = \frac{1}{6}$$

   $\rightarrow$ A positive LC index indicates convergence over the period, whereas a negative value reflects divergence.

D Appendix - Robustness Checks for the Linguistic Convergence

In this Appendix, I present results of an extensive set of robustness checks to support the validity of the baseline results. Precisely, I rule out findings' sensitivity to the nature of the radio treatment, the measurement of radio exposure, the data source for radio signal, the computation of the linguistic metrics, the matching procedure of atlases municipalities, geographical restrictions on the sample of analysis and the inclusion of additional confounders (internal migration and pre-radio political characteristics).

D.1 Radio Exposure Controls

Appendix Table D1 presents estimates using equation (2), while varying the set of controls and sample restrictions relative to the baseline results presented in the main text. The table shows the robustness of the results to the inclusion of an additional control for the hypothetical signal strength, assuming no natural ground constraints that would otherwise diffract and weaken radio signal propagation. Precisely, I set uniform levels of ground conductivity and relative permittivity across the entire territory, using the maximum values, so that attenuation in wave propagation depends solely on the distance to the transmitter. This procedure further controls for antenna power, with the coefficient for *Signal* remaining virtually unchanged although slightly less precise (column 2). Columns (3) and (4) further introduce an indicator for the presence of a radio antenna either within the municipality or in one of its neighboring municipalities. Finally, the sample is restricted by excluding municipalities located at short distances (less than 10 kilometers) from an antenna (column 5), at long distances (more than 100 kilometers) (column 6), or both (column 7).

D.2 Radio Exposure Measurement

Appendix Table D2 reports a sensitivity exercise to radio exposure measurement. I examine the concern that the positive coefficient underlying the use of the continuous variable *Signal* stems from the bottom part of distribution of the variable of interest, while a minimum threshold of field strength is considered as the minimum sensitivity limit for AM broadcasting (ETSI [2021]). Hence, I first replicate equation (2) using a dummy variable following a cutoff of 66 $dB\mu V/m$ instead of a continuous variable for *Signal* in column (2). I rule out sensitivity to threshold settings, con-

Table D1: Radio Exposure and Linguistic Convergence, robustness to radio exposure controls

	Baseline	Free Signal	Station	Neighbor	>10km	<100km	>10km & <100km
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Radio Exposure	0.623***	0.556*	0.497**	0.522**	0.588**	0.697***	0.856***
	(0.204)	(0.301)	(0.242)	(0.211)	(0.264)	(0.206)	(0.268)
Baseline set of FE	✓	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓	✓
Observations	612	612	612	612	598	450	436
R-squared	0.60	0.72	0.60	0.61	0.60	0.63	0.64

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

sidering an alternative cutoff of 60 $dB\mu V/m$ field strength (column 3), and a scalable approach (column 4), that applies different thresholds: 48 $dB\mu V/m$ for rural areas, 60 $dB\mu V/m$ for cities and 70 $dB\mu V/m$ for major urban areas (Crabtree and Kern [2018]; International Telecommunications Union [2008]).[72] Results remain essentially analogous, with a positive and statistically significant coefficient. Similarly, I decompose the continuous variable into four similar quartiles in size. Column (5) reports the estimates from this procedure, with the first quartile – the lowest values for radio signal strength – being the omitted category. Reassuringly, the coefficients for radio exposure increase in size with the quartiles, with the largest magnitude obtained for the last quartile, which comprises values above 64 $dB\mu V/m$. This result suggests that the observed effect using the continuous measure of radio exposure primarily derives from the highest values of radio exposure, which proxy for a decent radio coverage. Finally, I show that results are insensitive to arbitrarily setting other values of transmitter and receiver heights (Appendix Figure D1).

D.3 Radio Data Source

I explore alternative methods and data sources to construct measures of radio signal strength. As described in Appendix B, the baseline annual signal-strength measures are computed using a Python-based wrapper around the original NTIA/ITS propagation algorithm written in C++. Using the same set of inputs, I replicate the computation procedure with another Python wrapper

[72] Since the national census lacks data to classify municipalities by rural, urban, or large city status, I use population thresholds as follows: under 2,500 for rural, 2,500–50,000 for urban, and over 50,000 for large cities.

Table D2: Radio Exposure and Linguistic Convergence, robustness to radio exposure measurement

	Linguistic Convergence				
	(1)	(2)	(3)	(4)	(5)
Radio Exposure (continuous)	0.623***				
	(0.204)				
Radio Exp. (dummy - 66 $dB\mu V/m$)		0.442***			
		(0.159)			
Radio Exp. (dummy - 60 $dB\mu V/m$)			0.317**		
			(0.149)		
Radio Exp. (dummy - ITU scale)				0.249*	
				(0.146)	
Radio Exposure - bin q2					0.317**
					(0.137)
Radio Exposure - bin q3					0.409**
					(0.179)
Radio Exposure - bin q4					0.721**
					(0.282)
Baseline set of FE	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓
Observations	612	612	612	612	612
R-squared	0.60	0.70	0.58	0.58	0.58

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

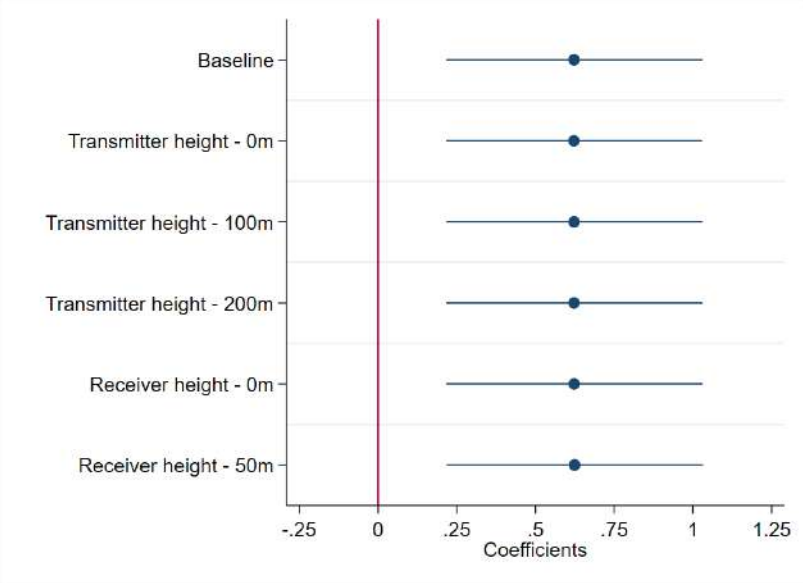


Figure D1: Robustness to different transmitter and receiver heights

Notes: This figure shows the results robustness to setting alternative values for transmitter and receiver height in the signal strength modelling process. "Baseline" plots the baseline coefficient from column (4) of table 3, with predicted antenna height and 10m height receiver. Next, antenna height is set to 0, 100 and 200 meters, and receiver height to 0 and 50 meters.

for the NTIA/ITS implementation of the Low Frequency / Medium Frequency (LF/MF) propagation model.[73] Column (2) of Appendix Table D3 reproduces the baseline estimates using this alternative set of radio signal measures. In column (3), I instead rely on radio signal predictions produced by RAI engineers.[74]

D.4 Linguistic Index Construction

Additionally, Appendix Table D4 reports the results considering alternative measures of linguistic convergence. Column (2) adds to the baseline specification a local measure of linguistic distance to Italian before radio expansion, as linguistic convergence may be driven by greater initial distance (where larger gaps mechanically facilitate convergence). The inclusion of this additional control poorly affects the main coefficient of interest, suggesting that language convergence occurred independently of the initial distance to Italian. In column (3), I normalize the baseline measure of language convergence, as defined in equation (1), by the number of years between the collection of the two surveys for each municipality, in the same fashion as an annual rate of linguistic convergence.

[73] Further details on the package are available at https://github.com/NTIA/LFMF-python.
[74] A huge thank you to Sara Lazzaroni for kindly sharing these data with me.

Table D3: Radio Exposure and Linguistic Convergence, robustness to radio data source

	Linguistic Convergence		
	(1)	(2)	(3)
Radio Exposure (Baseline)	0.623***		
	(0.204)		
Radio Exposure (NTIA)		0.661***	
		(0.216)	
Radio Exposure (RAI)			0.355*
			(0.187)
Baseline set of FE	✓	✓	✓
Baseline Controls	✓	✓	✓
Dist. Weight	✓	✓	✓
Observations	612	612	612
R-squared	0.60	0.60	0.58

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Estimates from this exercise further yield a coefficient with a positive sign and statistically different from zero (column 3). Likewise, I consider alternative methods for the string distance computation and for the municipalities-matching procedures. Coefficients of *Signal* remain stable across all these specifications, independently of using the Damerau-Levenshtein (DL) and the Optimal Sting Alignment (OSA) distances instead of the Levenshtein distance (columns 4 and 5). Finally, I impose additional restrictions on the universe of atlas words used to compute the linguistic distance indices. Precisely, I restrict the vocabulary in both atlases to items drawn from the Swadesh list—a standardized set of basic terms such as "bird", "eye", "moon" or "night", expected to exist across all languages [Swadesh, 1952]. This list, previously employed by Blanc and Kubo [2023] to guide word selection for digitization, ensures that both atlases rely on comparable and conceptually simple vocabulary rather than more specialized terms. After this restriction, the number of words used to construct the indices falls to 107 for the AIS and 25 for the ALI. Results from this procedure, presented in column (6), indicate that the main findings are not driven by differences in the word lists underlying the two atlases.

Table D4: Radio Exposure and Linguistic Convergence, robustness to LC measurement

	Baseline	Initial LD	Year-normalized LV	Method-DL	Method-OSA	Swadesh
	(1)	(2)	(3)	(4)	(5)	(6)
Radio Exposure	0.623***	0.640***	0.009***	0.628***	0.626***	0.531***
	(0.204)	(0.237)	(0.002)	(0.204)	(0.204)	(0.201)
Baseline set of FE	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓
Observations	612	612	612	612	612	598
R-squared	0.60	0.61	0.82	0.60	0.60	0.59

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.5 Matching Procedure

Besides, I perform several tests to rule out concerns underlying the matching strategy in Appendix Table D5. First, I re-estimate the model using an alternative set of distance weights in which the distance assigned to perfect matches is reduced to 0.5 km (column 2), thereby increasing their

relative weight compared to the baseline value of 1 km. Likewise, I limit the sample to municipalities matched within a 10km distance cutoff (column 3), removing the inverse-distance weighting scheme. Third, I impose a one-to-one matching rule by retaining only the closest ALI–AIS pair in terms of distance (column 4). I also consider matched samples restricted to municipalities within the same linguistic subarea (column 5), or based solely on geographical distance (column 6). Last, I interact the radio exposure measure with dummies identifying perfect and imperfect matches, allowing for differential effects across the two groups (column 7). All these exercises aim to refine the analysis between more comparable municipalities, with results consistently suggesting a positive effect of radio exposure on linguistic convergence.

Table D5: Radio Exposure and Linguistic Convergence, robustness to matching procedure

	Baseline	Weighting	Match<10km	Closest Match	Match-Sub	Match-Free	Matching
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Radio Exposure	0.623***	0.687***	0.460*	0.674***	0.664***	0.629***	
	(0.204)	(0.186)	(0.241)	(0.236)	(0.234)	(0.217)	
— x Perfect Matches							0.647***
							(0.208)
— x Imperfect Matches							0.641***
							(0.202)
Baseline set of FE	✓	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓			✓	✓	✓
Observations	612	612	242	245	245	245	612
R-squared	0.60	0.72	0.64	0.81	0.82	0.81	0.60

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.6 Geographical Restrictions

Additionally, I narrow down the analysis sample by imposing a range of geographical criteria, as detailed in Appendix Table D6. First, I exclude the municipality of Florence from the sample, as I use it as reference point in the linguistic convergence process (column 2). I also exclude municipalities where transmitter antenna were located (column 3) and allophone regions that were

integrated to Italy after WWI and where the first language is not part of the Italian linguistic family (column 4). As bordering areas could also have been exposed to foreign local radio broadcast, I additionally remove all the provinces that have an international border (column 5). All these sample restrictions have virtually little impact on the results magnitude and precision.

Table D6: Radio Exposure and Linguistic Convergence, robustness to sample

	Baseline	No Florence	No Station	No Allophone	Bordering Areas
	(1)	(2)	(3)	(4)	(5)
Radio Exposure	0.623***	0.479**	0.518**	0.637***	0.672***
	(0.204)	(0.187)	(0.244)	(0.224)	(0.212)
Baseline set of FE	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓
Observations	612	611	607	520	467
R-squared	0.60	0.59	0.59	0.62	0.61

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D.7 Internal Migration

Next, I address the concern that the observed effect of radio exposure on linguistic convergence may in fact reflect internal migration patterns rather than a direct influence of radio broadcasts. Specifically, areas with stronger radio signals might have attracted greater population inflows, with population mixing driving local linguistic convergence, rather than radio exposure per se . However, it is important to note that the Fascist regime effectively ended Italian emigration [D'Amico et al., 2018] and imposed strict controls on internal migration (Livi Bacci [2015]; Treves [1980]). At the same time that the regime promoted an ideology of rural self-sufficiency and idealized agricultural life, it legally restricted movement from rural to urban areas. Administrative barriers to employment and residency required individuals to obtain permits or special authorizations to relocate, particularly when moving to cities exceeding specified population thresholds.

To further address the possibility that urban areas disproportionately drive the results through indirect effects of rural exodus and internal migration, I consider several sample restrictions by population size. The results are reported in Appendix Table D7. I first progressively restrict the

sample to smaller municipalities, down to fewer than 2,500 inhabitants, where the political and economic incentives to provide radio coverage were likely minimal, implying that exposure or non-exposure occurred "by chance" (columns 2 and 3). Across these increasingly restrictive samples, the estimated coefficients remain positive and statistically significant for both the 10,000- and 2,500-inhabitant thresholds, and are in fact larger in magnitude.[75] Next, I rely on information compiled by Krefeld [2005] to exclude from the sample municipalities in which linguistic survey respondents had personal migration experience, as well as municipalities identified by survey administrators as having been exposed to substantial past emigration (column (5)). Finally, I exclude the new towns established by the Fascist administration as part of the "*Battle for Land*" using the list compiled by Carillo [2022], as these places were subject to a selective migration process encouraged by the regime.[76]

Table D7: Radio Exposure and Linguistic Convergence, robustness to migration

	Baseline	Pop. > 10,000	Pop. > 2,500	Immigration	Emigration	New Town
	(1)	(2)	(3)	(4)	(5)	(6)
Radio Exposure	0.623***	0.688**	0.653**	0.620***	0.498**	0.651***
	(0.204)	(0.262)	(0.308)	(0.208)	(0.207)	(0.217)
Province FE	✓	✓	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓	✓	✓
Additional Controls	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓
Observations	612	430	164	536	543	595
R-squared	0.60	0.66	0.90	0.63	0.64	0.60

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[75] In the Online Appendix, I interact the main variable of interest with several measures of population. The resulting heterogeneous coefficients are statistically distinguishable from zero across specifications, indicating no meaningful differences between rural and urban areas.

[76] The list contains 122 new towns with cross-checked information. After reallocation to the 1991 geography, 18 of the 624 observations in the analysis sample are classified as "new towns". The original source of the list is taken from Pennacchi [2008].

D.8 Initial Political Adhesion

Last, I explore if individuals sharing fascist/antifascist values could have been more/less receptive to the regime propaganda promoting the adoption of the common language. Precisely, I link radio exposure with measures of initial political adhesion to fascism and socialism. I supplement the regression model with information collected by Acemoglu et al. [2022], which includes a variety of measures capturing the local penetration of fascism and socialism before the advent of the fascist regime. The fascist measures include a measure of fascist violence (*squadrismo*) between 1920 and 1922 (normalized by municipality population), the presence of local party branches in 1921, the fascist vote share in 1924 and the presence of large donors for the Fascist party. Appendix Table D8 shows that initial adhesion of fascism only played a little role in shaping language practices. Column (2) reproduces radio exposure estimates from equation (2), adding the additional set of covariates controlling for early support for fascism, without any changes on the main coefficient magnitude and precision. Columns (3) to (6) further include interaction terms between radio exposure with a dummy flagging the non-missing status and each measure of adherence to fascism. Reassuringly, the coefficient for the interaction term between radio exposure and the binary marker for non-missing values is never significant across the specifications, suggesting that sample selection was most likely random. Additionally, none of the interaction terms between radio coverage and the measure of early support to fascism is significantly different from zero, ruling out the hypothesis that initial adhesion to fascism was a key driver in the linguistic convergence process. In the Online Appendix, I perform a analogous exercise using several measures of local adhesion of socialism, similarly showing that political adhesion only mattered little in the process of language convergence. [77]

[77] A related concern is the political legacy of WWI casualties on public cohesion and national identity. Therefore, I examine the heterogeneous impact of radio exposure based on foot-soldier casualties reported by Acemoglu et al. [2022], with no differential effects observed, as detailed in the Online Appendix.

Table D8: Heterogeneous effects of Radio Exposure based on Initial Adhesion to Fascism

	Linguistic Convergence					
	(1)	(2)	(3)	(4)	(5)	(6)
Radio Exposure	0.623***	0.628***	0.646***	0.625***	0.597***	0.570**
	(0.204)	(0.198)	(0.210)	(0.209)	(0.199)	(0.217)
– × Fascism Adhesion Non-Missing			-0.038	-0.042	-0.036	-0.049
			(0.096)	(0.095)	(0.094)	(0.096)
– × Fascism Violence			0.021			
			(0.040)			
– × Fascism Vote Share				-0.049		
				(0.036)		
– × Fascism Branch					0.060	
					(0.044)	
– × Fascism Large Donor						0.043
						(0.044)
Baseline set of FE	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓
Adhesion to Fascism Controls		✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓
Observations	612	612	612	612	612	612
R-squared	0.60	0.60	0.60	0.61	0.61	0.61

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E Appendix - Additional details on the mass persuasion effects estimation process

In this appendix, I provide additional details on the procedure conducted to derive reliable estimates of the effects of radio coverage on fertility decisions.

E.1 Static Difference-in-differences estimates

I start by investigating the effects of radio exposure on fertility, setting a generalized difference-in-difference design as follows:

$$Y_{p,t+1} = \beta RadioCoverage_{p,t} + X'_{p,t}\gamma + \delta_p + \zeta_t + \epsilon_{p,t} \tag{11}$$

where $Y_{p,t+1}$ is the fertility rate of province p at time $t+1$, defined as crude birth rate following the annual number of live births per 1,000 population and standardized for interpretation purpose. To account for the lagging feature of fertility underlying the 9-months long pregnancy period, I consider the outcome in the subsequent year. The main variable of interest is $RadioCoverage_{p,t}$, computed as a dummy variable equal to one if the predicted municipality population-weighted radio signal strength of province p at time period t is above the cutoff of $66 dB\mu V/m$ field strength, zero otherwise.[78] I include the vectors δ_p and ζ_t as province and period fixed effects, respectively, to control for unobserved province characteristics with time-invariant effects on fertility and time-varying factors affecting fertility rates homogeneously within the country. $X'_{p,t}$ is a set of potential province-level cofounders, which is the same as above. The standard errors are clustered at the province level to account for serial correlation.

Appendix Table E1 presents panel estimates from equation (11), pointing to positive effects of radio exposure on fertility rates. Column (1) only includes for province fixed effects and year fixed effects, while column (2) accounts for radio signal in open ground, column (3) adds province log-population and Column (4) additionally adjusts for time-invariant province geographic and socio-

[78] I select this cutoff as it is considered as the minimum sensitivity limit for AM broadcasting (Trainotti [1990]; ETSI [2021]). In order to rule out results' sensitivity to this arbitrary cutoff, I consider alternative radio treatments, using a cutoff of $60 dB\mu V/m$, a 50% population-threshold of individuals featured with good coverage, the province population proportion featured with sufficiently strong signal and the continuous measure of signal strength. The estimated results lead to a similar pattern and are available in the Online Appendix.

economic characteristics interacted with year dummy variables. This approach allows for differential effects across time periods of province time-invariant factors, which may be related to both ground propagation of radio waves and fertility rates. The resulting coefficient of radio coverage suggests for large effects of radio exposure on fertility rate, which remains robust allowing for specific time-trend for each large geographic areas (column 5). Precisely, coefficient of column (4) suggests that radio coverage is associated with a 0.05 standard deviation increase in fertility rate, equivalent to 1 additional live births.

Table E1: Radio Exposure and fertility Rate

	fertility				
	(1)	(2)	(3)	(4)	(5)
Radio Exp. (Dummy $>$ 66 V/m)	0.057	0.074*	0.073*	0.118***	0.069***
	(0.041)	(0.042)	(0.043)	(0.023)	(0.024)
Province FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	
Year $\times$ 5 Geo. Areas FE					✓
Signal Free		✓	✓	✓	✓
Population (log)			✓	✓	✓
Prov. Characteristics x Year				✓	✓
Observations	1,805	1,805	1,805	1,786	1,767
R-squared	0.95	0.95	0.95	0.96	0.98

Notes: OLS regressions. The sample is comprised of 95 provinces and 20 time periods, for a total of 1,9000 observations. The dependent variables is the standardized birth rate, defined as the the annual number of live births per 1,000 population. Radio exposure is computed as the standardized municipality population-weighted radio signal strength at the province level. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E.2 Heterogeneity in time and space

One limitation of the static dynamic difference-in-differences (DiD) approach relies on its assumption of constant treatment effects over time. I relax this assumption, considering a dynamic difference-in-differences (DiD) approach. This methodology regards radio exposure as treatment events of similar intensity and allows for treatment heterogeneity relative to the time since radio coverage began. Essentially, it estimates the impact of radio coverage at each period relative to the first year of coverage. Moreover, it dynamically constructs a control group by exploiting differences in the timing of the initial year of coverage.

Following the staggered design of radio expansion, estimating equation (6) using a dynamic two-way fixed effects (TWFE) regression model would carry potential biases as pointed out in the recent literature on difference-in-differences (DID) designs (Goodman-Bacon [2021]; Roth et

al. [2023]). Specifically, two primary issues undermine the validity of these estimates. First, the method relies on the assumption that treatment effects are homogeneous across all cohorts. If this assumption is violated, TWFE estimator can be severely biased due to the presence of negative weights in the treatment group. Second, it combines valid comparisons (treated vs. untreated) with invalid ones (treated vs. already-treated), which further distorts the estimates in the case of heterogeneous treatment effects.

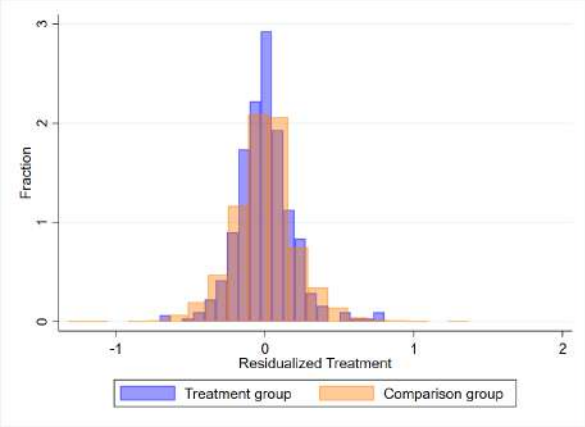


Figure E1: Two-way fixed effects weights, by treatment status

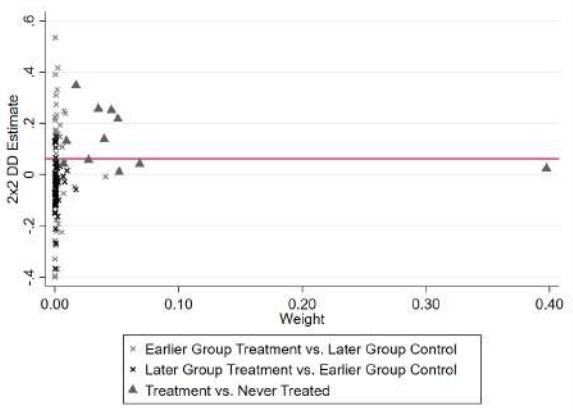


Figure E2: Goodman-Bacon [2021] Decomposition of the effects of radio coverage on fertility rates

Notes: Panel (a) shows the distribution of two-way fixed effects weights, by treatment status. Panel (b) shows the Goodman-Bacon [2021] decomposition of the effects of radio coverage on fertility rates using a static difference-in-difference approach.

To assess the likely severity of the bias introduced by TWFE estimator, I follow the empirical procedure developed by Jakiela [2021]. I start by investigating the presence of negative weights within the treated units in the computation of the average treatment effect. Appendix Figure E1 plots the derived weight for each province-year observations in calculating the TWFE estimate of the treatment effect of radio coverage on fertility rates of column (1) from Appendix Table E1. These weights are proportional to the residuals from a regression of the treatment dummy on the set of province and year fixed-effects. These weights sum to zero (across the treatment and control observations), but approximately 11 percent of all treated province-year observations receive negative weight. Negatively weighting observations in the treatment group is appropriate if treatment effects are homogeneous, but can lead to bias when treatment effects change over time within treated units. If the homogeneity assumption holds, the relationship between the residualized outcome variable

and the residualized treatment variable is linear. However, the positive and statistically significant coefficient of the later suggests for heterogeneity in treatment effects (Appendix Table E2). I provide additional support to the heterogeneity assumption by breaking down the TWFE estimates into weighted averages following Goodman-Bacon [2021]. The *Goodman-Bacon* decomposition exercise reveals differential coefficients between comparison types, stating for treatment heterogeneity (Appendix Figure E2).

Table E2: Testing Relationship Between Residualized Outcomes, Residualized Treatment

	Fertility rate
	(1)
Residualized treatment	0.083***
	(0.026)
Treatment group	0.053**
	(0.025)
Treatment group × residualized treatment	-0.203***
	(0.073)
Observations	1,805
R-squared	0.01

Notes: OLS regressions. Dependent variable is the residual from a regression of the fertility rate province and year fixed-effects. Residualized treatment is the residual from a regression of the treatment dummy (an indicator for radio coverage) on province and year fixed-effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E.3 Sensitivity Analysis

The key identifying assumption of the difference-in-difference specification is that fertility rates in provinces with different levels of exposure to fascist radio would have followed the same fertility trend in the absence of of radio coverage. Although Figure 10 gives empirical support to the plausibility of the parallel trend assumption suggesting for the absence of pre-trends, it may still mask heterogeneity in responses to economic shocks and smooth differences, potentially leading to non-parallel trends.

Although there is no formal empirical test to definitively confirm the parallel trends assumption, an alternative is to extrapolate the existing difference to the post-treatment period using pre-treatment differences in trends. Rambachan and Roth [2023] proposes a sensitivity framework that derives an interval of differences in trends based on pre-treatment differences, under the assumption that pre- and post-treatment differences in trends are similar to some degree. This framework requires selecting appropriate restrictions depending on the expected and context-specific deviations

from parallel trends.

In this study, it is unclear whether economic shocks (e.g., the 1929 financial crisis or the 1936 League of Nations economic sanctions) or smooth differential trends (e.g., gradual differences in fertility decisions, with radio stations being endogenously placed in more populated areas) pose the greater concern to the parallel trends assumption. As such, I alternatively consider both types of restrictions in my sensitivity analysis to account for these potential sources of bias.

Bounds on relative magnitudes. With multiple economic shocks affecting fertility decisions during the analysis period, it is reasonable to assume that the magnitude of these differential shocks in the post-treatment period is not drastically different from those observed in the pre-treatment period. Therefore, it is plausible to assume that violations of parallel trends in the post-treatment period cannot exceed a certain constant $\bar{M}$ times the maximum violation observed during the pre-treatment period.

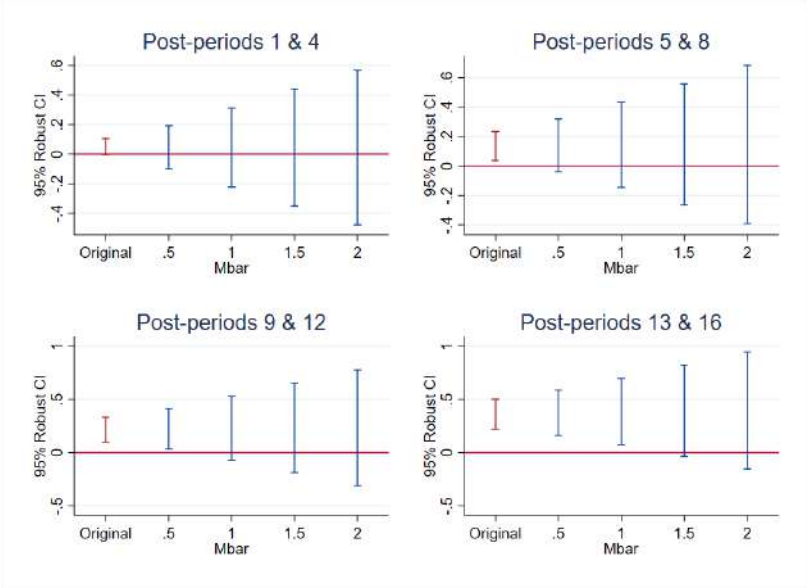


Figure E3: Bounding violations of parallel trends

Notes: This reports 95% confidence intervals (CIs) derived using the framework proposed by Rambachan and Roth [2023]. These CIs impose the restriction that the maximum post-treatment violation of parallel trends between consecutive periods is bounded $\bar{M}$ times the maximum pre-treatment violation, applied to four aggregated post-treatment periods.

Appendix Figure E3 reports 95% confidence intervals (CIs) derived using the framework proposed by Rambachan and Roth [2023]. These CIs impose the restriction that the maximum post-treatment violation of parallel trends between consecutive periods is bounded $\bar{M}$ times the maximum pre-treatment violation, applied to four aggregated post-treatment periods. The original estimates

fall predominantly on the positive side (with one inclusion of zero). However, the CIs expand significantly when allowing for small post-treatment violations of parallel trends. For example, the CI for the short-term effect ranges from -0.1 to 0.2 when post-treatment violations are restricted to a maximum of 0.5 times the pre-treatment violations. In contrast, the long-term estimates permit larger post-treatment deviations, with the "breakdown value" (the point where the effect becomes indistinguishable from zero) occurring at approximately $\bar{M} = 1.5$.

This suggests that the observed long-term effect of radio coverage on fertility rates remains robust under the restriction that post-treatment violations of parallel trends are no more than 1.5 times as large as the maximum pre-treatment violation. Additional figures using alternative breakdowns of periods are provided in the Online Appendix.

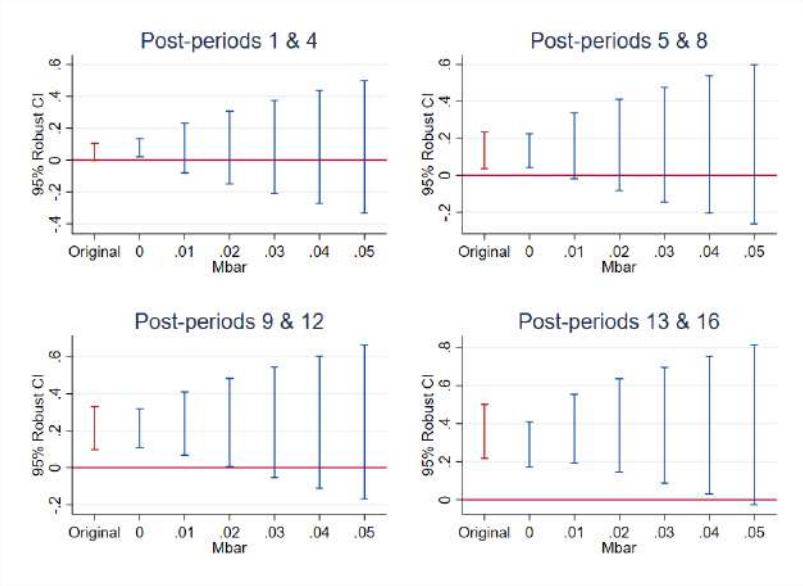


Figure E4: Smooth violations of parallel trends

Notes: This reports 95% confidence intervals (CIs) derived using the framework proposed by Rambachan and Roth [2023]. These CIs impose the restriction that the maximum post-treatment violation of parallel can smoothly deviate by $\bar{M}$, applied to four aggregated post-treatment periods.

Smoothness restrictions. Because one can be worried about confounding factors from secular trends in fertility decisions, an alternative restriction is to impose the post-treatment violations of parallel trends cannot deviate too much from a linear extrapolation of the pre-trend. Specifically, this approach limits the slope of the pre-trend to change by no more than a constant M across consecutive periods.

The results, presented in Appendix Figure E3, lead to similar conclusions as the relative magni-

tudes bounding exercise. While the estimates for the initial post-treatment periods allow only small deviations from a linear trend, the analysis suggests that the breakdown value for long-term effects is approximately 0.05. This implies that I can reject a null effect as long as the linear extrapolation of trends across consecutive pre-treatment periods deviates by less than 0.05. Additional figures using alternative breakdowns of periods are provided in the Online Appendix.

F Appendix - Additional figures

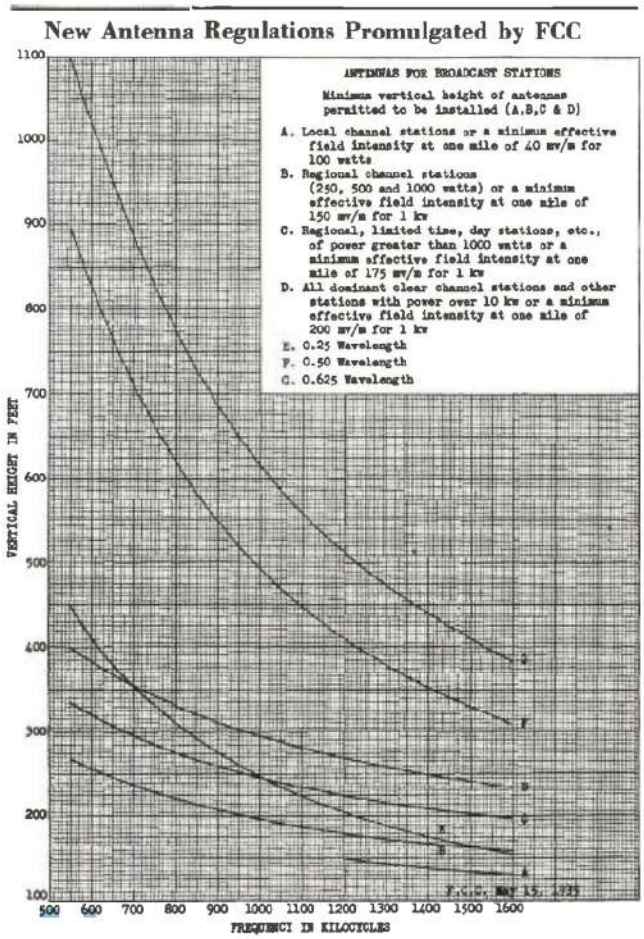
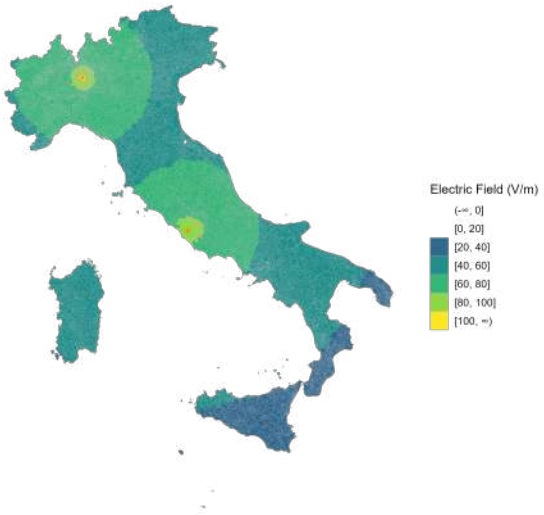
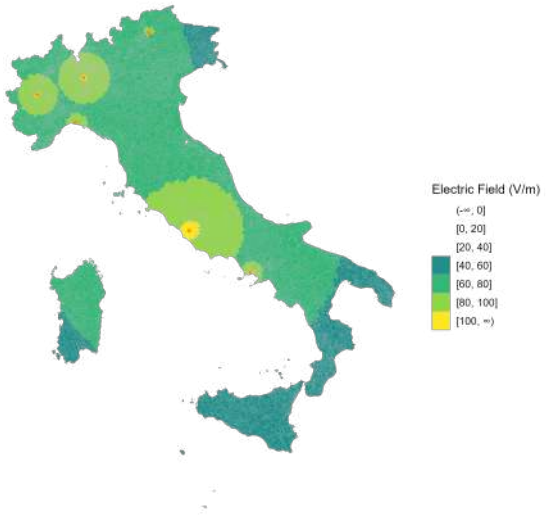


Figure F1: Antenna Height Modelling

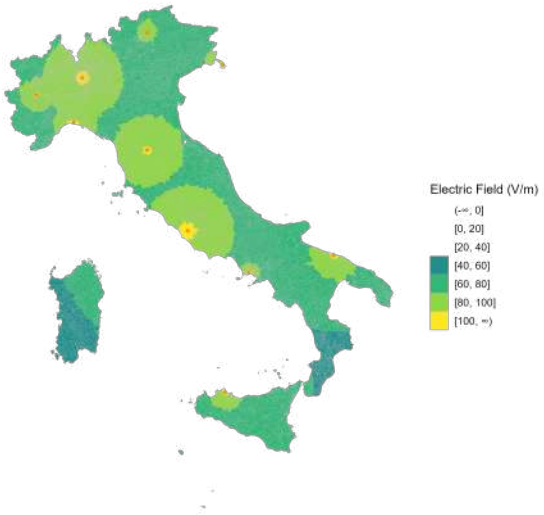
Notes: This figure shows the minimum physical height of antenna proper that stations must have depending on stations power, under Rule 131 adopted Oct. 31, 1935, by FCC. This relationship between station power and antenna height is used to predict antenna height. The source is the 1936 publication of the Broadcasting Magazine.



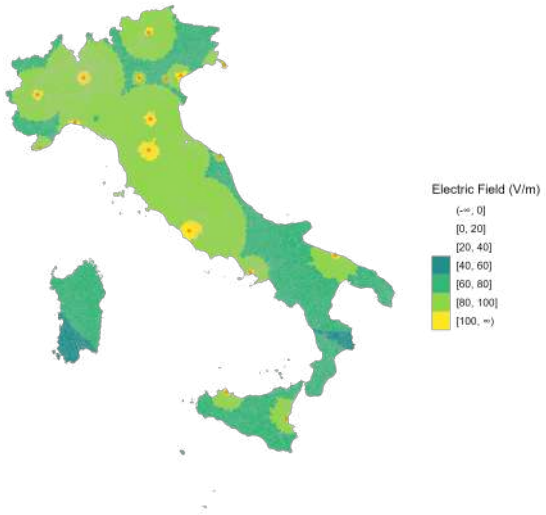
1925



1930



1935



1940

Figure F2: Radio Signal Strength in Open Ground Over Year

Notes: This figure shows the expansion of radio signal strength, measured in field strength, with no constraints on ground conductivity, at four periods of time in Italy. The orange dots represent the radio stations and transmitter antennas.

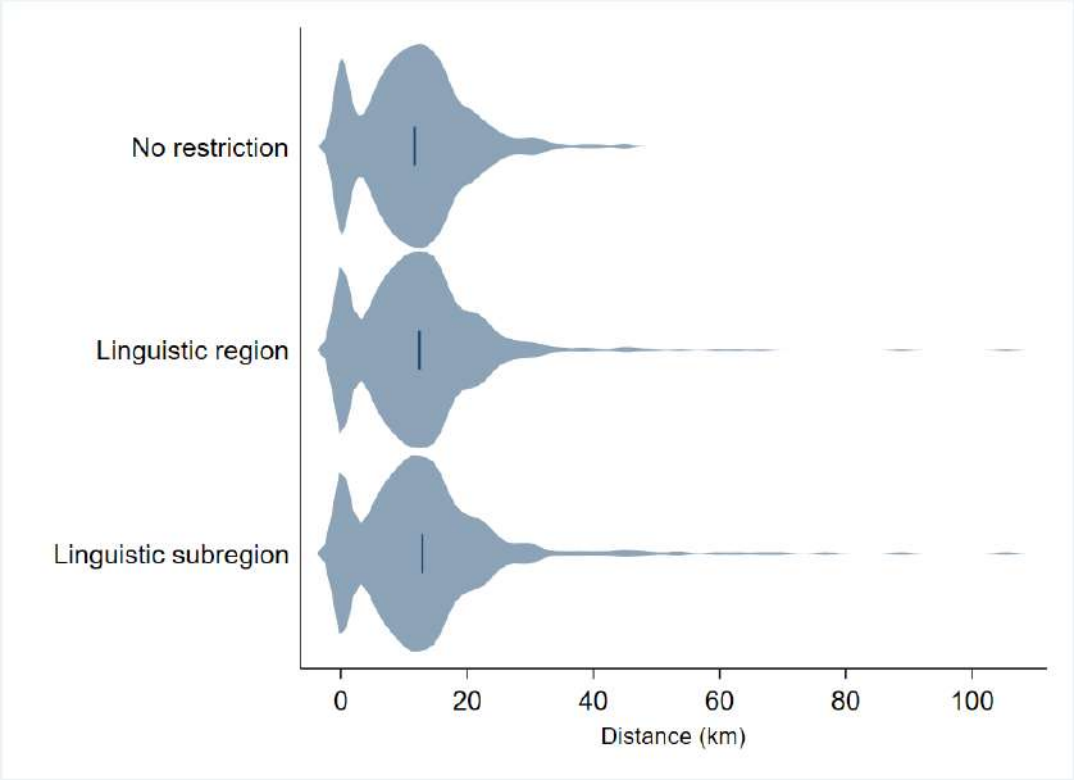
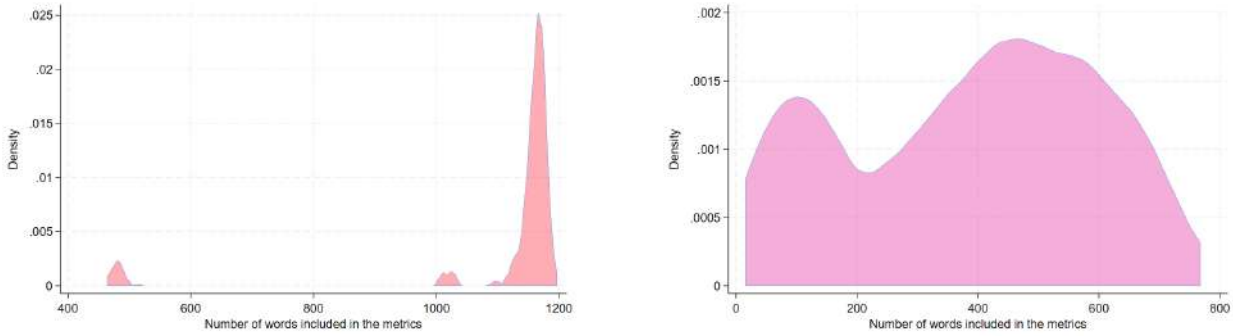


Figure F3: Distribution of distances between AIS-ALI matches, by matching procedure

Notes: This figure shows the distribution of geographical distance between the AIS-ALI matches, by matching procedure. "No restriction" implies no constrain added to the geographical proximity rationale between the two municipalities. "Linguistic region" and "Linguistic subregion" imposes the matching municipalities to be located in the same linguistic region/subregion. The blue vertical lines flag the average distance for each distribution.



(a) AIS (pre-radio atlas) (b) ALI (post-radio atlas)

Figure F4: Density of words used to compute the linguistic distance metrics

Notes: Panel (a) shows the density of number of linguistic entries used to compute the linguistic distance metrics using the pre-radio atlas (AIS). Panel (b) shows the density of number of linguistic entries used to compute the linguistic distance metrics using the post-radio atlas (ALI).

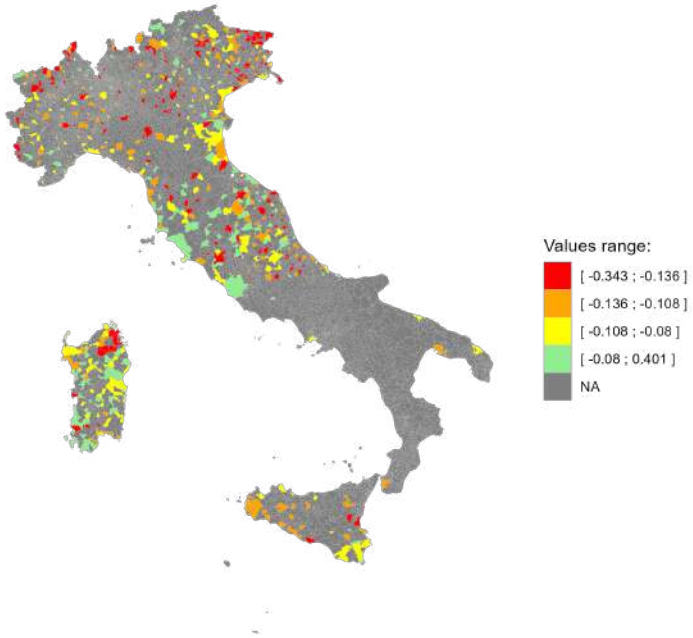
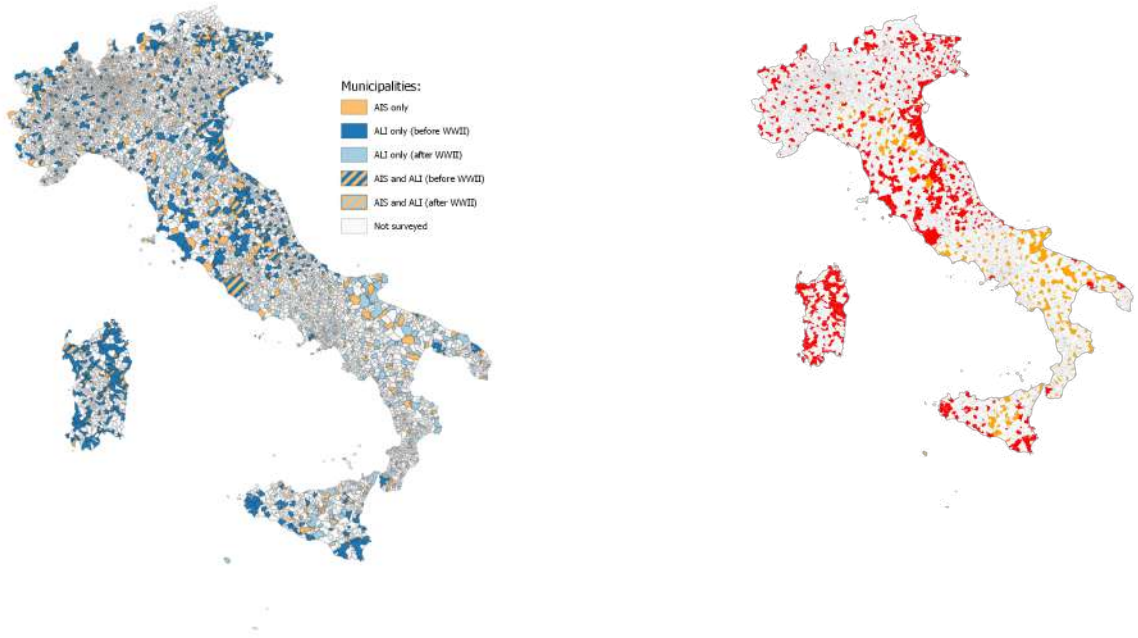


Figure F5: Linguistic convergence to Italian (1920-1940)

Notes: The figure shows the spatial distribution of linguistic convergence to Italian between 1920 and 1940, at the municipality level. Linguistic convergence from Italian is defined as the difference in the Levenshtein distance from Florence computed in the AIS and the ALI, as detailed in equation 1. The values ranges represent the four quarterlies of the linguistic convergence index.



(a) Map of surveyed municipalities

(b) Municipalities in the sample

Figure F6: Sample composition

Notes: Panel (a) shows all the municipalities surveyed by at least one of the two atlases. Panel (b) displays the final sample of 1991 municipalities (in red) and the municipalities excluded as surveyed in the ALI after WWII (in orange).

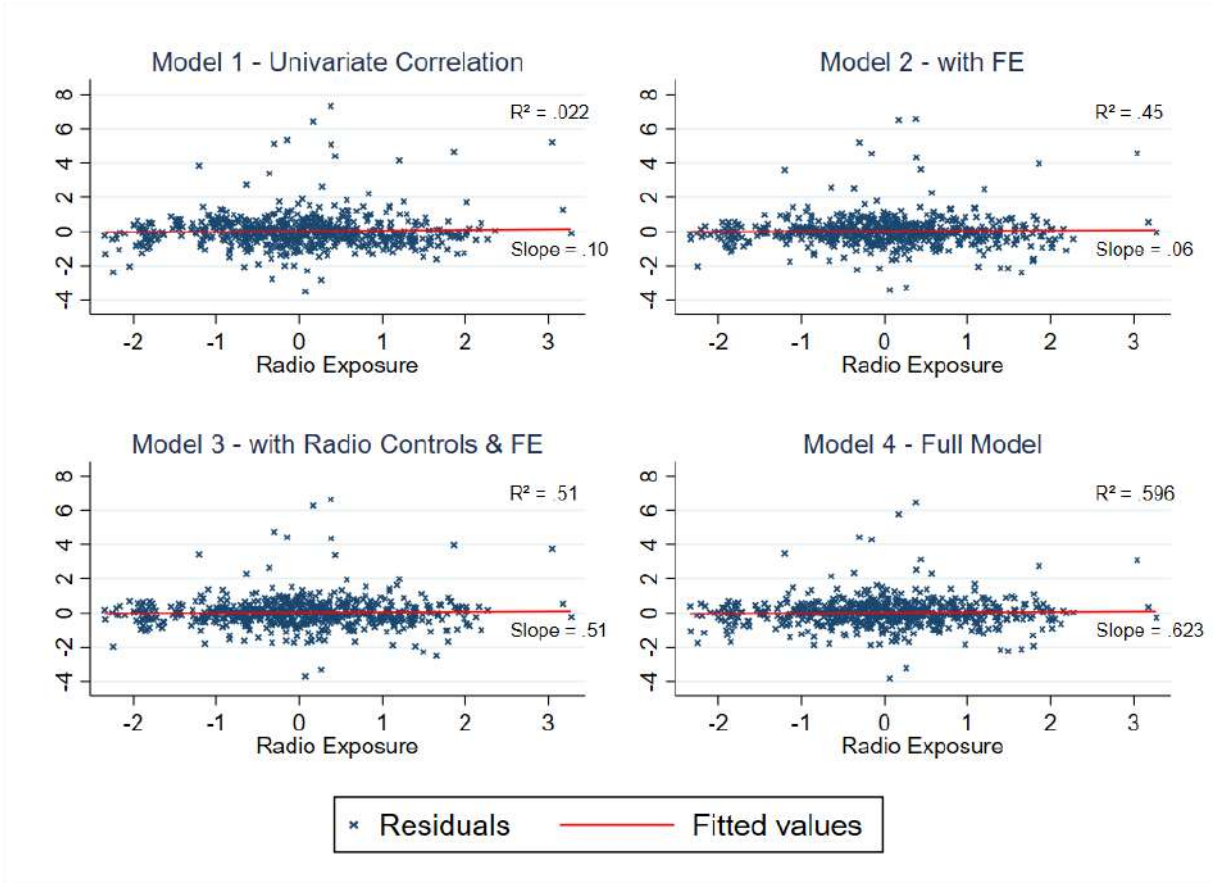
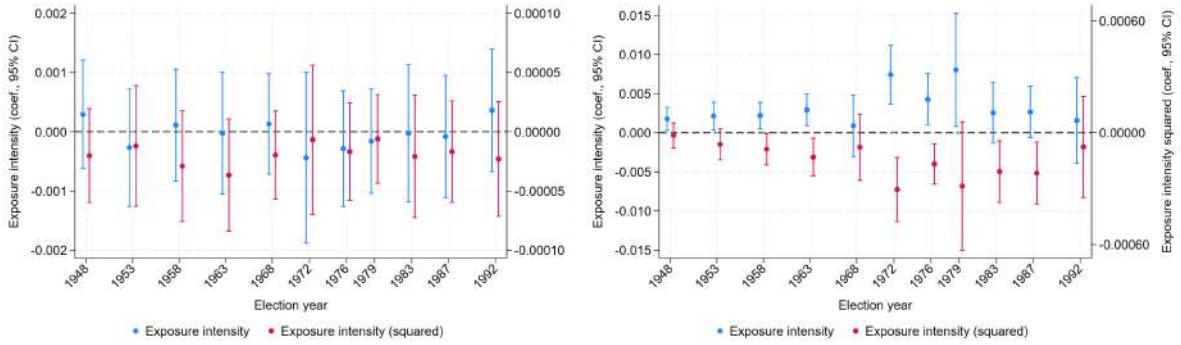


Figure F7: Variation in Residuals in Linguistic Convergence across Regression Models

Notes: This figure shows the residuals of increasingly-restricting regressions of the radio exposure measure on the linguistic convergence index against the main variable of interest. Model 1 starts with the univariate correlation between radio exposure and linguistic convergence, model 2 adds the set of fixed-effects, models 3 adds the set of radio propagation controls (model 3), and last, models reproduces the baseline regression model adding the set of additional controls.



(a) MSI vote (b) Turnout

Figure F8: Long-term Effects of Radio Exposure on Voting Behaviors

Notes: The figures show the effects of radio exposure intensity for eleven electoral rounds on the vote share of the neo-fascist party (Panel (a)) and voter turnout (Panel (b)). Data are taken from Carillo [2022]'s replication package.

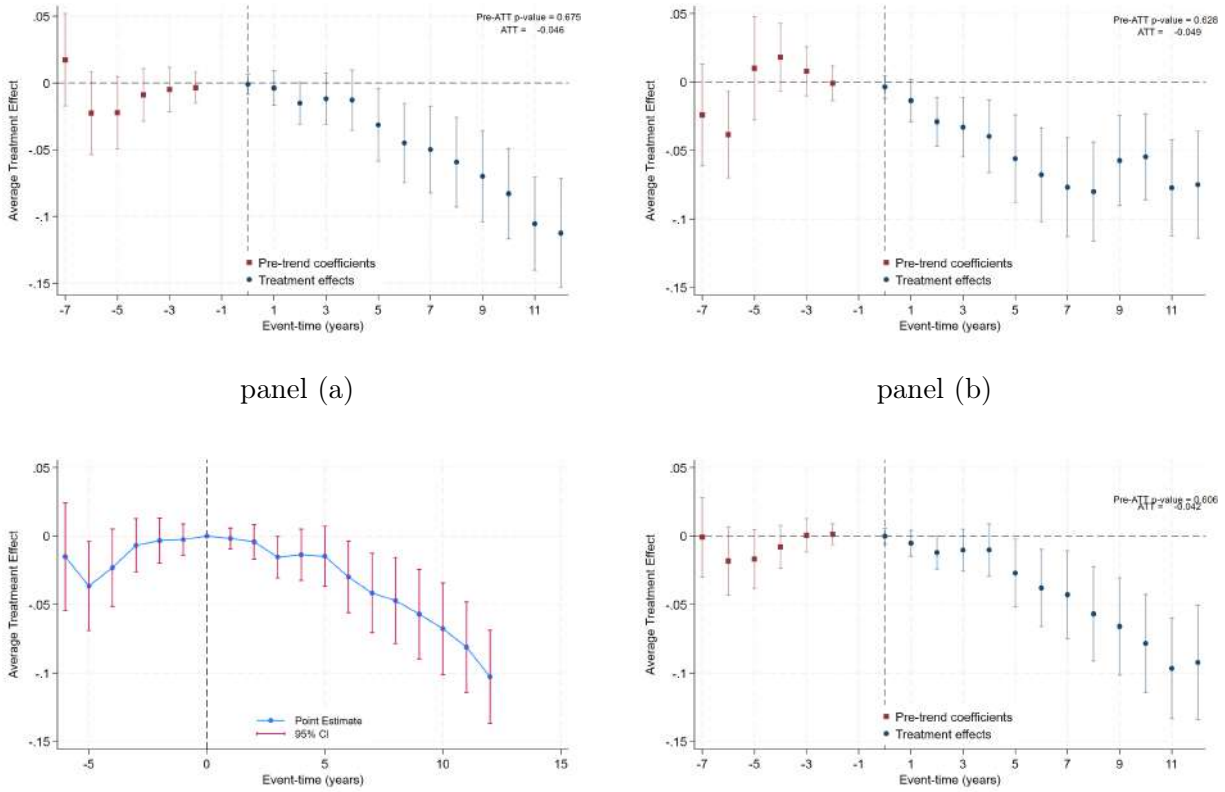
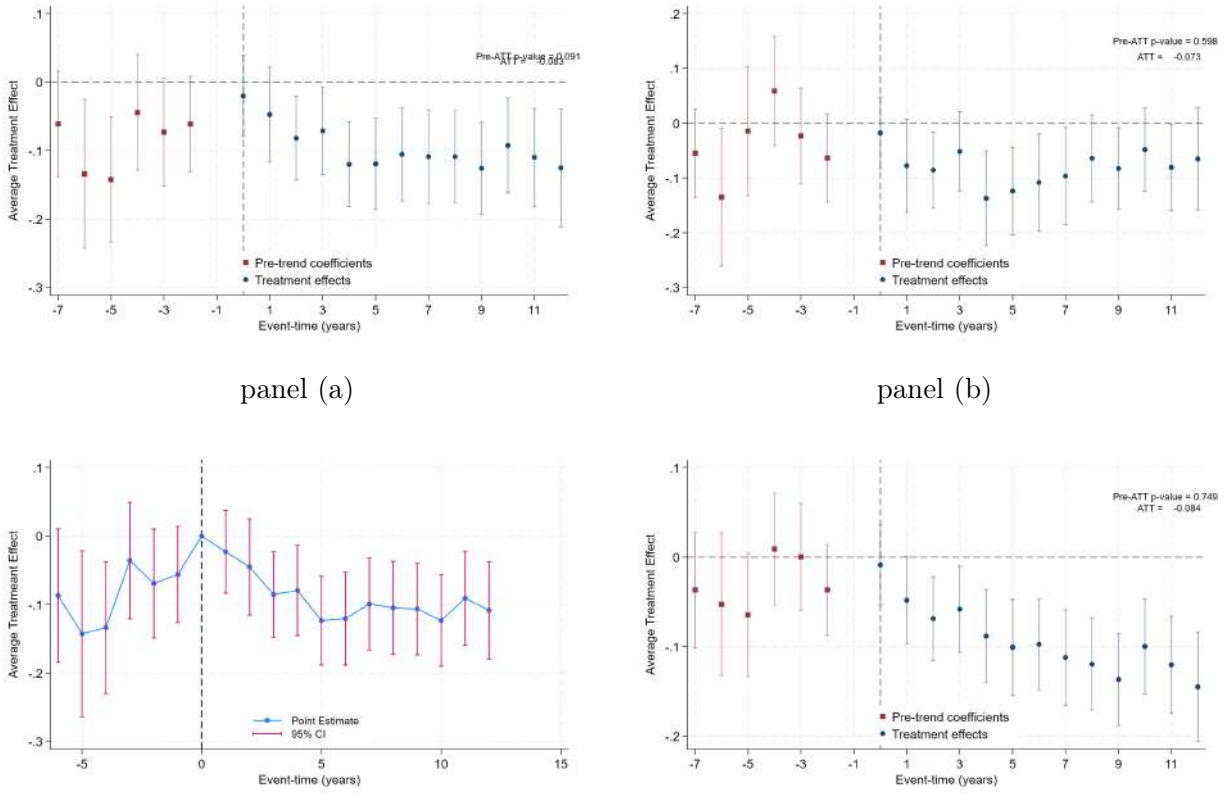


Figure F9: Dynamic effect of radio on the share of total surveilled individuals (robustness).
Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from equation 4, representing the dynamic effect of radio coverage on the share of total surveilled individuals. Panel (a) uses the never-treated municipalities only as control group; panel (b) adds the the set of time-varying baseline and radio-propagation controls; panel (c) considers the estimator proposed by De Chaisemartin and d'Haultfoeuille [2024]; and panel (d) considers the surveilled individuals municipality of birth instead of municipality of residence to aggregate the outcome. Standard errors are corrected for clustering at the municipality level



panel (a) panel (b)

panel (c) panel (d)

Figure F10: Dynamic effect of radio on the share of newly-surveilled individuals (robustness).
Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from equation 4, representing the dynamic effect of radio coverage on the share of total surveilled individuals. Panel (a) uses the never-treated municipalities only as control group; panel (b) adds the the set of time-varying baseline and radio-propagation controls; panel (c) considers the estimator proposed by De Chaisemartin and d'Haultfoeuille [2024]; and panel (d) considers the surveilled individuals municipality of birth instead of municipality of residence to aggregate the outcome. Standard errors are corrected for clustering at the municipality level

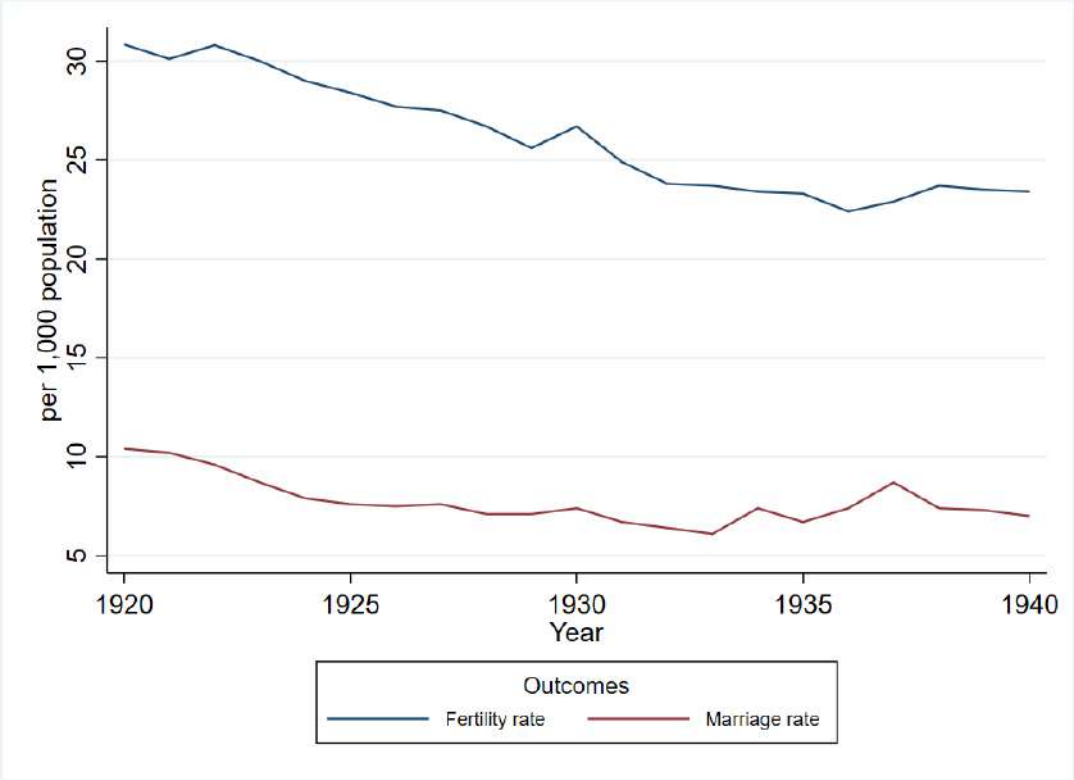


Figure F11: Fertility and Marriage Rates in Italy, 1922-1939

Notes: This figure shows the fertility and marriage rates in Italy between 1922 and 1939. Fertility rate is computed as the crude birth rate, defined as the the annual number of live births per 1,000 population. Marriage rate is set at number of marriages per 1,000 inhabitants. The source is the governmental annual reports *Movimento' della popolazione secondo gli atti dello' stato' civile*.

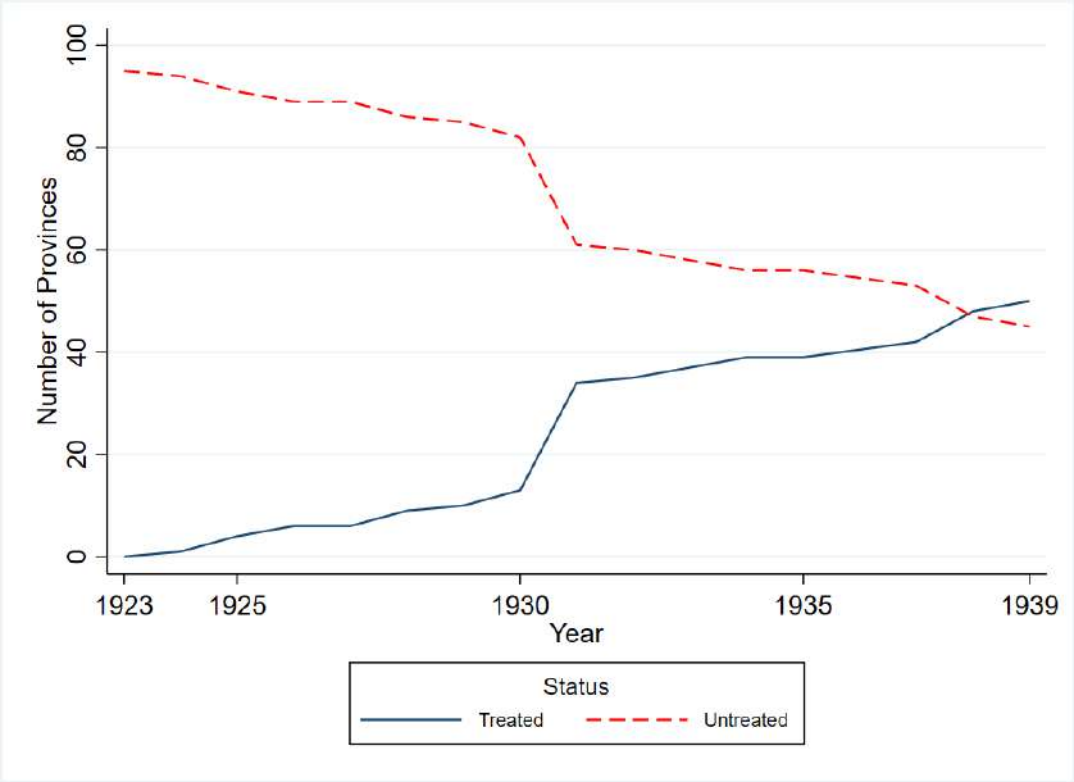
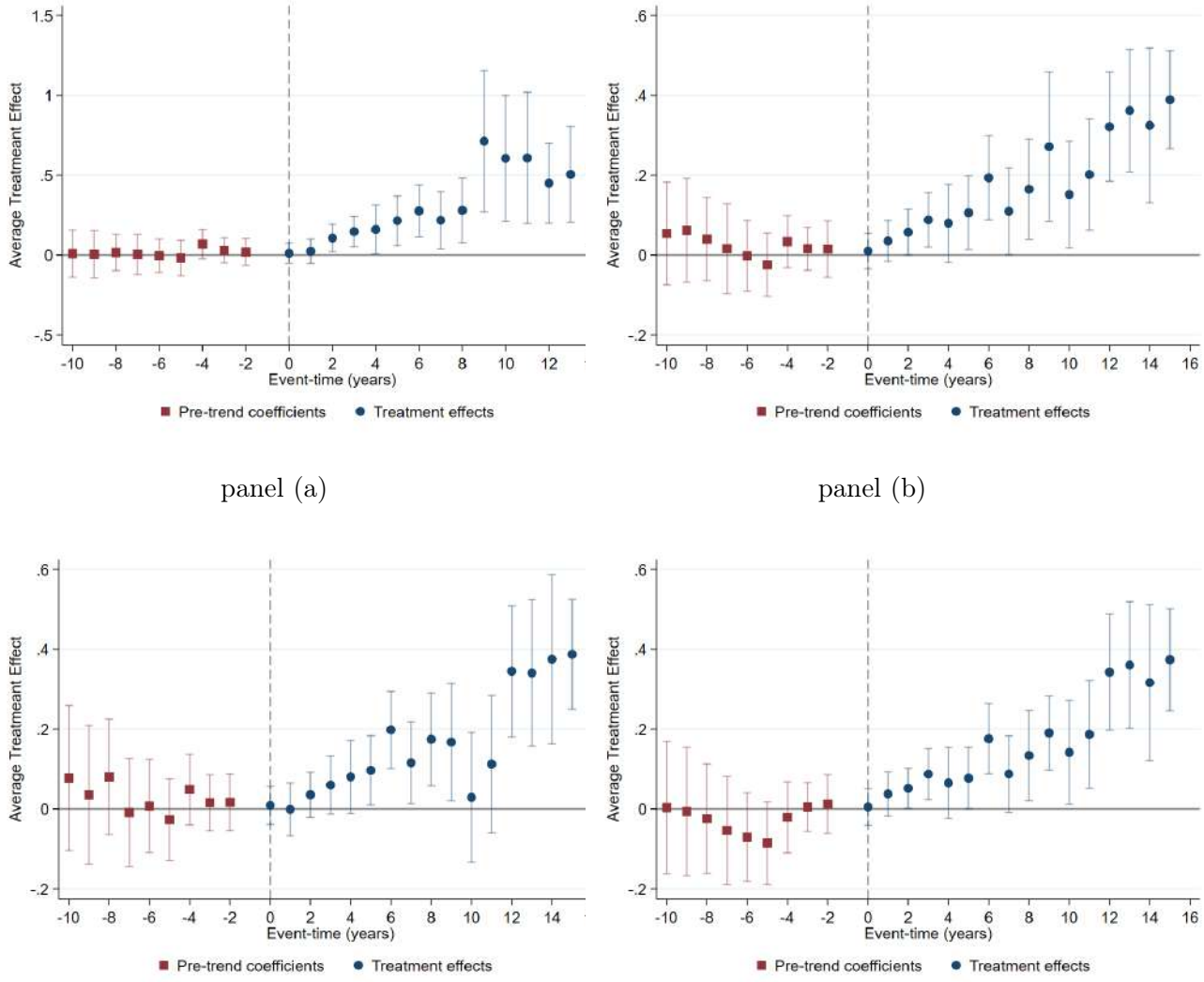


Figure F12: Number of Treated Provinces over the Period

Notes: The figures show the evolution of the number of treated and untreated provinces between 1921 and 1940, using the cutoff of $66 dB\mu V/m$ field strength for sufficient signal strength as treatment.



panel (a) panel (b)

panel (c) panel (d)

Figure F13: Dynamic effect of radio on fertility rate (robustness).

Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from equation 6, representing the dynamic effect of radio coverage on fertility rate. Panel (a) uses the non-treated yet as control group; panel (b) controls for the province population and artificial signal strength; panel (c) considers another treatment dummy based on a cutoff of $60 dB\mu V/m$ for minimum radio coverage; and panel (d) considers another treatment dummy based on a 50% population-threshold of individuals featured with good coverage.

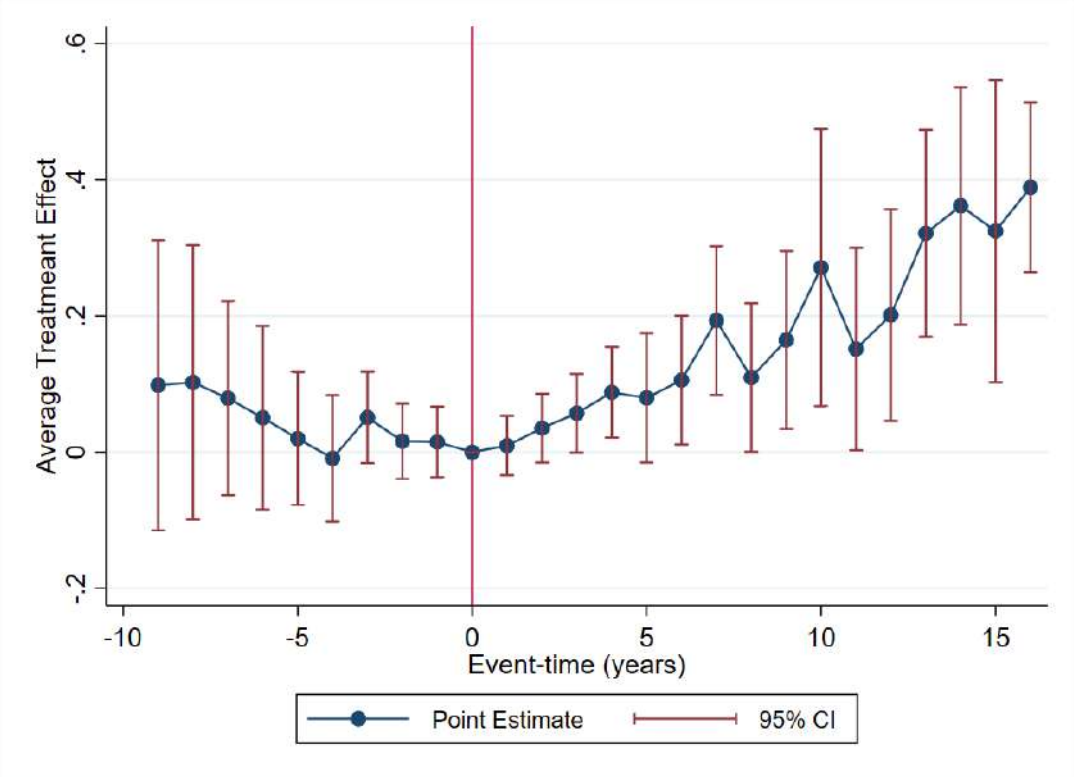


Figure F14: Dynamic effect of radio coverage on fertility rate (robustness to estimator)

Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from equation 6, representing the dynamic effect of radio coverage on fertility rate. The period prior to radio exposure is normalized to zero. The dummy treatment is defined following threshold of $66 dB\mu V/m$ field strength in province radio signal, which is considered as the minimum sensitivity limit for AM broadcasting. Standard errors are corrected for clustering at the province level. Estimated using the method proposed by De Chaisemartin and d'Haultfoeuille [2024].

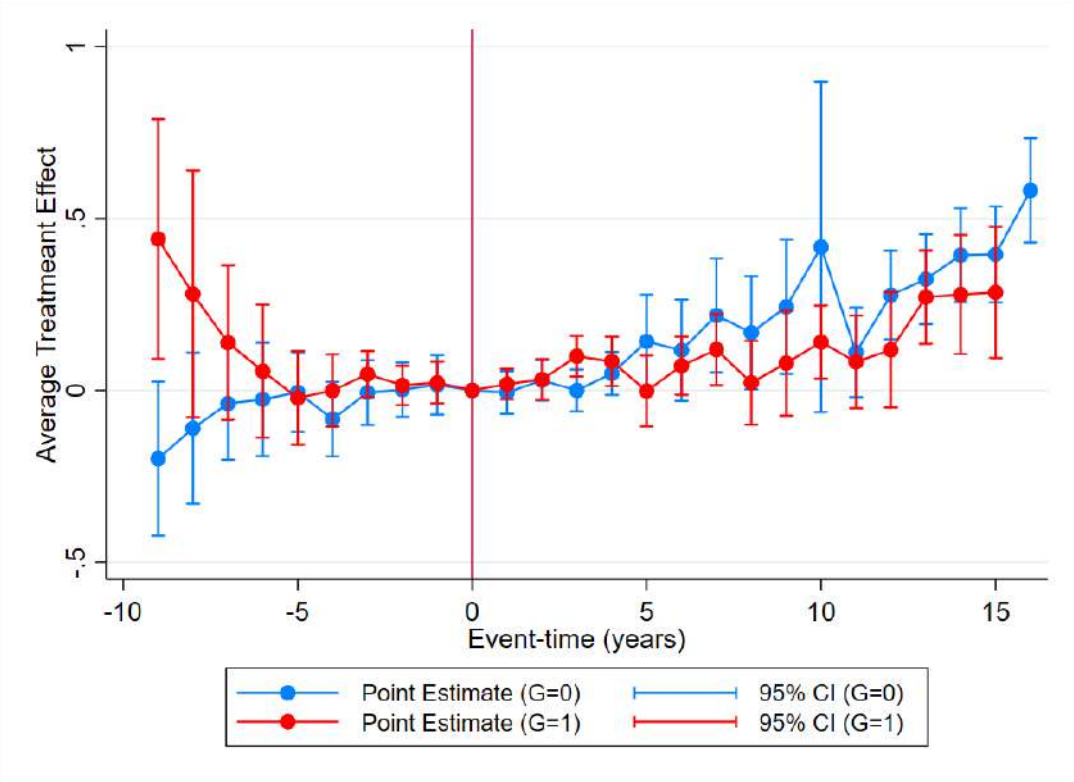


Figure F15: Dynamic effect of radio exposure on fertility, heterogeneity by linguistic proximity to Italian (robustness)

Notes: The figures show point estimates and 95% confidence intervals of the β_ℓ parameters from Equation 6, representing the dynamic cumulative effect of radio coverage on fertility rate. The period prior to radio exposure is normalized to zero. The dummy treatment is defined following threshold of $66 dB\mu V/m$ field strength in province radio signal, which is considered as the minimum sensitivity limit for AM broadcasting. G=0 is equivalent to province group below the median value of linguistic proximity to Italian; G=1 is equivalent to province group above the median value of linguistic proximity to Italian. Standard errors are corrected for clustering at the province level. Estimated using the method proposed by De Chaisemartin and d'Haultfoeuille [2024].

G Appendix - Additional tables

Table G1: Correlation Coefficients between AIS-Linguistic Distance Metrics

	LV dist.	DL dist.	OSA dist.	Salz. RIW prox.	Salz. GIW prox.
LV dist.	1				
DL dist.	1.000***	1			
OSA dist.	1.000***	1.000***	1		
Salz. RIW prox.	-0.971***	-0.971***	-0.971***	1	
Salz. GIW prox.	-0.969***	-0.969***	-0.969***	0.966***	1

Notes: This table shows the correlation coefficients between the AIS linguistic distance measures and the dialectometric proximity measures. "LV dist." stands for Levenshtein distance, "DL dist." for Damerau-Levenshtein distance, "OSA dist." for Optimal Sting Alignment distance, "Salz. RIW prox." for Relative Identity Value proximity and "Salz. GIW prox." for Weighted Identity Value (GIW)

Table G2: Radio Exposure and Linguistic Convergence

	Words-similarity rate
	(1)
Radio Exposure (dummy)	0.025*
	(0.015)
Radio Controls	✓
Local Geography	✓
Socioeconomics	✓
Province FE	✓
ALI Year FE	✓
Ling. Reg. FE	✓
Dist. Weight	✓
Observations	616
R-squared	0.96

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as a dummy variable using a minimum threshold in electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of local geographic controls is comprised of the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to Florence and maritime access. The set of socioeconomic controls includes the log-transformed population and market access, a dummy for railroad access, distance to post office, the cumulative number of propaganda events, the proportion of active population and the occupational shares of agriculture, industry, transport and communication, trade, banking, liberal professions, public administration, private administration and domestic economy. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G3: Radio Exposure and Linguistic Convergence, DiD specification

	Linguistic Distance					
	(1)	(2)	(3)	(4)	(5)	(6)
Radio Exposure × Post	-0.007*	-0.017***	-0.013**	-0.037**	-0.032**	-0.029**
	(0.004)	(0.005)	(0.005)	(0.018)	(0.015)	(0.015)
Controls						
Free Signal		✓	✓	✓	✓	✓
Population Controls			✓	✓	✓	✓
Radio Controls x Year FE				✓	✓	✓
Time duration between Surveys x Year FE					✓	✓
Fixed-effects						
Municipality FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	
Province-by-year FE						✓
Dist. Weight	✓	✓	✓	✓	✓	✓
Observations	1,240	1,240	1,240	1,240	1,240	1,222
R-squared	0.95	0.95	0.95	0.96	0.96	0.97

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Baseline measure of radio exposure is computed as the standardized electric field strength interacted with a time dummy at the municipality level. The set of population controls is comprised of the log-transformed population and market access. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the municipality level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G4: Radio Exposure and Linguistic Convergence, placebo exercice

	Linguistic Convergence	
	(1)	(2)
Radio Exposure	0.114	0.209
	(0.159)	(0.172)
Province FE	✓	✓
ALI Year FE	✓	✓
Ling. Reg. FE	✓	✓
Radio Controls	✓	✓
Additional Controls	✓	✓
Regional Cap. Excluded		✓
Dist. Weight	✓	✓
Observations	612	598
R-squared	0.53	0.54

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G5: Radio Exposure and Linguistic Convergence

	Florence	Pisa	Siena	Camaiore	Cortona	Castagneto	Pontremoli	Roma
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Radio Exposure	0.479**	0.407**	0.215	0.199	0.381**	-0.011	0.130	0.080
	(0.187)	(0.171)	(0.181)	(0.161)	(0.188)	(0.155)	(0.279)	(0.071)
Province FE	✓	✓	✓	✓	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓	✓	✓	✓	✓
Additional Controls	✓	✓	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓	✓	✓
Distance to Florence (km)	0.00	68.85	69.15	78.57	80.51	85.40	128.95	231.41
Observations	611	612	609	608	609	611	613	612
R-squared	0.59	0.68	0.61	0.71	0.70	0.64	0.58	0.87

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G6: Radio Exposure and Linguistic Convergence, by words characteristics

	Baseline	Lexical Freq.	Mussolini Freq.	Mussolini RFI
	(1)	(2)	(3)	(4)
Radio Exposure	0.623***	0.785**	0.502**	0.449**
	(0.204)	(0.319)	(0.201)	(0.207)
Province FE	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓
Additional Controls	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓
Observations	612	612	606	606
R-squared	0.60	0.64	0.68	0.68

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G7: Radio Exposure and Linguistic Convergence, Regional Differences

	Wording & Pronunciation			Wording only		
	(1)	(2)	(3)	(4)	(5)	(6)
Radio Exposure	0.633***	0.435*	0.606***	0.448**	0.221	0.414*
	(0.206)	(0.223)	(0.187)	(0.224)	(0.219)	(0.209)
Radio Exposure x Distance to Rome		0.528***			0.613***	
		(0.162)			(0.159)	
Radio Exposure x Distance to Florence			0.183			0.128
			(0.124)			(0.114)
Province FE	✓	✓	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓	✓	✓
Additional Controls	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓
Observations	612	611	611	612	611	611
R-squared	0.59	0.59	0.70	0.54	0.56	0.66

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G8: Heterogeneous effects of Radio Exposure based on Occupational Rates

	Linguistic Convergence								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Radio Exposure	0.623***	0.653***	0.540**	0.615***	0.517**	0.459**	0.619***	0.706***	0.570***
	(0.204)	(0.231)	(0.229)	(0.211)	(0.233)	(0.221)	(0.218)	(0.240)	(0.195)
– × Agriculture rate		-0.013							
		(0.072)							
– × Industry rate			0.146**						
			(0.072)						
– × Transport & Com. rate				0.054					
				(0.083)					
– × Trade rate					0.152*				
					(0.090)				
– × Banking rate						0.212**			
						(0.096)			
– × Liberal Prof. rate							0.034		
							(0.059)		
– × Public Adm. rate								-0.082	
								(0.093)	
– × Private Adm rate									0.103
									(0.084)
Province FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Baseline Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	612	612	612	612	612	612	612	612	612
R-squared	0.60	0.57	0.58	0.58	0.58	0.58	0.58	0.58	0.58

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table G9: Heterogeneous effects of Radio Exposure based on Literacy and Elite Rates

	Linguistic Convergence			
	(1)	(2)	(3)	(4)
Radio Exposure	0.623***	-0.018	0.650***	0.564**
	(0.204)	(0.216)	(0.222)	(0.218)
– × Literacy Rate Non-Missing		0.292		
		(0.187)		
– × Literacy Rate		0.388***		
		(0.125)		
– × Elite/Bourgeois Rate Non-Missing			-0.030	-0.027
			(0.085)	(0.082)
– × Elite Rate			-0.050	
			(0.061)	
– × Bourgeois Rate				0.025
				(0.047)
Province FE	✓	✓	✓	✓
ALI Year FE	✓	✓	✓	✓
Ling. Reg. FE	✓	✓	✓	✓
Radio Controls	✓	✓	✓	✓
Additional Controls	✓	✓	✓	✓
Dist. Weight	✓	✓	✓	✓
Observations	612	612	612	612
R-squared	0.60	0.61	0.60	0.60

Notes: OLS regressions. The sample is comprised of 624 observations. The number of observations reported in the table reflects the total after excluding those whose values are fully captured by the fixed effects. Radio exposure is computed as the standardized electric field strength at the municipality level. The set of radio controls includes latitude, longitude, their interaction, and second-order polynomials in distance to the closest radio transmitter, average conductivity, conductivity variance and mean permittivity. The set of additional controls is comprised of the log-transformed population and market access, and the second-order polynomials in mean elevation, land area, terrain ruggedness, distance to the closest river, distance to Rome, distance to post office, cumulative number of propaganda events, a dummy for railroad access and maritime access, and the occupational, active population and literacy rates. Regressions are weighted by the matching distance between AIS and ALI municipalities. Standard errors are reported in parentheses and are clustered at the province level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.