Empowering Women Through Radio: Evidence from Occupied Japan*

Yoko Okuyama †

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Abstract

I study the impact of women's radio programs that the US-led occupying force aired in Japan (1945-1952) to dismantle the prewar patriarchal norms. Through the lens of economics of identity, the radio messages can be viewed as attempts to alter gendered identity norms, and thus to shift women's outcomes. Using local variation in radio signal strength driven by soil conditions as an instrumental variable, I show that greater exposure to women's radio programs increased women's electoral turnout, and the vote share for female candidates, highlighting women's votes matter. Moreover, exposure to women's radio programs accelerated the postwar fertility decline.

JEL codes: A13, D72, J13, J16

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†Kyrkogårdsgatan 10B, Department of Economics, Uppsala University, 753 13 Uppsala, Sweden. yoko.okuyama@nek.uu.se

1 Introduction

Over the last century, societies have made a significant stride in expanding women's socioeconomic opportunities. Amongst numerous factors, even wars and armed conflicts, albeit terrible ordeals, have provoked changes in the economic landscape, which further became the catalysts for advancing women's economic[1] as well as political participation.[2] Yet, a growing body of economic research also acknowledge that preexisting gendered norms can nonetheless sustain [3] and continue to hold women back.[4] A question that follows is what helps loosen such constraints when the winds of change blow. This is what the present study seeks to answer.

In this study, I examine the impacts of disseminating pro-gender-equality messages through radio on women's outcomes in Occupied Japan, i.e., Japan during the occupation period (1945-1952) following its defeat in World War II. While Japan was embracing its defeat, the US-led occupying force set women's empowerment as a core occupation policy. During the occupation period, Japanese women gained voting rights, greater access to higher education, and even a new constitution prohibiting discrimination on the basis of

[1] Wars raised female labor force participation by particularly drawing women into previously male-dominated occupations. In the US around World War II, for example, female labor force participation increased from 23 percent in the 1930 census to 33 percent in the 1950 census. While Goldin (1991) documents that more than half of the women drawn into the labor force by the war left again, studies also show that some groups of women remained in the workforce and moreover the wartime surge of female labor force participation influenced other outcomes such as the gender wage gap (Acemoglu et al. 2004) and female labor force participation among the subsequent next generation (Fernández et al. 2004).

[2] World War I was arguably a watershed for women's suffrage. For example, in 1918, women in the United Kingdom over the age of 30 (with certain property qualifications) were granted the right to vote. In the US, the 19th Amendment was finally ratified on August 18, 1920. Similarly in the aftermath of World War II, several other countries granted women the right to vote. For example, women in France cast their ballot for the first time on April 29, 1945; on April 11, 1946, in Japan; on June 2, 1946, in Italy.

[3] Gender norms are shown to have deep, historical roots in relation to factors such as different types of agricultural practices (See, for example, Alesina et al. (2013), and Alesina et al. (2018)) grammatical gender (See, for example, Gay et al. (2013), and Galor et al. (2020)), the practice of matrilineality (See, for example, Gneezy et al. (2009), Hoffman et al. (2011), Gong and Yang (2012), Gong et al. (2015), Robinson and Gottlieb (2019), and Lowes (2020)) and the bride price and dowry traditions (see, for example, Ashraf et al. (2020)).

[4] Studies show that gender norms drive gender-related outcomes such as the employment gap (Fernandez and Fogli 2009), intrahousehold decisions (Bertrand et al. 2015), fertility patterns (Doepke et al. 2022), and the child penalty (Kleven 2022).

sex. Yet above all, what occupying force put efforts into was a radio policy: notably, just one month after the occupation started, they began airing women's radio programs (*Fujin no Jikan* or *Women's Hour*) to dismantle the prewar, patriarchal norms that Japanese women had previously internalized (Japan Broadcasting Corporation 1947). Thus Occupied Japan provides a unique testing ground to answer the question posed above.[5]

As historians' accounts and my own text analyses on *GHQ/SCAP Weekly Radio Reports* reveal, women's radio programs covered a wide range of topics. Initially, they were dedicated to encouraging women's political participation, but then gradually diversified to cover topics including freedom of marriage, new labor laws, birth control and spacing, and women's health. Even though the content was quite progressive with respect to contemporary gender norms, many female listeners tuned in. In fact, a series of listener surveys uncover that women's radio programs drew a high listenership.[6]

Through the lens of Akerlof and Kranton (2000)'s economics of identity, the radio messages can be viewed as attempts to alter gendered identity norms. Women previously considered incapable of participating in politics were now encouraged as important political voices. Similarly, birth control, which was once considered taboo, was promoted as beneficial for maternal and children's health. Through the radio, listeners were informed that old norms were being dismantled and new ones introduced. This would have reduced the psychological cost of previously unacceptable behaviors that could potentially hold women

[5]The idea of empowering women through radio programs is not uncommon across the world. In fact, Women's radio programs were a widespread feature of the heyday of radio. To name a few, BBC Radio 4's Woman's Hour in the UK (from October 7,1946); Radio Donna by Radio Città Futura in Rome, Italy (from March 1976 onwards); Womankind by Pacifica Radio in New York (1969); Hemmafru byter yrke (The Housewife Switches Jobs) by Swedish Radio P1 in Sweden (from October 7, 1965 to December 9, 1965); and RadiOrakel in Oslo, Norway (from October 16, 1982). They have, however, usually emerged hand-in-hand with women's rights movements. Therefore, separating the causal impact of the radio campaign from that of the overarching women's rights movement would be more challenging in other contexts. Meanwhile, Occupied Japan provides an ideal experimental setting because women's radio programs were brought in externally without anticipation upon Japan's defeat in World War.

[6]In the listener's survey conducted between July 14th and 17th in 1949, more than 70 percent of women with a radio subscription said that they currently listened to or had listened to "Women's Hour," the flagship programs among women's programs (Japan Broadcasting Corporation 1949).

back. In theory, therefore, one predicts that women who were exposed to radio messages would behave differently than they would have otherwise – greater participation in elections and the labor market, as well as greater use of birth control and hence lower birth rate.

To empirically investigate these predictions, I build a unique district-level dataset that includes both the prewar and postwar periods. The dataset includes data on election results, labor force participation, marriages, births, and the geographical reach of the radio, gathered from various historical resources such as the Japan Broadcasting Corporation's reports and maps, newspapers, official election results, newly digitized vital statistics, and population census.

Exposure to women's radio programs, which is my main independent variable, comes from district-level variation in radio listenership. Listenership is proxied by the district-level radio subscription rate, a statistics that originates from the state-owned radio licensing system at the time. Across the nation, listenership varied from below 10 percent to above 70 percent with an average of 37 percent. This provides cross-sectional variation in women's exposure to gender-egalitarian norms on air.

I address potential endogeneity in radio listenership by using field strength, which is a measure of AM radio signal strength that varies locally based on soil conditions during daytime hours. Although AM radio signal quality depends on other factors such as distance to a nearby transmitter, transmission power, and frequency, I control for these three factors and use the residual variation in field strength to instrument for radio listenership. This helps eliminate any concern that the location of a transmitter correlates with women's outcomes. Essentially, the identifying variation comes from districts equidistant from the same transmitter but receiving different signal strength due to different soil qualities. I show that the first stage is strong, as field strength positively predicts radio subscriptions even after controlling for distance to the nearest radio transmitter and transmitter fixed effects. I also provide support for my identification by finding no correlation between the instrumental variable and preintervention outcomes.

Using conditional field strength as an instrumental variable (hereafter abbreviated as IV), I find that greater exposure to women's programs significantly increases women's political participation, both as voters and representatives, in the first election where women were allowed to vote. Specifically, a one standard deviation increase in exposure to women's radio programs increases women's electoral turnout by 2.4 percentage points. The impact is heterogeneous based on a district's male-to-female ratio. Exposure to women's radio programs has a greater effect in areas where men are more scarce due to the high military mortality rate. Meanwhile, no radio effect is evident for male turnout.

In addition, a one standard deviation increase in exposure also raises a female candidate's vote share by 1.33 percentage points. This positive effect contributes to women's increasing representation in the national legislature: had there not been women's radio programs in place, then women's share among winners would have been only 4.2 percent, almost half of the actual representation of 8.2 percent. This finding also makes a case against the double-vote hypothesis, which posited that women, especially married women, would simply cast the same votes as their husbands and have no influence on electoral outcomes. My finding, however, highlights that women's votes matter.

Furthermore, radio exposure gradually impacts decision-making within the household. I find that radio exposure accelerates the decline in the number of births, albeit not immediately. A one standard deviation increase in radio exposure contributes to decreasing the 1950 birth rate by 2.7 per 1,000 population, which accounts for 58.0 percent of the standard deviation. Meanwhile, I do not find any significant impacts on either women's labor market participation or marriage. All in all, declining fertility is due to neither an increase in women's career aspirations nor a decline in marriages. Moreover, I provide supportive evidence that declining fertility is not a temporary delay but likely to reflect a reduction in the number of births per woman in her lifetime. Overall, my results suggest that disseminating the idea of gender equality contributed to the fertility transition of postwar Japan.

A careful reader may wonder if the presented effects arise from radio in general but not necessarily limited to women's radio programs, as I measure radio exposure by radio subscription. I present archival evidence and conduct placebo tests that women's radio programs are likely to be the main driver. My archival evidence reveals that it was women's programming that covered the topic of women's political participation and birth control. Thus, it is unlikely that women's programming did not contribute to women's electoral and fertility outcomes at all but more general programming did. Moreover, I also present that across different radio programming, the listenership gap only exists for women's radio programs. If radio itself was the main driver, then it benefited both men and women. I find, however, no such evidence. While I cannot completely rule out the possibility that women listeners were impacted by more general programming, this evidence suggests that women's programming is the more likely catalyst.

Finally, my supplementary analyses do not support the idea that radio effects emerge solely from reducing informational friction and not from influencing gendered identity norms. In theory, one could be interested in the informational channel in the present context, because radio broadcasting is particularly useful for reaching the illiterate population thanks to its audio-based nature. Thus, if the informational channel were the main driver, one would expect a greater radio effect on illiterate and semi-illiterate (less educated) women who otherwise face greater informational constraints. I tested this prediction and found that the effect on women's turnout did not differ based on the district's share of highly educated women. The effect on birth rate appears to be magnified in districts with more highly educated women but not less. These findings contradict the presumption that radio can compensate for the lack of information. Therefore, one can conclude that at least part of the effect likely comes from shifting gendered social norms as intended by the policy.[7]

Taken together, my findings confirm that the pro-gender-equality messages targeting women have helped empower Japanese women in the aftermath of World War II. More broadly, they provide historical, quantitative evidence that disseminating pro-gender-equality messages can be an effective way to loosen the constraint that women face when the winds of change blow.

This study contributes to three strands of literature. First, this study provides evidence that mass media can help disseminate messages that women's voice counts in elections, which get them out to vote and influence the electoral outcomes. Generally, the literature on mass media and electoral turnout has shown that political information disseminated through mass media increases voter turnout (DellaVigna and Gentzkow 2010, Gentzkow et al. 2011, Strömberg 2004, Strömberg, 2015). This line of literature, however, mostly focuses on long-enfranchised voters. Meanwhile, my study shed light on the newly enfranchised women. They deserve careful attention: studies universally acknowledge that "[o]verall turnout declined as a result of adding women to the eligible electorate." (Corder and Wolbrecht, 2016). In fact, a small number of studies do confirm that women turned out less than men did (Corder and Wolbrecht, 2016). That is to say, women's suffrage, albeit a crucial milestone in advancing the position of women, may not automatically translate into equal exercise of political power between men and women. My findings highlight that disseminating new norms through mass media can be a way to move the needle: it mobilizes more women into the active electorate and influences electoral outcomes. Mass media help to incorporate women into the electorate.

Second, this study is complementary to the literature on the effects of media expo-

[7] The lack of attitudinal surveys around the time of World War II disables me from directly testing the radio effect on women's attitudes and beliefs.

sure on fertility decline.[8] For example, Jensen and Oster (2009) show that the introduction of cable television contributed to decreasing fertility in rural India. La Ferrara et al. (2012) provide evidence that Globo, the Brazilian soap opera, has disseminated the smaller family size norm and thus contributed to the rapid fertility decline in Brazil. Kearney and Levine (2015) identify that the American TV show 16 and Pregnant contributed to reducing the teenage birth rate by spurring interest in contraceptives among teens.[9] While these studies shed light on the role of entertainment content of commercial mass media in empowering women, the context of Occupied Japan provides a direct example of using mass media as a gender-policy tool. I also point to Beach and Hanlon (2019) showing that greater exposure to the Bradlaugh and Besant trial contributed to the fertility decline in England and Wales starting in 1877, by disseminating a positive image of family planning. Altogether, this line of studies underscores the importance of integrating norms and cultural factors to better understand fertility change in economic literature.

Third, this study relates to the literature that examines the impacts of radio broadcasting. Studies show that radio messages work by reducing information friction (Strömberg 2004, Svensson and Yanagizawa-Drott, 2009, Russo 2019), disseminating propaganda or populist persuasion (Yanagizawa-Drott 2014, DellaVigna et al. 2014, Adena et al. 2015, Wang 2020), changing time use (Olken 2009), coordinating social movement (Gagliarducci et al. 2020, Wang 2021), or facilitating norms and attitudinal changes (Cheung 2012, Blouin and Mukand, 2019, Khalifa While the mechanism at work depends on the context, the norm channels appear to fit the present study. In terms of empirical strategies, this paper follows the spirit of Strömberg (2004) and Adena et al. (2015), which identify the impact of AM

[8] While economists have long focused on analyzing the costs and benefits that give incentives to reduce fertility (see Guinnane 2011 for a review), there is now growing evidence that norms, attitudes and cultural change also play a critical role in the fertility transition across the globe (see Silva and Tenreyro 2017 for review).

[9] As an instrumental variable for the viewership of 16 and Pregnant, Kearney and Levine (2015) use MTV viewership in a year before the show started. Jaeger et al. (2020) raise a concern that such an IV may violate the exclusion restriction because demographic characteristics determining MTV viewership may directly affect teenage pregnancy.

radio waves using ground conductivity as an instrumental variable. The present study also provides quantitative content analysis, which existing literature has rarely done due to data availability.

The remainder of the paper is organized as follows. Section 2 provides a brief background of women's radio programs in Occupied Japan and highlights key features that are critical for my empirical analysis. Section 3 explains the model, identification, and estimation strategy. Since data collection and digitization are also key steps in this project, Section 4 discusses them in detail. Section 5 discusses the results and addresses potential threats to the identification strategy. Section 6 mentions the remaining points that my present study does not address. Finally, Section 7 concludes.

2 Historical background: women's radio programs in Occupied Japan

This section provides three pieces of historical background that are essential for my study. Subsection 2.1 highlights the fact that women's radio programs were one of the first efforts of the Allies to raise women's social status. Subsection 2.2 explains the preexisting radio broadcasting infrastructure, which informs my identification strategy. Subsection 2.3 summarizes the content of women's radio program, and presents an examination of women's political participation, labor market participation, and family formation as relevant behavior.

2.1 The Allies' efforts to raise women's status in Occupied Japan

After World War II, Japan was occupied by the Allied Powers from September 2, 1945 to April 28, 1952. Although officially called the "Allied Occupation," it was mostly an undertaking of the United States, with contributions from Australia, India, New Zealand,

and the United Kingdom, and therefore it was often called the "American Occupation." General Douglas MacArthur oversaw the occupation as the Supreme Commander for the Allied Powers (SCAP). The acronym SCAP was soon used to refer not only to the commander himself, but also to the offices of occupation set up under him to guide Japan to demilitarize and democratize the nation.

When General MacArthur set up five major reforms on October 11, 1945, later known as the Five Major Reform Directives, one of them turned out to be raising the legal and social status of Japanese women.[10] The idea behind it was that SCAP arguably attributed the prewar militant political system to the patriarchal Japanese social system (Kobayashi 2004). The idea of raising women's status was placed at the core of the occupation policies as a major pathway for peacebuilding. In this way, Japanese women gained several legal rights during the Allied Occupation, including rights to vote and run for office (in December 1945 for the national election, and in September 1946 for the local election) and to attend college (1948).[11]

The U.S. occupying force "chose to make Japan a laboratory for one of the world's most radical experiments with women's rights" (Pharr 1987). Women-related policies under the Allied Occupation are considered not only radical in relation to the status quo in Japanese society in 1945, but also more liberal than the situation in Western societies at the time.[12]

[10]The other four reforms were to abolish the secret police, to encourage the formation of labor unions, liberalize the education system, and democratize the economy. Source: Diplomatic Records A' 1.0.0.2-3-4 "Conference Abstracts and Memoranda between the Supreme Commander for the Allied Powers and his Staff and the Prime Minister and other ministers of Japan" <GAI-1, Reel No. A'-0055>.

[11]Uemura (2007)'s pioneering work uncovers the role of the Occupation regime in raising Japanese women's status and, in particular, analyzes the relationships between occupier and occupied.

[12]For example, the postwar Japanese Constitution, enacted in 1947, guarantees the equal rights of men and women not only in the public domain but also in marriage and family life. In fact, in the new Japanese Constitution, Article 14 reads "All people are equal under the law and there shall be no discrimination in political, economic or social relations because of race, creed, sex, social status or family origin" while Article 24 states that "marriage shall be based on the mutual consent of both sexes and it shall be maintained through mutual co-operation with the equal rights of husband and wife as a basis; With regard to choice of spouse, property rights, inheritance, choice of domicile and other matters pertaining to marriage and the family, laws shall be enacted from the standpoint of individual dignity and the essential equality of the sexes." As Pharr (1987) argues, there were no other countries except for Communist countries such as the USSR and Poland

In a significant effort to raise women's status, the first initiative of the Allied Forces was to start women's radio programs. In fact, as early as October 1, 1945, just one month after the Allies started to occupy Japan, the government-sponsored radio station, the Japan Broadcasting Corporation, began to air educational programs targeting women. The women's programs aimed "to raise political, social, and cultural standards of ordinary women and breaking away from feudalism," and "in order to select qualified female leaders, [the women's radio programs introduced] not only anti-militarists who remained silent during the war but also many unknown progressive, young women." (Japan Broadcasting Corporation Yearbook (1947); translated by the author).

The important takeaway from this subsection is that women's radio programs started in the unique context of the Allies' broader efforts to raise women's legal and social status. As I shall explain in Section 3, however, the analysis relies on cross-sectional variation in exposure to women's radio programs but not the timing. Leveraging cross-sectional variation allows me to ensure the internal validity of the results. Otherwise, different timing may also reflect a different legal environment that women were facing.

2.2 Radio reception and use in Occupied Japan

In this subsection, I explain the preexisting radio broadcasting infrastructure that existed before the Allies' arrival, which allowed the General Headquarters (GHQ)/SCAP to introduce women's radio programs in the very early stage of the occupation period. Not only were the programs on air, but they were also well received by female listeners, as I uncover from listeners' surveys.

At the onset of the Allied occupation, there were 53 radio transmitters and 39 amplifiers across the nation, all of which were connected and operated by a single state-

that guaranteed equal rights between sexes in domestic life.

sponsored radio station, the Japan Broadcasting Corporation (JBC). The JBC has a primary channel, channel 1 (*daiichi hoso* in Japanese) which aired various programs throughout the day, and a secondary channel, channel 2 (*daini hoso*) which was used for only part of the day and mainly for rebroadcasting. Until 1952, there was no private radio broadcasting. In effect, a radio holder had only two choices: either to listen to the JBC's programs, or not to listen to any programs at all. Such a binary choice set turns out to be critical for my empirical analysis. I do not need to consider the listener's selection into different radio stations at the same time window.

Importantly for my analysis, the JBC kept records on the number of households subscribing to radio as well as the total number of households in all municipalities. This is because the JBC mandated all radio holders to register and pay subscription fees. The fee was not expensive and thus, I do not worry that it may have excluded low-income families from acquiring radio. In fact, the mandated annual fee in 1950 was 35 yen, which was 2.5 times the price of one serving of Soba noodles, Japanese staples.[13] I digitize the JBC record to calculate the radio subscription rate, which I later use as an independent variable in my empirical analysis.

During the Allied occupation, the JBC operated under the close supervision of the GHQ/SCAP Civil Information and Education Section Radio Unit (later also called the Radio Branch and hereafter referred to as the Radio Unit). Radio broadcast content was censored in advance by the Radio Unit.[14] The Radio Unit also conducted modern listener surveys (Mayo 1988, Luther and Boyd 1997, Smulyan 2002). In effect, the Radio Unit had a large say over what kind of content was on air and therefore played a key role in disseminating

[13] See Table G.7 on annual radio subscription fee from 1925 to 1955. Data are drawn from Okabe (2018).

[14] The head of the production team for women's programs, Fuji Egami recalls "All women's programs, including introductory announcements, were to be submitted to the Civil Information and Education Section 10 days before the broadcast. Translators kept typing all the time. All dramas, stories, lectures, interviews, debates and even round tables were stenographed, rewritten into Japanese, then translated into English. It took more than two weeks to broadcast programs after they were recorded. It was impossible to deliver timely information" (Egami 1955, translated in English by the author.)

information to meet the GHQ's purposes.

The JBC started airing the flagship women's program "Women's Hour (*Fujin no jikan*)" on October 1, 1945, just about a month after the Allies started occupying Japan. The program was designed to draw as many women as possible. A time slot allotted to the women's program was the lunch break when women used to listen to a war-time women's program during World War II; women were appointed as the director of the production team, as well as moderators, in order to be friendly to female listeners; music was played occasionally for a pause so that listeners could maintain concentration (Japan Broadcasting Corporation, 1947, 1950)

As the JBC's Listener survey reveals, women's programs were indeed well received. In the 1947 survey, more than 70 percent of women with a radio subscription said that they currently listened to or used to listen to the women's program. Not only did they listen to the women's program, but more than 60 percent of them answered that they had gained new knowledge through the program. This survey reassures me that women's programs conveyed new information to women as GHQ/SCAP intended.

As time went by and the JBC's production capacity increased, the JBC added more time slots for women's programs. By the end of 1950, the weekly airtime that the JBC allocated to women's programs had quadrupled from its onset in October 1945.[15] This underscores the fact that GHQ/SCAP maintained and strengthened efforts to raise women's status throughout the occupation. As the airtime expanded, the content covered by the women's programs grew too, as I show in detail in the next subsection.

Before diving into the radio content analysis, I note that the analysis primarily focuses on the occupation period (1945-1952) although the JBC continued to air women's

[15] See Figure F.2 NHK Yearbook (Japan Broadcasting Corporation 1947, 1949) and GHQ/SCAP CIE Weekly Report (Radio Education Branch, 1946 - 1950).

programs until 1963. I restrict my attention mainly to the occupation period because, at the end of the occupation period, private radio broadcasting as well as TV broadcasting started, giving more choices to potential listeners. Competition among different mass media outlets may have fundamentally changed the nature of media content as well as complicated the listeners' decision process about which information they acquire and why. Although this transition in the broadcasting market opens up a new avenue of research, it is beyond the scope of my current analysis.

2.3 Contents of women's programs

What kind of messages did the women's programs try to disseminate? Answering this question is key to determine which women's outcome this study should consider. Therefore I turn to the Weekly Radio Reports (from January 1946 to December 1950), which document daily radio content. I classify them into several topics, and see how the composition of topics changed over the course of the Allied occupation.

The Weekly Radio Report[16] was reported every week, with one section dedicated to the featured programs of the week. The following are examples of content descriptions.

> Women's Hour March 12, 1946
>
> "While it may be praiseworthy for a wife to bow to her husband's will in many cases, the forthcoming general election demands that she make her own decision, entirely independent of others"
>
> Women's Hour December 7, 1950
>
> "Birth control was the subject of a discussion among three prominent guests:

[16] Weekly Radio Report GHQ/SCAP CIE Box No. 5318 Folder 9.

> Mrs. Kato [Kato Sizue], disciple of Margaret Sanger; Mrs. Yamamoto, physician and Mr. Mochizuki, member of the purity education committee of the ministry of education. While Mrs. Kato and Mrs. Yamamoto stressed the need for birth control in Japan's rapidly expanding population, Mr. Mochizuki turned his attention to a discussion on specific related problems in a married life"

Both of the above examples appear to challenge the prewar gender norms. In the first example, the program demands that women make their own choices of whom to vote. This goes against the conventional view that a woman obeys her father, her husband, and her son. In the second example, Shizue Kato airs her support for birth control. This highlights a significant shift in norms around birth control. The wartime militaristic government had the "births for the nation (Umeyo Fuyaseyo)" policy, and oppressed birth control as a dangerous thought. In fact, Shizue Kato, who had pioneered the birth control movement since the 1920s, was arrested in December 1937 (Tipton 1997). With this background, airing her voice in the public women's radio programs would shift the public discourse around birth control.

To understand the topic composition of the women's radio programs in a more systematic manner, I classify the daily contents of women's programs using Latent Dirichlet allocation, and show the year-by-year topic composition (Figure 1).[17] I find that, women's programs were primarily about politics and elections in 1946, which is consistent with what Okahara (2007) uncovers in her case study.[18] Interestingly, the content covered by women's programs became more diverse over the years to cover women's organizations, the interests of young women and girls' interests, child development, new labor and welfare laws, and information on food and health.

[17] For a detailed explanation, see Appendix E.

[18] Toyoda (2012) reviews Okahara (2007) in English.

The fact that program content became diverse over time motivates me to explore whether exposure to women's radio programs can affect not only political behavior but also other women's outcomes, particularly labor market participation, marriage rate, and fertility rate. Based on the words and phrases that appear in the radio content, I hypothesize the following. First, women's electoral turnout increases in response to larger exposure to women's radio programs, which urged women to vote in the 1946 general election. Second, women's labor market participation increases in response to greater exposure to women's radio, whose content included women's careers and to labor laws that protect women's rights in the workplace. Third, the annual marriage rate decreases, at least in the short run, in response to larger exposure to the women's radio programs, which emphasized women's freedom to choose their own marriage partners. Fourth, the annual birth rate decreases in response to greater exposure to women's radio programs, which discussed the benefit of birth spacing for women's health.

2.4 Women's radio programs through the economics lens

Through the lens of Akerlof and Kranton (2000)'s economics of identity, the radio messages described above can be viewed as attempts to alter gendered identity norms. Women previously considered incapable of participating in politics were now encouraged as important political voices. Similarly, birth control, which was once considered taboo, was promoted as beneficial for maternal and children's health. Through the radio, listeners were informed that old norms were being dismantled and new ones introduced. This would have reduced the psychological cost of previously unacceptable behaviors that could potentially hold women back. In theory, therefore, one predicts that women who were exposed to radio messages would behave differently than they would have otherwise – for example, greater participation in elections and the labor market, as well as greater use of birth control and hence lower birth rate. It is still an empirical question, however, whether these radio programs had any intended consequences: internalized identity norms may be hard to change anyway. Alternatively, radio campaigning can also backfire.

3 Empirical model and identification strategy

Based on the content analysis, I hypothesize and test that exposure to women's radio programs can affect women's decision-making on political participation, labor market participation, marriage, and fertility. To identify the causal effects of radio exposure, I instrument for the exposure to the radio using quasi-random variation in AM radio reception quality induced by soil conditions and perform an instrumental variable (IV) analysis.

3.1 Empirical model

I assume a linear causal model between exposure to women's radio programs and the outcomes of interests. Here I aim to identify a causal parameter β_1 below, which captures the impact of the exposure on each outcome.

$$\text{Outcome}_{j,t} = \beta_0 + \beta_1 \text{radio exposure}_{j,1946} + \gamma x'_{j,t} + u_{j,t} \tag{1}$$

where j indicates a district. $x_{j,t}$ is a vector of district characteristics, explained in detail in the next subsection.

I describe in detail in Section 4 how each variable is measured, but note here that radio exposure is proxied by the district-level radio subscription rate, defined as the share of households subscribing to radio; this proxy has both advantages and shortcomings. On the one hand, the subscription rate captures the actual listener rate better than signal strength or cable introduction, which potentially overstate the radio listenership but are nonetheless used as a main explanatory variable by most of the existing studies on mass media. To this end, I take advantage of the radio receiver license system in Japan, which provides data on district-level radio subscription rates. Having the actual radio subscription turns out to be especially critical for scaling in this study, because the average radio subscription rate is only 36.7 percent, while the radio signal covers almost the entire nation, however weak it is.

Meanwhile, one may worry that the radio subscription captures the impact of radio listenership in general but not necessarily the exposure to women's programs. To address this concern, I draw on evidence that men's and women's ratings were statistically indistinguishable for all programs except women's programs (Figure F.3). Moreover whenever possible, I perform regressions for both men and women separately and compare their impacts. Under the assumptions that (i) there is no gender difference in the impact of radio exposure and (ii) men's and women's ratings are the same across districts, the gender-differential impact of the radio subscription rate captures the impact of women's radio programs on women's outcomes. However, we could instead assume that women react more to new norms than men do, owing to preexisting gender inequality. Under this alternative assumption, the impact of the radio subscription rate can indeed confound women's radio programs and other radio programs. I still argue that the primary impact most likely comes from the women's radio programs, because women's programs but not other programs provide relevant content on female election candidates, labor laws relevant to women, freedom of choosing marriage partner, the health benefit of birth spacing, and so forth. It is beyond the scope of my research to ask how impacts would change if such contents were conveyed within general programs that do not specifically target women. An interesting open question remains about how the effects of information vary when conveyed in and out of gendered spaces.

3.2 Identification strategy

The key empirical challenge to identify the causal effect β_1 is that radio exposure, proxied by the radio subscription rate, might be endogenous to women's outcomes through women's unobserved characteristics. Such a concern arises when radio subscriptions are correlated with subscribers' unobserved characteristics, such as attitude toward the American occupation, openness to new ideas, willingness to acquire new information, potential for local economic growth, local culture, or religion. For example, women with a greater interest in politics may subscribe to radio to obtain information on politics. Such a positive correlation between the subscription and unobserved characteristics overstates the causal effect β_1.

To address the endogeneity issue, I leverage quasi-random variation in radio reception quality during daytime hours, which is as good as random to potential subscribers but increases their likelihood of radio subscription. The metric of the radio reception I use is the ground wave field strength (hereafter field strength), which depends on the horizontal distance from a nearby transmitter, output power of the transmitter, wavelength, and ground conductivity between the transmitter and receiver. The ground conductivity measures how fast the AM radio wave can propagate through a given soil type and depends on the moisture and salt contents of the soil. The key idea is as follows. On the one hand, the distance to a nearby transmitter, output power, or wavelength may be based on strategic considerations,[19] and the ground conductivity is as good as random to potential subscribers. Therefore, after controlling for distance and transmitter fixed effects, the local variation in the field strength

[19]For example, radio transmitters may have been strategically placed in the area with higher political aspirations, higher aspiration for freedom of marriage, higher demand for birth control, higher potential supply of female labor force, and so forth. Although such a concern may be unwarranted given the historical background of radio, as described in Section 2, these unobserved characteristics of women may indirectly relate to transmitter locations through urbanness, and therefore it is still important to control for the distance.

can serve as an instrumental variable for the radio subscription rate.[20] My identification strategy is in the similar spirit of Strömberg (2004) and Adena et al. (2015) which also exploits features of AM radio wave propagation.

Furthermore, I control for other district characteristics, which were denoted by a vector $x_{j,t}$ in equation (1): industry composition, measured by the labor share in major three industries (agriculture, forestry, and mining). Doing so addresses the concern that the soil may reflect how fertile the land is and correlate with the economic potentials of a given area. I also include the number of households, number of households per square km, and a city indicator to control for urbanness. Moreover, I control for the fact that a district was subject to bombing during World War II to take into account that bombings might have affected citizens' attitudes toward the American Occupation and their radio programs. Finally, prefecture fixed effects control for any inter-prefectural public policy differences.[21]

Figure 2b shows the identifying variation – the residualized field strength after controlling for the distance, transmitter fixed effects, and all the other control variables. Notice that areas with high residualized field strength, in dark blue, and areas with low residualized field strength, in dark red, are adjacent to each other. It is reassuring that there is no systematic pattern. As Figure 3 shows, greater residualized field strength does increase radio subscriptions.

With the instrumental variable in hand, I estimate the causal impact of radio exposure on each outcome of interest via two-stage least squares (TSLS) and compute robust

[20]Formally, our conditional exogeneity condition and the relevance conditions take the form

$$E[\text{Field strength} \times u|\text{transmitter fe, distance}, \mathbf{x}] = 0$$

$$E[\text{Field strength} \times \text{Radio exposure}|\text{transmitter fe, distance}, \mathbf{x}] \neq 0$$

[21]A prefecture is the first level of jurisdiction and administrative division in Japan and is overseen by an elected governor, legislature and administrative bureaucracy.

standard errors.

To conclude this section, I discuss potential mechanisms through which my instrumental variable may violate the conditional exogeneity assumption. There might be a concern that soil type, which provides local variation in the field strength, directly determines the outcomes that I am interested in. Such concern arises if the soil type happens to indicate agricultural productivity, which then directly determines the optimal labor input. Alternatively, the soil type may capture an environmental factor for human fertility, which then directly determines the birth rate. In either case, the direct association between the outcomes and field strength would undermine the exclusion restriction of the instrumental variable.

To address these concerns, I regress the pre-intervention outcomes on the field strength and full set of control variables. Pre-intervention variables are available for the annual marriage rate (1935), the birth rate (1935), and the labor force participation rate (both men and women in 1940). For a political outcome, I use men's turnout in the 1942 general election, which was the last national election before the American occupation, to proxy for the district-specific political aspiration.[22,23] As Table C.3 shows, the outcome variables are not associated with field strength, in the absence of the radio intervention.

4 Data

I hand-collect data on election turnout, labor market participation, marriage, and fertility, as well as the geographical reach of the radio from population census, vital statistics, local newspapers, and other reports. All variables are observed at the district (*shi* and

[22] In 1942, all men above the age of 25 had the right to vote whereas women did not.
[23] Data sources are explained in the next section in details.

gun) level[24] and all but electoral turnout cover the entire nation. As Corder and Wolbrecht (2016) point out, collecting gender-specific electoral turnout is not a trivial undertaking across the world. I hand-collect the 1946 electoral turnout from newspapers. Since the resulting sample does not cover all prefectures,[25] my analyses exploit within-prefecture, across-district variation but not the across-prefecture variation. Using these variables, I construct a unique, district-level panel dataset, which covers both the prewar and postwar periods. All but the 1946 electoral turnout cover the entire nation. Table A.1 summarizes all the data sources and I highlight key issues below.

As mentioned in Subsection 3.1, the degree of exposure to women's radio programs is proxied by the radio subscription rate, which is defined as the share of households subscribing to radio in 1946. I draw the radio subscription rate from the 1946 yearbook published by the JBC, which recorded the number of households subscribing to radio as well as the total number of households at the village level. In 1946, the village level subscription rate ranges from less than 10 percent to over 80 percent, with an average of 37.7 percent.

I draw data on the AM wave field strength, which serves as the instrumental variable for radio exposure, from the map that the JBC published in 1949. According to Japan Broadcasting Corporation (1947), the JBC measured field strength the year before. To the best of my knowledge, this is the first map of the field strength published after World War II. I digitize the map (Figure 2a) and compute the district level average field strength to construct the instrumental variable. I also compute the distance from each district to the nearest radio transmitter by utilizing the information on latitude and longitude of radio transmitters

[24]There were 785 districts (248 Shi, 14 Shicho, and 523 Gun) in 1950. The average population size is 54,000 in 1950. For the purpose of my analyses, I exclude the following islands: O shima, Miyake jima, Hachijo jima, Oki shima, Amamio shima, Kikai jima, Tokuno shima, Okinoerabu jima, and Yoron jima. *Shima* and *jima* are Japanese words meaning *island*.

[25]A prefecture is the first level of jurisdiction and administrative division in Japan and is overseen by an elected governor, legislature and administrative bureaucracy. Each prefecture consists of multiple districts.

taken from the JBC 1947 yearbook[26] as well as data on administrative boundaries.[27]

Here I highlight challenges to collect data on gender-specific electoral turnout. I draw data on electoral turnout by sex in the 22nd House of Representatives Election held on April 10, 1946, the first election after women's suffrage. The data are from local editions of three national newspapers as well as prefectural newspapers, which reported district level turnout by sex between April 12 and April 18, 1946.[28] My final dataset contains 26 prefectures, covering 56.7 percent of eligible voters[29] in Japan in the 1946 election. Since the resulting sample does not cover all prefectures, my analyses rely on within-prefecture, across-district variation but not across-prefecture variation.

It is reassuring that the average turnout in my sample is statistically indistinguishable from the nationally aggregated turnout by sex[30]: In my sample, women's average turnout rate is 0.66 with a standard deviation of 0.08 while the national average is 0.67. Meanwhile, men's average turnout rate is 0.80 with a standard deviation of 0.06 in my sample, while the national average is 0.78.

Table 1 summarizes district-level radio subscription rate, residualized field strength, and other characteristics for all districts (Column 1), districts in my election sample (Column

[26]There is a time lag between the political effects (1946) that I estimate and the map on field strength that I use. However, according to the Ministry of Internal Affairs and Communications, only two transmitters were added between 1946 (111) and 1948 (113). Therefore, I would not worry about the confounding effects of additional transmitters.

[27]I use shape files on administrative boundaries provided by Maruyama Lab, Tsukuba University, Japan.

[28]I went through all the newspapers held in the Gordon W. Prange Collection (accessed at the Harvard-Yenching Library) and the National Diet Library. My final dataset includes electoral turnout from the following newspapers: the Yomiuri and Yomiuri's local editions in Iwate, Miyagi, Fukushima, Ibaraki, Gunma, Saitama, Chiba, and Nagano; the Asahi (on April 11) and the Asahi's local edition in Shizuoka, Shimane (on April 18), Nagasaki, Oita, and Miyazaki; Yamagata Shinbun; Kitaguni Shibun; Yamanashi Nichi Nichi Shinbun (on April 13); Chubu Nihon Shinbun; Ise Shinbun; Kyoto Shinbun; Bocho Shinbun (on April 16); Tokushima Shinbun; Ehime Shinbun; Saga Shinbun. Unless stated otherwise, the date of publication is April 12, 1946. *Shinbun* is a Japanese word for *newspaper*.

[29]In the 1946 election, men and women aged 20 years or above were eligible to vote. Eligible voters were automatically registered.

[30]Tabulated statistics on electoral turnouts by sex are drawn from the Japan Ministry of Internal Affairs and Communications and complied by the National Women's Education Center.

2), and districts out of my election sample (Column 3). It is reassuring that radio subscription rate and residualized field strength are statistically similar between in-sample districts and out-of-sample districts. Meanwhile, in-sample districts has a slightly smaller male-to-female ratio, have a larger share of agriculture but a smaller share of mining industry. In my analyses, I control for all these district characteristics.

Lastly, Table 2 and Table 3 show the means and standard deviations of labor force participation and vital statistics. In 1950, female labor force participation was 52 percent. One should note that the participation rate falls to 28 percent if I only look at employed women. Turning to vital statistics, the number of live births per 1,000 population was 32.78 in 1935, and went up to 34.67 in 1947, which is the beginning of the postwar baby boom. The baby boom lasted until 1949. In 1950, the average number of live births per 1,000 population appeared to be as low as 27.95.[31] The number of marriages per 1,000 population in 1935 was 8.56 and 8.29 in 1950. Note that my dataset also includes stillbirths and divorces. While they are not directly relevant to radio content, I use them to elicit potential mechanisms through which radio exposure affects fertility decisions.

5 Findings

This section presents the main results concerning the effects of exposure to women's radio programs on political participation (Subsection 5.1), labor market participation and family formation (Subsection 5.2).

[31] Figure K shows Japan's historical demographic trends.

5.1 Political participation

Table 4 shows results from the regressions of equation (1). See page 19 for the detailed description of control variables (x_{jt}). Column 1 reports the first stage estimate with the minimal set of covariates: after controlling for the transmitter fixed effect and distance to a nearby transmitter, a one standard deviation of field strength increases radio subscription by 0.45 standard deviation unit. Column 2 reports the first stage estimate with the complete set of covariates. A one standard deviation of field strength increases radio subscription by 0.51 standard deviation unit.

I find that exposure to women's radio programs yields positive impacts on women's political participation. Table 4 shows results from the regressions of equation (1) with three different outcomes: women's turnout (Columns 3, 4 and 5), men's turnout (Columns 6 and 7), and women's share of those who cast ballots (Column 8). For each outcome, I present ordinary least squares (OLS) and TSLS estimates. The key independent variable (radio subscription rate at district level) is in standard deviation units. Analyzing the OLS estimates first, radio subscription has a strong positive association with women's turnout (Column 3) but not men's turnout (Column 6).

These associations turn out to be causal: Column 5 demonstrates that a one standard deviation increase in radio subscriptions increases women's electoral turnout by 2.4 percentage points. The magnitude of the TSLS estimate is not statistically distinguishable from the OLS estimate (Column 3). To see the role that some control variables play, Column 4 exclude city indicator and industrial compositions. Notice that these control variables do not affect the estimate of the causal effect of women's radio programs. Column 7 presents the TSLS estimate regressing men's turnout on the radio subscription. Similar to the OLS estimate, the TSLS estimate is not statistically distinguishable from zero at the five percent level. The positive gap between women's turnout (Column 5) and men's turnout (Column

7) suggests that the radio subscription has impacts only on women through the provision of women's radio programs.

In addition, Column 8 shows the impact on the women's share among voters, defined by the share of women out of men and women who cast ballots, and confirms that the radio exposure increases the women's share by 1.6 percentage points. Later in this section, I further ask if the increase in the women's share among voters induced by radio increases a female candidate's vote share.

The magnitude of 2.4 in Column 5 is not only statistically significant at the five percent level, but also substantially important: it accounts for 29 percent of the standard deviation of women's turnout.[32] I use the regression estimates on female candidate's vote share and perform a back-of-the-envelope calculation. Assuming that the impact is homogenous at any level of radio subscription rate, this simple calculation suggests that the radio exposure overall reduced the gender disparity in turnouts by 5.0 percentage points.[33]

Additionally, I explore the possibility of heterogeneous impact based on the male to female ratio. Due to military casualties, the male to female ratio varies substantially with the mean of 0.92 and the standard deviation of 0.06. Asai and Kambayashi (2020) document that such across-district variation comes from *home regiments*: each regiment consisted of men from the same prefecture and it was as if home away from home. Moreover by chance, some regiments were heavily damaged. This is because the allies employed the leapfrogging strategy, i.e., bypassing heavily fortified islands instead of capturing every island in sequence. Therefore, variation in the male-to-female ratio in the aftermath of WWII is as-good-as-random, and provides the opportunity to test the heterogeneous effect

[32] Appendix O.12 examines the placebo effect of radio exposure on the pre-occupation outcome, namely men's turnout in the 1942 election. I find no significant impact.

[33] To calculate the overall impact, I assume that the impact of radio subscription is homogenous at any level of radio subscription rate. By setting the radio subscription to be zero, I compute the level of women's turnout that would have occurred in the absence of radio in each district and then aggregate them to the national level. I compare such counter-factual turnout with the observed turnout of 0.66 to get at the overall impact.

of radio exposure.

$$\text{Turnout}_{j,1946} = \beta_0 + \beta_1 \text{radio exposure}_{j,1946} + \beta_2 \text{radio exposure}_{j,1946} \times \text{male to female ratio}_j$$
$$+ \beta_3 \text{male to female ratio}_j + \gamma x'_{j,1946} + u_{j,1946} \quad (2)$$

Different theories would predict the heterogeneous impacts in the opposite direction. On the one hand, the critical mass theory or male backlash theory predicts that female scarcity would yield a negative coefficient β_2. The idea is that women would be less likely to act on new norms if women have a smaller mass to avoid backlash. On the other hand, the marriage bargaining theory predicts that female scarcity would yield a positive coefficient β_2. The idea is that female scarcity would increase their bargaining power, and therefore would amplify the effect of radio exposure. It is an empirical question whether that would be the case.

Column 2 of Table 5 shows results from the regression of equation 2. A one standard deviation increase in the male to female ratio decreases the impact of radio exposure by 1.63 percentage points. In other words, radio exposure has a greater impact on women's turnout if men are relatively scarce. This result is in favor of the critical mass theory rather than the marriage bargaining theory.

Does women's greater turnout matter in the end? Does it translate into greater women's representation at the Diet?[34] To observe this, Table 6 presents the impacts of radio exposure (Column 2) as well as women's turnout share (Column 4) on a female candidate's

[34] In the 1946 general election, 2770 candidates run for office and 79 (2.8 %) were women. Of 46 prefectures, 40 prefectures had at least one female candidate and the share of female candidates ranged from 0.01 to 0.09 with a median of 0.03. As Figure G.5 shows, there is no systematic relationship between the radio subscription rate and the female candidacy.

vote share, each of which is instrumented by field strength. Note that the unit of observation is a candidate-district pair.[35] Column 2 shows that greater radio exposure increases a female candidate's vote share by 1.33 percentage points. The direct impact of female turnout is also positive although the estimate is noisier (Column 4): a one percentage point increase in women's turnout share increases a female candidate's vote share by 1.3 percentage points.

Was the impact large enough to push a female candidate to win? To put the 1.33 percentage points into perspective, I compute the counterfactual election outcome by setting radio exposure to be zero in every district. Had there not been women's radio programs in place, the female share among winners would have been only 4.2 percent, almost half of the actual representation of 8.2 percent.[36,37] Therefore, I conclude that women's radio programs play a critical role in increasing women's representation at the Diet.

Overall, women's radio programs contemporaneously amplified women's voices in the political sphere in Japan: the women's programs effectively induced more women to vote, which in turn resulted in closing the gender representation gap. The findings echo what the GHQ/SCAP Radio Unit wrote in a weekly radio report: the women's programs "undoubtedly contributed in a large measure to the fact that 65 percent of the eligible women voters went to the polls." [38]

I note that the long-run impacts appear to be more nuanced. Appendix I shows the trend in gender-specific, district-level turnout in the 1949 and 1952 House of Representative elections. The average women's turnout increased overtime. Interestingly, closing was the gap in women's turnout between areas with high radio exposure and low radio exposure. In

[35] Appendix H explains in detail how the electoral system worked in the 1946 general election.

[36] One should note that the 1946 election was quite competitive. The minimum win-loss margin, by which I mean the vote share difference between the last winner and the runner up, was 0.005 percentage points, the median win-loss margin was 0.23 percentage points, and the maximum win-loss margin was 2.19 percentage points.

[37] In this counterfactual exercise, I assume that female candidates' gain in the vote share entirely comes from the female voters who would have abstained in the absence of women's radio programs.

[38] Weekly radio report, SCAP Civil Information and Education Section.

fact, the areas that were less exposed to radio did see a larger increase in women's turnout in the later elections. One probable reason would be a spillover effect from high-exposure areas to low-exposure areas through social sanctions: areas with initially-low women's turnout were named and shamed, and therefore more mobilization efforts took place in the later elections. Meanwhile, evidence suggests that the unexpectedly high share of female representatives faced oppositions. General Douglas MacArthur is said to have "warned them [female parliamentarians] from forming a female bloc" (Ichikawa 1977, see Ogawa 1997 p.62 for an English exposition). Furthermore, there was an electoral reform in 1947 even though it was expected to be disadvantageous for women's representation.[39]

5.2 Labor market participation and family formation

This section extends the analysis to labor force participation and family formation. I examine the causal impact of radio subscription on women's labor force participation, marriage and fertility decisions by adding two control variables to the main equation (1)[40];

$$
\begin{aligned}
\mathrm{Y}_{j,t} &= \beta_0 + \beta_1 \text{radio exposure}_{j,1946} + \gamma x'_{j,t} \\
&\quad + \gamma_1 \mathrm{Y}_{j,\text{prewar}} + \gamma_2 \text{Male-to-female ratio}_{j,t} + u_{j,t}
\end{aligned}
\tag{3}
$$

First, I include prewar outcome denoted by $\mathrm{Y}_{j,\text{prewar}}$. The prewar women's labor force participation is measured in 1940 while prewar marriage and fertility rates are measured in 1935. Second, I also include the male to female ratio (Male-to-female ratio$_{j,t}$) as a de-

[39] For example, the following is an excerpt taken from the March 28 1947 committee meeting. The speaker is identified in the minutes as Kato Chuzo of the Social Democratic Party of Japan: "many people believe that it [the proposed electoral reform] will greatly reduce the number of female representatives. I have heard that yesterday, or the day before, the chairman of the Japan Liberal Party, Mr. Ono [Banboku], told female representatives 'it is going to be your last chance [to attend the Diet], so watch it carefully'. I have heard that they were really upset" (The House of Representatives 1947a; translated from Japanese to English by the author). Hara Hyonosuke of the Social Democratic Party of Japan brought up this concern again on the March 30 1947 House floor (The House of Representatives 1947b; translated from Japanese to English by the author).

[40] See page 19 for the detailed description of control variables (x_{jt}) in equation (1).

terminant of women's labor force participation, marriage and fertility rate. The inclusion of the sex ratio as a determinant of women's labor force participation is motivated by the existing literature on the impact of wartime male casualties on women's labor market participation after the war (Rose (2018) on the United States after World War II and Boenke and Gay (2019) on France after World War I). Similarly, the idea of the sex ratio determining marriage-market outcomes dates back to Becker (1973). A growing body of empirical literature exploits the war-induced variation in the male to female ratio and shows its causal impacts on marriage and fertility.[41]

Regardless of how I define the female labor force participation rate, I find no significant impact of radio subscription. Table 7 presents the first stage (Column 1) and TSLS results from regressions of the form of equation 3 with three different outcomes: female labor force participation rate (Columns 2), female labor force participation rate excluding family employees (Column 3), and women's share in the labor force (Column 4). I exclude family employees from the definition of women's labor participation in Column 3 in order to isolate the impact of radio on salaried employees. Women's share in the labor force in Column 4 highlights the composition of the labor force rather than the level of the labor force. The radio subscription rate is in standard deviation units. In no case is the impact of the radio subscription distinguishable from zero or economically significant.

Turning to the impact of women's programs on family formation, Table 8 Column 2 presents that the impact of radio exposure on the crude marriage rate is 0.1 but statistically indistinguishable from zero. Column 8 presents that the radio impact on the crude divorce rate is 0.1, which is also statistically indistinguishable from zero. At the extensive margin, radio exposure does not appear to have a contemporaneous effect on marriages and marriage stability.

[41]For examples, refer to Abramitzky et al. (2011) in post World War I France, Kvasnicka and Bethmann (2012) in the German state of Bavaria during and after World War II, Brainerd (2017) in post World War II Soviet Union and Ogasawara and Komura (2021) in post World War II Japan.

Regarding the birth rate, Figure 4 visualizes changes in the average number of births by the degree of exposure to women's radio programs. I residualize the 1946 radio subscription rate by regressing it on the distance to the transmitter and transmitter fixed effects. Then I define the "low-exposure" group as the bottom one third of the residual distribution, "high-exposure" as the top one third of the residual distribution, and "medium exposure" as the rest. The vertical bars indicate the 95 percent confidence intervals. There is no significant difference between groups either in the prewar period (1935) or during the baby boom (1947),[42] but a significant gap emerges in 1950.[43] In high-exposure districts, the birth rate decline appears to be faster.

Formally, Table 9 shows results from the regressions of equation (3). Column 1 reports the first stage estimates with the complete set of covariates for the year 1947. A one standard deviation of field strength increases radio subscription by 0.391 standard unit. Similarly, Column 4 reports the first stage estimate for the year 1950. A one standard deviation of field strength increases radio subscription by 0.389 standard unit. This numerically differs from Column 1 because of the differential male-to-female ratio in 1947 and 1950. The difference is, however, minor and statistically insignificant.

I find that exposure to women's radio programs yields negative impacts on the crude birth rate. Table 9 shows results from the regressions of equation (3) with two different years: 1947 (Columns 2 and 3), and 1950 (Columns 5 and 6). For each outcome, I present ordinary least squares (OLS) and TSLS estimates. The key independent variable (radio subscription rate at district level) is in standard deviation units. Analyzing the OLS estimates first, radio subscription does not have a significant association with the birth rate in 1947 (Column 2) but it appears to have a negative association with the birth rate in 1950 (Column

[42] After World War II, Japan experienced a short-lived baby boom from 1947 to 1949.

[43] Table K.8 shows numerical data corresponding to Figure 4, and the t-test result comparing the high-exposure group and low-exposure group. The difference between high-exposure districts and low-exposure districts in 1950 is indeed statistically distinguishable from zero.

5).

These associations turn out to be causal: Column 3 presents the TSLS estimate regressing the 1947 birth rate on the radio subscription. Similar to the OLS estimate, the TSLS estimate is not statistically distinguishable from zero at the five percent level. Meanwhile, Column 6 demonstrates that a one standard deviation increase in radio subscriptions increases the number of births per 1000 population in 1950 by 2.7.[44] Unlike electoral turnout, however, the impact on the 1950 birth rate does not vary based on the district's male to female ratio (Appendix L).

Additionally I show that the decline in live births is not due to the change in stillbirths (fetal deaths). One may worry that radio exposure may change stillbirths while the total births remain constant. For example, radio exposure may raise women's health awareness, which may prevent fetal deaths. Alternatively, radio exposure may inform women about the Eugenic Protection Law of 1948. Since the law legalized abortions, informed women may be more likely to access abortions. To best address such a concern, I examine the impact of radio exposure on stillbirths, which include both induced abortions and stillbirths due to natural causes after 12 weeks of pregnancy.[45] Table 9 Column 8 presents the impact of radio exposure on the number of stillbirths per 1000 births.[46] A one standard deviation increase in radio subscriptions decreases the number of stillbirths per 1000 births in 1950 by 5.4. The estimate is not statistically indistinguishable from zero and, if anything, negative. Thus the decline in live births is not due to the significant change in stillbirths.

Putting all together, radio exposure contributed to fertility decline. The results above suggest that the decline is due neither to an increase in women's labor force partic-

[44] Appendix O.12 examines the placebo effect of radio exposure on the pre-occupation birth rate. I find no significant effect.

[45] No data available on abortions and stillbirths due to natural causes separately.

[46] The number of births is the sum of the number of live births and stillbirths. Data on stillbirths are not available for the year 1947.

ipation, to a decrease in marriages, or an increase in the utilization of induced abortions. Thus the fertility decline is due to the remaining mechanism – an increase in family planning.

In Appendix N, I provide suggestive evidence that the fertility decline is likely to reflect the total fertility decline but not the temporary fertility delay. I gather 10-year of panel data for municipalities in five prefectures.[47] I find that the negative effect lasts until around 1955 but do not see any reversal. Although the sample size is small, this provides a piece of suggestive evidence that the fertility decline was permanent.

How can the impact be so substantial? One possibility would be that women's radio programs changed the norms around fertility from one polar opposite to the other. As I document in Section 2.3, the wartime government had the "births for the nation" policy. Having more children was praiseworthy, and the concept of birth control was a "dangerous thought." With this background, airing the benefit of birth control would have been a substantial paradigm shift for women. This can yield a bigger impact on fertility than it would have been without the "births for the nation" policy in the preintervention period.

6 Discussion

Overall my findings provide evidence that greater exposure to women's radio programs improves women's outcomes in the political sphere and within the household during the Allied Occupation. Before I conclude, I discuss the remaining three aspects of this study.

First, while the women's radio programs intended to dismantle the existing patriarchal norms, I also acknowledge the possibility that radio may have provided new information to women. The informational channel would be particularly probable if the radio

[47] The five prefectures are Iwate, Chiba, Mie, Nara, and Tokushima.

campaign affected more illiterate and less-educated women, who were more informationally constrained. Evidence, however, does not favor this premise. Tables M.10 and M.11 show the heterogeneous impact of women's radio program on turnout and fertility rate based on the share of highly educated women in a district. In each of the tables, Column 1 repeats the TSLS estimate of the radio effect. In Column 2, I further interact the radio exposure with an indicator on whether the share of highly educated women exceeds the national median. Here I define highly educated women as women aged 25 and above with seven or more years of education. To see if the finding is robust to the definition of higher education, Column 3 uses an alternative definition: women aged 25 and above with ten or more years of education. In either definition, Table M.10 Column 2 and 3 show that the effect of radio exposure on turnout does not differ based on women's educational attainment. As for fertility, Table M.11 shows that the greater share of highly-educated women slightly magnifies the radio effect. These findings go against the potential role of radio informing illiterate and less-educated women. Albeit not being silver-bullet evidence, they also constrain the probable nature of informational channels, if any.

Second, it is still an open question of whether radio exposure has long-run and inter-generational effects. Examining long-run effects requires contemporary individual-level data with detailed geographical information during their childhood, which are not found at this moment. In the context of postwar Japan, it is critical to trace individuals to elicit long-run effects. Looking at district-level contemporary data would likely confound regional migration effects because Japan experienced rapid urbanization during the period of fast economic growth in the1960s. Had there been individual-level data available, they would enable me to further examine the impact of radio on marriage timing, marriage matching, complete fertility, birth spacing, and moreover women's regional migration pattern. I leave these aspects in future research in other contexts.

Third, Occupied Japan's unique environment needs to be considered when extending my results to other contexts. In the aftermath of World War II, Japanese citizens may have questioned their prewar values and beliefs, and thus may have been more ready to embrace new norms. Such a societal environment may facilitate a larger impact of radio programs than it would have been in other contexts. Better understanding psychological mechanisms through which mass media interventions work would be invaluable for policy discussion.

7 Conclusion

This study examines the impact of women's radio programs that the US-led occupying force aired in Japan (1945-1952) to dismantle the prewar patriarchal norms. Doing so provides a new quantitative assessment of women's radio programs in Occupied Japan. Exploiting local variation in radio signal strength driven by soil conditions as an instrumental variable, I provide causal evidence that greater exposure to women's radio programs increased women's electoral turnout. A one standard deviation increase in exposure to women's radio programs increases women's electoral turnout by 2.6 percentage points. This further translated into a greater vote share for female candidates and mattered for women's representation: had there not been women's radio programs in place, the number of female winners would have been halved. Meanwhile, qualitative evidence suggests that the long-run impacts appear to be more nuanced.

Moreover, I show that greater exposure to women's radio programs has accelerated a decline in fertility. A one standard deviation increase in radio exposure contributes to decreases the 1950 birth rate by 2.7 per 1,000 population, which accounts for 58.0 percent of the standard deviation.The declining fertility is due neither to an increase in women's career aspirations, to a decline in marriages, nor to an increase in induced abortions. My results are not driven by a preexisting correlation between radio signal strength and women's behavior before the US occupation. Overall, my results provide a piece of evidence that disseminating the idea of gender equality contributed to the fertility transition of postwar Japan.

Broadly, my results provide quantitative evidence that, using mass media, public policy can alter gender norms to address gender issues – despite gender norms being shown to persist over long periods of time. They also highlight that norms can be challenged by an explicit policy choice rather than by accident or as a byproduct of a policy.

My findings open new avenues of economic research. First, it is still an open question as to whether the intervention during the Allied Occupation has had a long-run effect and triggered a virtuous cycle toward gender equality in Japanese society. Second, the case of Occupied Japan limits my ability to investigate what would have happened if both men and women, or only men, had been exposed to women's radio content. This limitation, however, provides motivation for field experiments to understand the nature of targeted massmedia interventions further. Third, women who are exposed to new gender norms may have passed them onto their children even if they themselves did not change their behavior. Such an inter-generational transmission of the impact of norm-based interventions would be an interesting avenue of future research.

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Figures

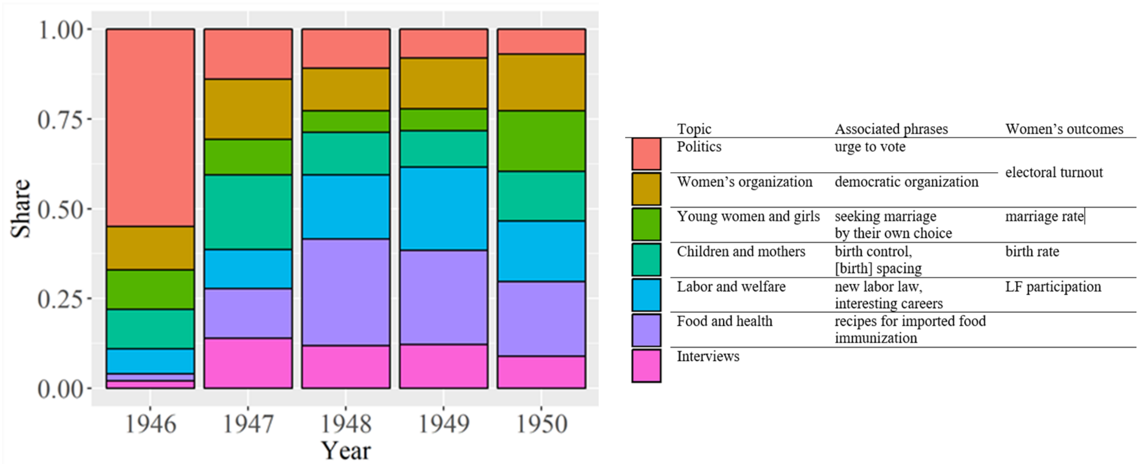
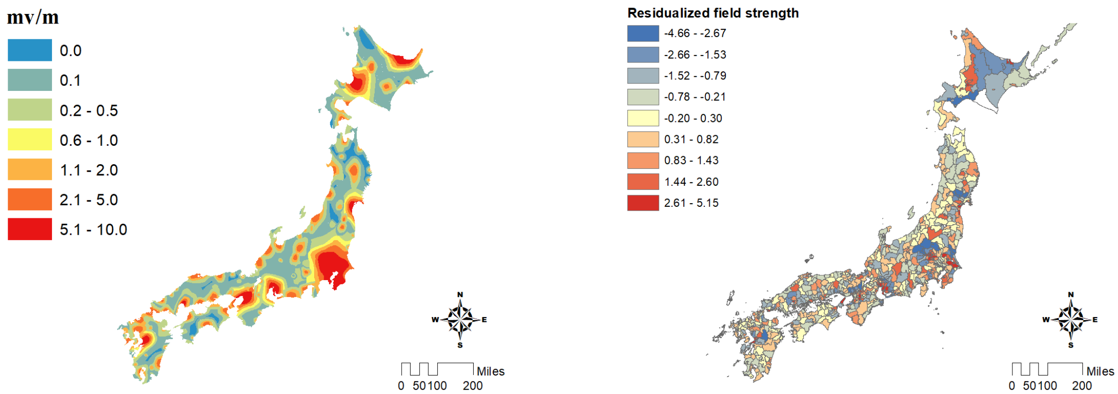


Figure 1: The year-by-year topic composition of women's radio programs from 1946 to 1950. Contents descriptions are drawn from GHQ/SCAP CIE Weekly Report (Radio Education Branch, 1946-1950, GHQ/SCAP CIE Box No. 5318 Folder 9) and classified using Latent Dirichlet allocation, described in Appendix E.



(a) Digitized map of the Radio 1 field strength

(b) Residualized field strength

Figure 2: Field strength and residualized field strength. Panel (a) shows the AM wave field strength, which serves as the instrumental variable for radio exposure. I digitized the map that the JBC published in 1949. Panel (b) shows the spatial distribution of residualized field strength. The residualized field strength is obtained by regressing field strength on the distance to a nearby transmitter, transmitter fixed effects, and all the other district characteristics variables such as population density and industrial composition.

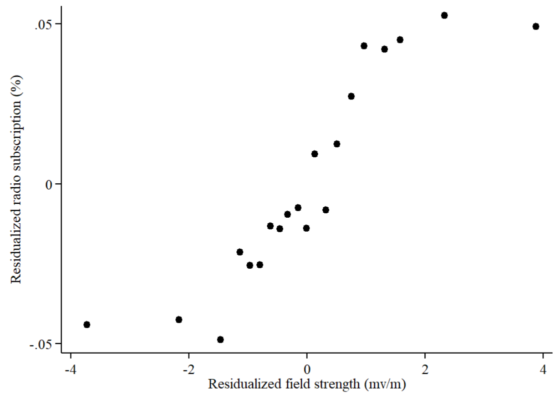


Figure 3: A binscatter plot of the residualized radio subscription rate against the field strength with a minimum set of control variables, i.e, the distance to a nearby transmitter and transmitter fixed effects. Each bin represents about 40 districts. This figure is a graphical depiction of the first stage: as we expect, greater residualized field strength does increase radio subscriptions. The S-shaped curve implies that the extremely low [high] field strength does not affect radio subscriptions because people there cannot [can] listen to radio anyway.

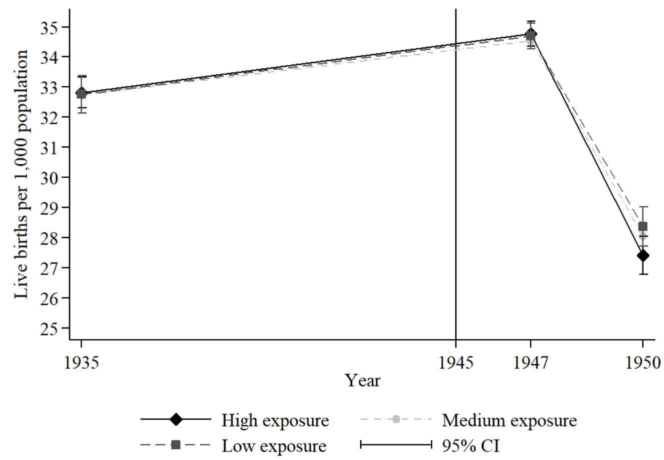


Figure 4: Changes in birth rate by the degree of exposure to women's radio programs. I residualize the 1946 radio subscription rate by regressing it on the distance to the transmitter and transmitter fixed effects. Then I define the *low-exposure* group as the bottom one third of the residual distribution, *high-exposure* as the top one third of the residual distribution, and *medium exposure* as the rest. The vertical bars indicate the 95 percent confidence intervals. Table K.8 shows numerical data and the t-test result comparing the high-exposure group and low-exposure group.

Tables

Table 1: Mean observable characteristics

	(1) All mean/[std.dev.]	(2) In-sample prefectures mean/[std.dev.]	(3) Out-of-sample prefectures mean/[std.dev.]	(4) Diff. diff/(std.err.)
Radio subscription rate	0.371	0.376	0.365	0.011
	[0.125]	[0.124]	[0.126]	(0.01)
Residualized field strength	-0.000	-0.000	0.000	-0.000
	[1.255]	[1.313]	[1.174]	(0.10)
Distance from a nearby transmitter (km)	32.954	33.613	32.076	1.536
	[21.842]	[22.256]	[21.280]	(1.64)
No. of households (in 1,000)	1.879	1.822	1.958	-0.136
	[1.994]	[1.745]	[2.295]	(0.16)
No. of hh (in 1,000) per km2	60.834	57.401	65.489	-8.088
	[164.218]	[166.483]	[161.262]	(12.61)
Labor share: Agriculture	0.404	0.421	0.382	0.040***
	[0.206]	[0.204]	[0.208]	(0.01)
Labor share: Forestry and fishery	0.044	0.043	0.046	-0.003
	[0.054]	[0.052]	[0.056]	(0.00)
Labor share: Mining	0.021	0.014	0.030	-0.016***
	[0.076]	[0.043]	[0.104]	(0.01)
Labor share: Construction	0.055	0.056	0.054	0.002
	[0.019]	[0.019]	[0.019]	(0.00)
Labor share: Manufacturing	0.155	0.149	0.163	-0.014*
	[0.100]	[0.096]	[0.106]	(0.01)
Labor share: Whole sale and retail	0.118	0.120	0.117	0.003
	[0.060]	[0.061]	[0.058]	(0.00)
Large-scale civilian casualties in WWII	0.209	0.208	0.210	-0.002
	[0.407]	[0.406]	[0.408]	(0.03)
Male to female ratio	0.913	0.908	0.919	-0.011**
	[0.060]	[0.052]	[0.069]	(0.00)
Observations	786	443	343	786

Note: Summary statistics for the main independent variable (district-level radio subscription rate), IV (residualized field strength), and control variables. Column 1 include 784 districts but not 785 districts because one district (Hidaka *shicho*) is missing in the 1950 population census. Residualized field strength is computed by regressing field strength on the distance to a nearby transmitter and transmitter fixed effects. Male to female ratio is defined as the number of men per woman. In-sample prefectures (Column 2) are the ones for which I found turnout data. The complete list of the in-sample prefectures are as folllows: Iwate, Miyagi, Yamagata, Fukushima, Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Niigata, Ishikawa, Yamanashi, Nagano, Shizuoka, Aichi, Mie, Kyoto, Shimane, Yamaguchi, Tokushima, Ehime, Saga, Nagasaki, Oita and Miyazaki. The remaining 20 prefectures are the out-of-sample prefectures (Column 3). Column 4 shows the differences in means between the in-sample and out-of-sample prefectures. Standard deviations are in square brackets. Standard errors are in parentheses.
Source: Radio subscription rate, and the number of households come from Japan Broadcasting Corporation Statistic Report 1946; industrial compositions and the male to female ratio come from the Japan Population Census 1950; I construct an indicator variable for large-scale casualties based on a list of heavily-damaged cities in "Overall Report of Damage Sustained by the Nation During the Pacific War". Note that "Overall Report of Damage Sustained by the Nation During the Pacific War" reports May-1948 estimates, and is known to underestimate casualties. In my analyses, I assume that a potential measurement error is orthogonal to my instrumental variable.

Table 2: Mean labor force participation, male and female

	1940 mean/[std.dev.]	1950 mean/[std.dev.]
Female labor force participation	0.38	0.52
	[0.09]	[0.13]
Male labor force participation	0.53	0.84
	[0.03]	[0.03]
Female labor force participation exclud. family employment		0.28
		[0.06]
Male labor force participation exclud. family employment		0.81
		[0.03]
Observations	782	784

Note: The mean labor force participation rate of men and women in 1940 and 1950. Standard deviations are in square brackets. A unit of observation is a district (*Shi* or *Gun*) at the time of the 1950 Population Census.
Source: Japan Population Census 1940 and 1950.

Table 3: Mean birth, stillbirth, marriage, and divorce rate

	1935 mean/[std.dev.]	1947 mean/[std.dev.]	1950 mean/[std.dev.]
No. of live births per 1000 population	32.78	34.67	27.95
	[4.21]	[3.15]	[4.72]
No. of births per 1000 population	32.78		30.54
	[4.21]		[4.96]
No. of stillbirths per 1000 births	48.75		85.77
	[12.95]		[23.01]
No. of marriages per 1000 population	8.56		8.29
	[1.29]		[1.61]
No. of divorces per 1000 population	0.72		0.96
	[0.22]		[0.40]
Observations	663	663	663

Note: The mean live birth rate, birth rate, stillbirth rate, marriage rate, and divorce rate in 1935, 1947, and 1950. Standard deviations are in square brackets. A unit of observation is a district (*Shi* or *Gun*) at the time of the 1950 Population Census. The number of births includes both live births and stillbirths. Stillbirths are defined as fetal deaths after 12 weeks of pregnancy. Note that the numbers of stillbirths in 1935 and 1950 are not comparable. In 1935, when abortions were still illegal, the reported number of stillbirths are all due to natural causes. Meanwhile, the Eugenic Protection Law of 1948 (*Yusei hogo ho*) legalized abortions. Consequently, the number of stillbirths in 1950 includes not only stillbirths due to natural causes but also abortions after 12 weeks of pregnancy.
Source: Japan Vital Statistics reported by place of residence in 1935 ("*Shi cho son betsu jinko dotai tokei showa ju nen*"), 1947 ("*Jinko dotai tokei showa 22 nen dai 8 bunsatsu dai 28 hyo*"), and 1950 ("*Jinko dotai tokei showa 25 nen dai 2 bunsatsu dai 26 hyo*").

Table 4: The impact of the radio subscription in 1946 on turnout in the first postwar election

	(1) First stage	(2) First stage	(3) OLS	(4) TSLS	(5) TSLS	(6) OLS	(7) TSLS	(8) TSLS
Field strength in std.dev. unit	0.579***	0.515***						
	(0.0822)	(0.0763)						
Radio subscription in std.dev. unit			0.0238***	0.0221**	0.0238**	0.00361	0.0124	0.0174**
			(0.00556)	(0.00897)	(0.0110)	(0.00400)	(0.00814)	(0.00814)
Observations	356	356	356	356	356	346	346	277
First stage F-stat				60.90	45.49		41.64	28.66
Distance control	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins
Transmitter FE	X	X	X	X	X	X	X	X
Men's turnout in 1942		X	X	X	X	X	X	X
N.of HH, HH density		X	X	X	X	X	X	X
WWII heavy damage		X	X	X	X	X	X	X
Prefecture FE		X	X	X	X	X	X	X
City indicator		X	X		X	X	X	X
Industrial composition		X	X		X	X	X	X
Male to female ratio								X
R-squared	0.69	0.81	0.76	0.73	0.76	0.73	0.72	0.76
2-step GMM estimate				0.0221	0.0238		0.0124	0.0174
(Spatial s.e. cutoff = miles)				(0.0079)	(0.0105)		(0.0090)	(0.0081)
(Spatial s.e. cutoff = miles))				(0.00660)	(0.00965)		(0.00906)	(0.00729)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note:This table shows the two stage least square estimates of the effect of radio exposure on women's and men's turnout in the 1946 general election. Columns 1 and 2 report first-stage impacts on radio subscription rate. In Columns 6 and 7, the sample size is reduced in men's regression because only women's (but not men's) turnout was reported in one prefecture (Miyazaki prefecture). In Column 8, the sample size further decreases because data on the number of qualified eligible voters are available for districts with at least one female candidate. Saitama, Aichi 2nd, and Yamaguchi prefectures did not have any female candidates. The male-to-female ratio is defined as the number of eligible male voters per female voters. At the bottom of the table, I also present two-step GMM estimates. The two-step GMM estimators and standard errors are calculated using Conley (1999). Conley (1999) proposes the way to allow for spatial correlation as a function of an economic distance between units by using a weighting function that is a product of one kernel in each dimension of the Cartesian plane (north/south and east/west). In each dimension, the kernel starts at one and decreases linearly until zero at a cutoff distance, and remains zero for larger distances. I measure an economic distance by a physical distance, and use the cutoff of 38.84 miles, which is the maximum value of the distance to the first nearest district. To show the robustness of the results, I also present another spatial standard error by doubling the cutoff (77.67 miles). A distance between two districts is measured by a distance between their centroids, and the average is 9.54 miles.

Table 5: The heterogeneous impact of greater exposure to women's radio on turnout based on male-to-female ratio

	Outcome: Women's turn out in 1946	
	(1) Women's turnout Mean 0.66 Std.dev. 0.08	(2) Women's turnout Mean 0.66 Std.dev. 0.08
Radio subscription in std.dev. unit	0.0238**	0.0231**
	(0.0110)	(0.0106)
Male to female ratio (above median) $\times$ Radio subscription (std.dev.)		-0.00932**
		(0.00364)
R^2	0.756	0.762
Control variables	X	X
First stage F-stat	45.49	22.13
Observations	356	356

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the two stage least square estimates of the effect of radio exposure on women's turnout in the 1946 general election. Both Columns 1 and 2 include the common set of control variables: distance decile bins, transmitter fixed effect, prefecture fixed effect, industrial composition, the number of households, the number of households per square km, city indicator, bombing indicator. Column 2 additionally includes the interaction between radio exposure and the indicator variable that takes 1 when the male to female ratio is above the median. The male to female ratio is defined as the number of men per woman. The smaller male to female ratio means that men are more scarce. Data on the male to female ratio are drawn the 1950 Census.

Table 6: The impact of greater exposure to women's radio on the vote share of a female candidate

	Vote share of female candidate Mean 0.08 Std.dev. 0.08			
	(1) OLS	(2) TSLS	(3) OLS	(4) TSLS
Radio subscription (std.dev)	0.00269 (0.00223)	0.0163* (0.00983)		
Female share turnout (p.p.)			0.00106 (0.000683)	0.0232 (0.0233)
R^2	0.539	0.530	0.625	-0.214
Control variables	X	X	X	X
Observations	963	963	465	465

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the two stage least square estimates of the effect of radio exposure on a female candidate's vote share in the 1946 general election. The unit of observation is a candidate-district pair. Standard errors are clustered at the level of electoral districts and shown in parentheses. In the 1946 general election, there were 52 multi-member districts, whose boundaries align with prefecture boundaries except for Hokkaido, Tokyo, Niigata, Aichi, Osaka, Hyogo, and Fukuoka prefectures, each of which was split into two. Appendix H explains in detail how the electoral system worked in the 1946 election. The sample size is larger than the dataset on women's turnout analysis because (i) I have data on all female candidates (whereas the data on turnout has missing values) and (ii) some electoral districts had multiple female candidates. I compute the dependent variable, the vote share of a female candidate, by dividing the number of votes a female candidate received by the number of voters who cast votes in the district. All columns include dummies for the deciles of the distance to the nearest transmitter, transmitter fixed effects, number of households, number of households per square km, an indicator for whether a district was bombed during World War II, and the male to female ratio defined as the number of eligible male voters per one eligible female voter. In all columns, I also control for the candidate's characteristics (party dummies, the age of a candidate, an indicator for whether a candidate was a women's suffrage activist, and an indicator for whether a candidate worked before running for office) and electoral district characteristics (total number of candidates, dummies for the number of female candidates, number of seats, and number of votes per voter).

Table 7: The impact of the radio subscription in 1946 on labor force participation

	First stage	TSLS		
	(1)	(2)	(3)	(4)
	Radio subscription in std.dev. unit	Women's LFP Mean 0.518 Std.dev. 0.134	Women's LFP excld. family emp Mean 0.283,Std.dev. 0.06	Female share in LF Mean 0.397 Std.dev. 0.065
Field strength in std.dev. unit	0.382***			
	(0.0440)			
Radio subscription in std.dev. unit		-0.0114	-0.00256	-0.00253
		(0.00829)	(0.00759)	(0.00424)
Distance control	decile bins	decile bins	decile bins	decile bins
Transmitter FE	X	X	X	X
N.of HH, HH density	X	X	X	X
WWII heavy damage	X	X	X	X
Prefecture FE	X	X	X	X
City indicator	X	X	X	X
Industrial composition	X	X	X	X
Male to female ratio	X	X	X	X
Prewar women's LFP	X	X	X	X
Observations	765	765	765	765

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the two stage least square estimates of the effect of radio exposure on women's labor force participation in 1950. Column 1 reports a first-stage impact of field strength on radio subscription. Columns 2-4 report coefficients from estimating the linear model by two-stage least squares. The dependent variable in Column 2 is female labor force participation rate in 1950. The dependent variable in Column 3 is female labor force participation rate excluding family employees. The dependent variable in column 4 is women's share among all participants in the labor force. Each column controls for a full set of covariates, including the number of household, household density, WWII damage, prefecture fixed effects, a city indicator, industrial composition, male to female ratio, and female labor force participation rate in 1940. The male to female ratio is defined as the number of women aged 15 and above per man in the same age group.

Table 8: The impact of the radio subscription in 1946 on the crude marriage and divorce rate in 1950

	No. marriages per 1000 population in 1950		No. divorces per 1000 population in 1950	
	(1)	(2)	(3)	(4)
	OLS	TSLS	OLS	TSLS
Radio subscription in std.dev. unit	-0.0408	-0.110	-0.0518*	-0.0805
	(0.114)	(0.285)	(0.0288)	(0.0514)
Observations	663	663	663	663
First stage F-stat		63.03		59.82
Distance control	decile bins	decile bins	decile bins	decile bins
Transmitter FE	X	X	X	X
Crude birth rate in 1935	X	X	X	X
N.of HH, HH density	X	X	X	X
WWII heavy damage	X	X	X	X
Prefecture FE	X	X	X	X
City indicator	X	X	X	X
Industrial composition	X	X	X	X
Male to female ratio	X	X	X	X
R-squared	0.47	0.47	0.48	0.47

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the ordinary least square (OLS) estimates and the two stage least square (TSLS) estimates of the effect of radio exposure on the marriage and divorce rate. The dependent variable in Columns 1 and 2 is the marriage rate defined as the number of marriages per 1000 population in 1950. The dependent variable in Columns 3 and 4 is the divorce rate defined as the number of divorces per 1000 population in 1950.

Table 9: The impact of the radio subscription in 1946 on the crude birth rate in 1947 and 1950

	No. live births per 1000 population in 1947			No. live births per 1000 population in 1950			No. births per 1000 population in 1950	No. still births per 1000 births in 1950
	(1) First stage	(2) OLS	(3) TSLS	(4) First stage	(5) OLS	(6) TSLS	(7) TSLS	(8) TSLS
Field strength in std.dev. unit	0.391***			0.389***				
	(0.0489)			(0.0492)				
Radio subscription in std.dev. unit		0.177	-0.368		-0.909***	-2.736***	-3.167***	-5.424
		(0.142)	(0.457)		(0.248)	(0.672)	(0.743)	(3.604)
Observations	663	663	663	663	663	663	663	663
First stage F-stat			63.81			62.45	62.45	62.27
Distance control	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins
Transmitter FE	X	X	X	X	X	X	X	X
Crude birth rate in 1935	X	X	X	X	X	X	X	X
N.of HH, HH density	X	X	X	X	X	X	X	X
WWII heavy damage	X	X	X	X	X	X	X	X
Prefecture FE	X	X	X	X	X	X	X	X
City indicator	X	X	X	X	X	X	X	X
Industrial composition	X	X	X	X	X	X	X	X
Male to female ratio	X	X	X	X	X	X	X	X
R-squared	0.80	0.78	0.77	0.79	0.73	0.70	0.68	0.64
2-step GMM estimate			-0.3681			-2.7359	-3.1670	-5.4236
(Spatial s.e. cutoff = 107.00 miles)			(0.5981)			(0.6643)	(0.7123)	(4.9614)
(Spatial s.e. cutoff = 214.00 miles)			(0.6458)			(0.6209)	(0.6403)	(4.3303)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the ordinary least square (OLS) and two stage least square (TSLS) estimates of the effect of radio exposure on the birth rate. Columns 1 and 4 report first-stage impacts on radio subscription rate. Columns 2 and 5 report the OLS estimates. Columns 3 and 6 report the TSLS estimates for the crude birth rate in 1947 and 1950 respectively. The crude birth rate is defined as the annual number of births per 1,000 population. Column 7 reports the TSLS estimate on the total number of births, which includes both live births and fetal deaths. Column 8 reports the TSLS estimate on the number of stillbirths per 1000 population. At the bottom of the table, I also present two-step GMM estimates. The two-step GMM estimators and standard errors are calculated using Conley (1999). Conley (1999) proposes the way to allow for spatial correlation as a function of an economic distance between units by using a weighting function that is a product of one kernel in each dimension of the Cartesian plane (north/south and east/west). In each dimension, the kernel starts at one and decreases linearly until zero at a cutoff distance, and remains zero for larger distances. I measure an economic distance by a physical distance, and use the cutoff of 38.84 miles, which is the maximum value of the distance to the first nearest district. To show the robustness of the results, I also present another spatial standard error by doubling the cutoff (77.67 miles). A distance between two districts is measured by a distance between their centroids, and the average is 9.54 miles.

Appendix

A Data sources

Table A.1

Data source	Variable
Japan Broadcasting Corporation Statistic Report 1946	Post-war radio subscription rate No. of households in 1946
A map on medium wave field strength published in 1949	Field strength
Latitudes and longitudes of transmitters obtained from Japan Broadcasting Corporation Yearbook 1947 District boundaries year by year provided by Maruyama Lab, Tsukuba University	Distance to a nearby transmitter
Prefecture Annual Statistics Book (annually from 1949 to 1960)	Postwar crude birth rate
The Annual Vital Statistics Report in 1935	Marriages, divorces, stillbirths, and live births
The Annual Vital Statistics Report in 1947	Live births
The Annual Vital Statistics Report in 1950	Marriages, divorces, stillbirths, and live births
Population Census 1940	Prewar labor force participation
Population Census 1947	Population in 1947
Population Census 1950	Labor force participation Industrial composition
The 21st House of Representatives election results	Turnout in the 1942 election (men)
News papers	Turnout in the 1946 election by sex
The 22nd House of Representatives election results A list of female candidates provided by Ito (2008)	Female candidate's vote share and characteristics
The 24th House of Representatives election results	Turnout in the 1949 election by sex
The 25th House of Representatives election results	Turnout in the 1952 election by sex
Overall Report of Damage Sustained by the Nation During the Pacific War	District-level total casualty during the World War II

B The association between district characteristics, radio subscription, and residualized field strength

Table B.2 Column 1 shows the association between radio subscription (i.e., my independent variable) and district characteristics. As Column 1 shows, radio subscription depends on the household density, whether or not a district is a city, and the industrial composition. The negative association between city indicator and residualized subscription may appear to go against the presumption that radio broadcasting was an urban phenomenon. One probable reason for the negative correlation, however, is that cities were more heavily damaged during WWII. City residents were more likely to get their radio receivers destroyed and were not able to find a replacement due to insufficient supply of vacuum tubes in the immediate postwar period. In sum, there is a selection on observables in the present context.

On the other hand, Column 2 shows the association between the residualized field strength (which is my IV and provides identifying variation) and district characteristics, including the number of households, household density, industry labor shares, a city (*Shi*) dummy, and the male-to-female ratio. The residualized field strength is computed by regressing field strength on the distance to a nearby transmitter and transmitter fixed effects. As Column 2 shows, the field strength does not correlate with the control variables. This provides another piece of evidence that field strength appears to be as-good-as random across districts that are equidistant from the same transmitter.

Table B.2

	(1) Radio subscription	(2) Residualized field strength (IV)
No. of households (in 1,000)	-0.00225	0.0541
	(0.00230)	(0.0358)
No. of hh (in 1,000) per m2	-72.04***	317.5
	(20.02)	(311.1)
Labor share: Agriculture	-0.707***	-0.681
	(0.0872)	(1.355)
Labor share: Forestry and fishery	-1.386***	-0.447
	(0.111)	(1.722)
Labor share: Mining	-0.710***	-0.788
	(0.0908)	(1.411)
Labor share: Construction	-2.120***	-4.321
	(0.309)	(4.808)
Labor share: Manufacturing	-0.360***	0.0116
	(0.0894)	(1.389)
Labor share: Whole sale and retail	-0.0793	0.360
	(0.194)	(3.020)
City (Shi) indicator	-0.0866***	0.380
	(0.0172)	(0.267)
Male to female ratio 1950	0.0401	-1.118
	(0.0788)	(1.225)
Observations	663	663

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: A unit of observation is a district (*Shi* or *Gun*) at the time of the 1950 Population Census. Column 1 shows the association between radio subscription (i.e., my independent variable) and district characteristics. Meanwhile, Column 2 shows the association between the residualized field strength (which is my IV and provides identifying variation) and district characteristics, including the number of households, household density, industry labor shares, a city (*Shi*) dummy, and the male-to-female ratio. The residualized field strength is computed by regressing field strength on the distance to a nearby transmitter and transmitter fixed effects.

C Balancing test

Table C.3: The association between field strength and prewar outcomes

	(1) Male turnout 1942 Mean 0.85 Std.dev. 0.04	(2) Female LFP 1940 Mean 0.37 Std.dev. 0.10	(3) Live birth rate 1935 Mean 32.71 Std.dev. 4.28	(4) Marriage rate 1935 Mean 8.50 Std.dev. 1.30
Field strength in std.dev.	0.00121	-0.00484	-0.237	-0.00353
	(0.00351)	(0.00374)	(0.201)	(0.0960)
R^2	0.724	0.850	0.841	0.635
Control variables	X	X	X	X
Observations	356	765	663	663

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the ordinary least square (OLS) estimates by regressing prewar outcomes on the field strength and other control variables. A unit of observation is a district (*Shi* or *Gun*) at the time of the 1950 Population Census. I spatially merge data in different years using year-by-year municipality boundaries, to take into account municipality mergers. In Column 1, men's turnout is defined as the number of eligible voters who cast ballots divided by the number of eligible voters. I draw data from *"Dai 21 kai Shugi-in so senkyo ichiran"* (The 21st (1942) House of Representatives election voting record). The sample is restricted to districts for which I have data on women's turnout in 1946. Methods of data collection are described in Section 4. In Column 2, LFP stands for the labor force participation rate, which is a share of the respective population working out of all the population (but not the working-age population). I draw the number of men and women working from Table 2-1 of the Japan Population Census 1940 while I draw the number of the total population from Table 1-1 of the same census. In Column 3, the birth rate is defined as the annual number of births in 1935 per 1,000 population. Similarly, in Column 4, the marriage rate is the annual number of births in 1935 per 1,000 population. I draw the number of births and marriages from the 1935 vital statistics (*Shi-cho-son betsu zinko dotai tokei: showa 10 nen*), which I digitize for this project. All columns control for a full set of covariates, including the number of household, household density, WWII damage, prefecture fixed effects, a city indicator, industrial composition, male to female ratio, and female labor force participation rate in 1940. The male to female ratio is defined as the number of women aged 15 and above per man in the same age group.

D Reduced-form estimates

In this section, I report the reduced form coefficients obtained from an ordinary least squares (OLS) regressions of outcomes on the field strength, distance to the nearby transmitter, transmitter fixed effect, and other covariates. The reduced-form effects of radio exposure on women's turnout (Table D.4 Column 2) and the birth rate in 1950 (Table D.6 Columns 4 and 5) are positive and statistically significant. Meanwhile, the reduced-form effects of radio exposure on women's labor force participation (Table D.5 Columns 1, 2, and 3), marriage (Table D.6 Column 1), divorce (Table D.6 Column 2), the birth rate in 1947 (Table D.6 Column 3) and the stillbirth rate in 1950 (Table D.6 Column 6) are not statistically distinguishable from zero. All of these results are qualitatively consistent with the results based on the two-stage least square estimation. This lends support to the credibility of my instrument.

Table D.4: Reduced-form estimates for women's and men's turnout in the 1946 general election

	(1)	(2)	(3)	(4)	(5)
Field strength in std.dev. unit	0.0122	0.0123*	0.000744	0.00621	0.00851*
	(0.00788)	(0.00667)	(0.00546)	(0.00470)	(0.00471)
Observations	356	356	346	346	277
Distance control	decile bins	decile bins	decile bins	decile bins	decile bins
Transmitter FE	X	X	X	X	X
Prefecture FE		X		X	X
N.of HH, HH density		X		X	X
WWII heavy damage		X		X	X
City indicator		X		X	X
Industrial composition		X		X	X
Men's turnout in 1942		X		X	X
Male to female ratio					X
R-squared	0.55	0.74	0.42	0.73	0.76

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the reduced-form coefficients obtained from an ordinary least square (OLS) regressions of outcomes on the field strength, distance to the nearby transmitter, transmitter fixed effect, and other covariates. The dependent variable in columns 1-2 is the share of women who turned out in the 1946 election. The dependent variable in columns 3-4 is the share of men who turned out in the same election. The dependent variable in column 5 is women's share among voters who cast ballots. Columns 2 and 4 control for a full set of covariates, including the number of household, household density, WWII damage, prefecture fixed effects, a city indicator, industrial composition, and men's turnout rate in the 1942 election. Column 5 additionally controls for the number of male eligible voters per female eligible voter in the 1946 election.

Table D.5: Reduced-form estimates for women's LFP and LFP gender gap in 1950

	(1) Women's LFP Mean 0.518 Std.dev. 0.134	(2) Women's LFP excld. family emp Mean 0.283,Std.dev. 0.06	(3) Female share in LF Mean 0.397 Std.dev. 0.065
Field strength in std.dev. unit	-0.00453	-0.00126	-0.00101
	(0.00354)	(0.00323)	(0.00180)
Distance control	decile bins	decile bins	decile bins
Transmitter FE	X	X	X
N.of HH, HH density	X	X	X
WWII heavy damage	X	X	X
Prefecture FE	X	X	X
City indicator	X	X	X
Industrial composition	X	X	X
Male to female ratio	X	X	X
Prewar women's LFP	X	X	X
Observations	768	768	768

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows reduced-form coefficients obtained by regressing an outcome on the IV, distance to a nearby transmitter, transmitter fixed effects and other control variables. The dependent variable in column 1 is female labor force participation rate in 1950. The dependent variable in columns 2 is female labor force participation rate excluding family employees. The dependent variable in column 3 is women's share among all participants in the labor force. Each column controls for a full set of covariates, including the number of household, household density, WWII damage, prefecture fixed effects, a city indicator, industrial composition, male to female ratio, and female labor force participation rate in 1940. participation. The male to female ratio is defined as the number of women aged 15 and above per man in the same age group.

Table D.6: Reduced-form estimates for the crude marriage and divorce rate in 1947 and 1950

	No. marriages per 1000 population in 1950	No. divorces per 1000 population in 1950	No. live births per 1000 population in 1947	No. live births per 1000 population in 1950	No. births per 1000 population in 1950	No. still births per 1000 births in 1950
	(1)	(2)	(3)	(4)	(5)	(6)
Field strength in std.dev. unit	-0.0421	-0.0303	-0.144	-1.064***	-1.231***	-2.110
	(0.124)	(0.0219)	(0.200)	(0.290)	(0.315)	(1.552)
Observations	663	663	663	663	663	663
First stage F-stat						
Distance control	decile bins	decile bins	decile bins	decile bins	decile bins	decile bins
Transmitter FE	X	X	X	X	X	X
Crude birth rate in 1935	X	X	X	X	X	X
N.of HH, HH density	X	X	X	X	X	X
WWII heavy damage	X	X	X	X	X	X
Prefecture FE	X	X	X	X	X	X
City indicator	X	X	X	X	X	X
Industrial composition	X	X	X	X	X	X
Male to female ratio	X	X	X	X	X	X
R-squared	0.47	0.47	0.78	0.73	0.72	0.66

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows reduced-form coefficients obtained by regressing an outcome on the IV, distance to a nearby transmitter, transmitter fixed effects and other control variables. The dependent variable in Column 1 is the number of marriages per 1000 population. The dependent variable in Column 2 is the number of divorces per 1000 population. The dependent variable in Column 3 is the number of live births per 1000 population in a district in 1947. The dependent variable in Column 4 is the number of live births per 1000 population in 1950. The dependent variable in Column 5 is the total number of births per 1000 population in 1950. The total number of births includes both live births and fetal deaths. The dependent variable in Column 6 is the number of stillbirths per 1000 births in 1950. Data on the total births and stillbirths are available only for 1950. X indicates that the respective covariate is controlled for. All columns control for a full set of covariates, including the number of households, household density, WWII damage, prefecture fixed effects, a city indicator, industrial composition, prewar outcome, and the male to female ratio in the same year as the dependent variable.

E Analyzing radio content

Latent Dirichlet Allocation (LDA) is an unsupervised machine learning technique for topic modeling. It considers each document as a predetermined number of topics in a certain proportion, and each topic as a collection of keywords in a certain proportion. A goal of LDA is to estimate a word distribution within each topic, then a topic distribution within each document by maximum likelihood. In other words, LDA tries to find a topic model that fits best to the corpus within a collection of documents under analysis. In my study, a document corresponds to a daily content of women's radio programs, two of which are quoted in Subsection 2.3. On the one hand, each topic obtains a probability distribution over words. Figure E.1 shows word clouds for each of seven topics; each word cloud shows the top-30 most frequently used words in each topic. The relative size of a word corresponds to its assigned probability, that is, larger words are weighted higher within the topic. Based on the word clouds, I assign labels to the topics: politics, women's organization, young women and girls, children and mothers, labor and welfare, food and health, and interviews. Each document (i.e., a daily content description) obtains a probability distribution over the seven topics as in Figure 1. Then, for further simplicity, I assign each document one topic with the highest probability, and obtain a mapping from a collection of documents to the seven topics. The choice of seven groups was made as follows. On the one hand, in a model with a larger number of topics than seven, some topics appear to be too specific. On the other hand, in a model with a smaller number of topics than seven, some topics turn out to be too general and need to be split to be interpretable. However, my main takeaways are robust to the number of topics.

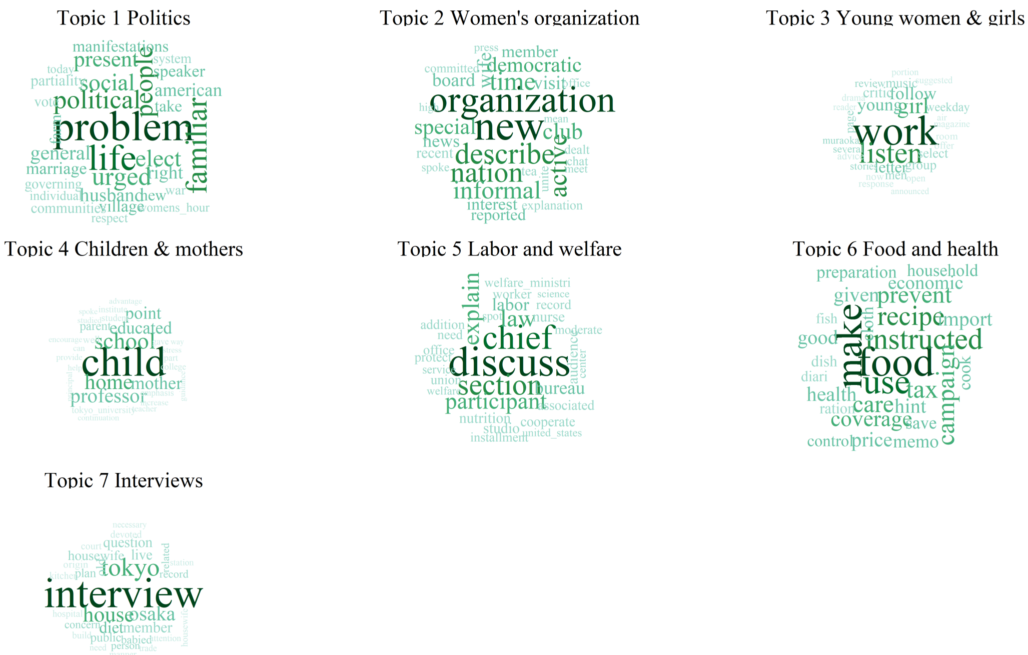


Figure E.1: Word clouds characterizing each of seven topics in women's radio programs.

F Women's programs

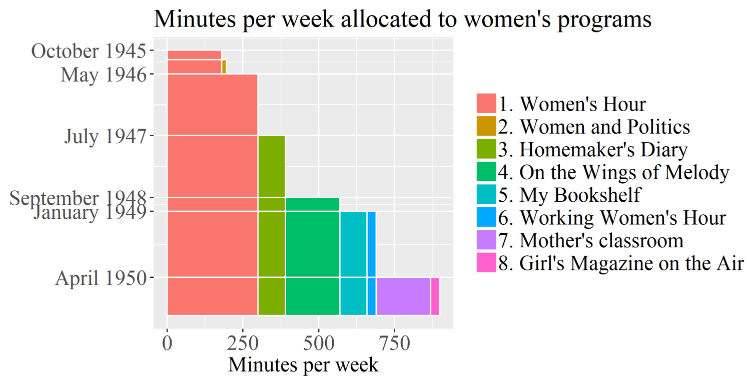


Figure F.2: Airtime allocated to women's programs. The programs were categorized as "Women's program" by the JBC. Source: NHK Yearbook (1947, 1949) and GHQ/SCAP CIE Weekly Report (Radio Education Branch, 1946 - 1950).

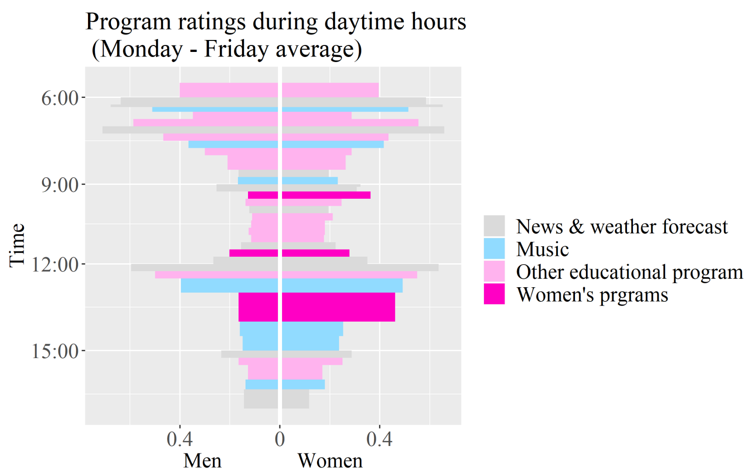


Figure F.3: Channel 1 program ratings during daytime hours. Rating is defined as a percentage of male and female radio holders who actively listened to the radio in a given time slot. The figure shows the average rating from Monday to Friday in the survey week. Dark pink represents time slots allocated to women's programs, which were aired daily. Grey, pale blue, and pale pink indicate news and weather forecasts, music, and educational programs respectively. Men's rating is no larger than women's rating for any time slot. Women's rating is especially higher than men's for women's programs: the gender rating gap is 23.6 percentage points from 9:15 to 9:30, and 29.6 percentage points from 1 pm to 2 pm. Source: Radio Listeners Survey - Report of the 3rd Regular Survey, Part 1-4 (November 1948).

G Radio subscription

In real terms, radio subscription fees had been declining before World War II. Table G.7 shows the monthly radio subscription fee (in Japanese Yen) from 1925 to 1955 along with the monthly salary for first-year teachers and a unit price for Japanese soba noodles. While inflation accelerated, the JBC decreased the monthly fee and made radio more accessible for a wide income-range of Japanese: the fee was 1 Japanese yen compared to 45 yen of teachers' starting salaries in 1925. In 1941, however, the fee halved while teacher salaries moderately grew. After World War II, inflation outpaced the increase in the nominal subscription fee, and thus the subscription fee further drops in real terms. Therefore, I am less concerned that subscription fees deterred low income Japanese from listening to the radio.

Table G.7: Radio subscription fees

	Radio subscription fee (monthly)	TV subscription fee (monthly)	Starting teacher salaries (monthly)	Japanese soba noodle unit price
1925	1.00		45.00	0.10
1930	0.75		45.00	0.10
1933	0.75		55.00	0.10
1937	0.50		55.00	0.13
1941	0.50		55.00	0.16
1946	2.50		400.00	-
1948	35.00		2000.00	-
1950	35.00		5000.00	15.00
1954	67.00	300.00	7800.00	30.00
1955	67.00	300.00	7800.00	30.00

This table reports the monthly radio subscription fee (in Japanese Yen) from 1925 to 1955 along with the monthly salary for first-year teachers and a unit price for Japanese soba noodles. While inflation accelerated, the JBC decreased the monthly fee and made radio more accessible for a wide income-range of Japanese: the fee was 1 Japanese yen compared to 45 yen of teachers' starting salaries in 1925. In 1941, however, the fee halved while teacher salaries moderately grew. After World War II, inflation outpaced the increase in the nominal subscription fee, and thus the subscription fee further drops in real terms. Therefore, I am less concerned that subscription fees deterred low income Japanese from listening to the radio.
Source: Okabe (2018) *"The 50 Years of Japanese Radio 1925-1975"* The Japan Radio Museum.

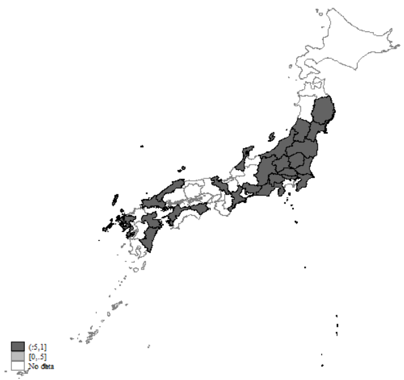
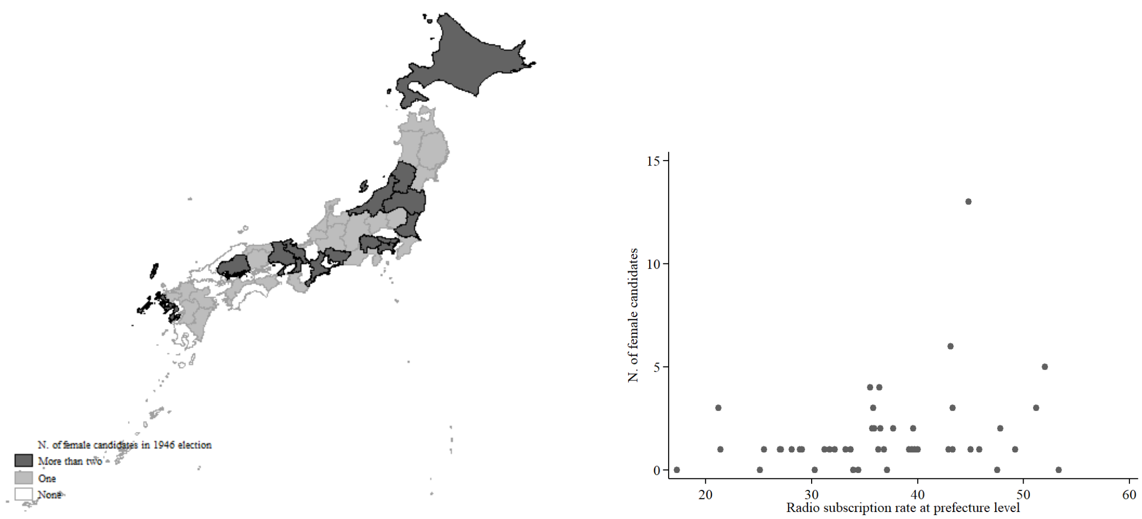


Figure G.4: The geographical distribution of prefectures for which data on 1946 turnout are available.



(a) (b)

Figure G.5: (a) Geographical variation in the number of female candidates in the 1946 general election. (b) Relationship between the radio subscription rate and the number of female candidates running for office in the 1946 general election. Each dot represents a prefecture. Five prefectures (Saitama, Shiga, Nara, Shimane, Yamaguchi, and Kagoshima) had no female candidates and therefore are omitted in from the figure. Conditional on having at least one female candidate, there is no significant relationship between female candidacy and the radio subscription rate.

H Background on the 1946 general election

This section explains in detail how the electoral system worked in the 1946 general election. The limited voting, as it is called, resembles multi-seat plurality voting because it also uses multi-seat districts. A key difference between the limited voting and the multi-seat plurality voting is that, in the limited voting, a voter casts multiple ballots, but the number of ballots per voter is *limited* strictly to less than the number of seats. In Japan's 1946 general election in Japan, in particular, a voter cast two ballots in a district with less than or equal 10 seats whereas they voted three ballots in a district with more than 10 seats. All eligible voters are automatically registered, but voting is not mandatory.

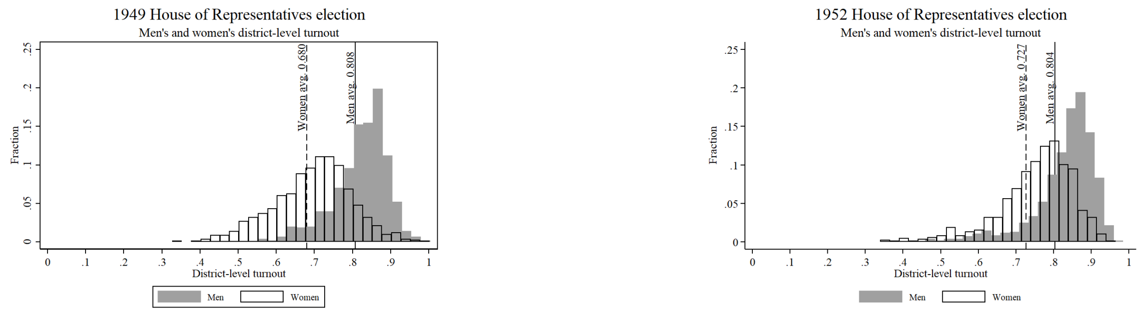
Although the limited voting system is less common compared to multi-seat plurality voting, and less understood theoretically, it is often advocated as a way to better reflect the voices of both majority and minority groups. In fact, the limited voting was considered a desirable electoral system as the very first election that Japanese women participated in. However the status-quo majority (right-wing male politicians) was less in favor of the limited voting and, in 1947, the Diet agreed to reform the electoral system again and employ multi-seat plurality. Therefore, the 1946 general election was the first and last to employ limited voting. In fact, in 1946, as many as 39 women were elected with a winning probability of 49.4 percent, which was much higher than that of men (15.8 percent). The initial success of a female candidate, however, was followed by a long stagnation, and 39 remained the record high for more than five decades until 2009.

I construct a dataset of 958 female candidate and district pairs and run the following regression. To identify the parameter of interest, β_1, I instrument the radio subscription by the ground wave field strength. Table 6 column (2) presents the result.

$$
\begin{aligned}
s_{i(p),j(d)} = \beta_0 + \beta_1 \text{radio subscription}_{d(j)} + f(\text{distance to a nearby transmitter}_{j,1946}) \\
+ \underbrace{\phi_d}_{\text{electoral district FE}} + \underbrace{\gamma x'_d}_{\text{electoral district characteristics}} + \underbrace{\iota c_{i(p)}}_{\text{candidate characteristics}} \\
+ \nu_{\text{transmitter(j)}} + \pi_{h1} \text{N of HH}_j + \pi_{h2} \frac{\text{N of HH}_j}{\text{SqKM}_j} + \psi_{\text{bombed(j)}} + u_{i(p),j(d)}
\end{aligned}
$$

where $s_{i(p),j(d)}$ is candidate i's vote share in administrative district j which belongs to an electoral district d. The exposure to the women's radio programs is again measured by the radio subscription rate, which is the share of households subscribing to radio in district j. The set of electoral district characteristics is meant to control for competitiveness in each district and include the number of seats, number of candidates, female candidates, number of votes per voter (two or three), and male-to-female ratio of eligible voters. The set of candidate characteristics include age, partisanship, whether or not she was employed before the election, and whether or not she was engaged in the women's suffrage movement in the prewar period. Unlike the regression of women's turnout, I do not include prefecture fixed effects, because they are highly collinear with electoral district fixed effects. In fact, in the 1946 general election in Japan, there were 52 multi-member districts, whose boundaries align with prefecture boundaries except for Hokkaido, Tokyo, Niigata, Aichi, Osaka, Hyogo and Fukuoka prefectures, each of which was split into two. Finally, standard errors are clustered at an electoral district level.

I Electoral turnout in the 1949 and 1952 elections



(a) 1949

(b) 1952

Figure I.6: District-level electoral turnout in the 1946, 1949 and 1952 House of Representatives elections. Averages are weighted by the number of eligible voters.

In this section, I examine whether women's exposure to women's radio programs had persistent effects on turnouts in later elections. To do so, I digitized data on women's and men's turnout in the 1949 (24th) and 1952 (25th) House of Representatives elections.[48] Figure I.6 shows histograms of women's and men's turnout in 1949 (left) and 1952 (right). The distribution of women's turnout shifted toward the right from 1949 to 1952.

While it would be interesting to evaluate the long-run impact of radio exposure, I find some narratives that the Stable Unit Treatment Value Assumption (SUTVA) does not hold in elections after 1946. According to news articles and the former occupation authorities' documents, there was a stronger women's mobilization effort in the lower-exposed districts. For example, two days after the 1946 election, the Asahi named and shamed Kojimachi district for the lowest turnout. Such a name-and-shame can be seen in other local news papers every time election took place. Moreover, I found in the GHQ/SCAP record RG331 Box 2957 the letter sent by Ms. Josephine Colletti, a civil-education officer in Hyogo prefecture, to the president of the League of Women Voters in the U.S. The letter was sent

[48] The next House of Representatives election after the 1946 election took place on April 25th, 1947. I exclude the 1947 election from the analysis because the gender-breakdown of turnout is not available either from newspapers or government report.

on January 13, 1949. In her letter, she wrote, "The Japanese women, I feel, need much guidance and training on the efficacious use of the vote." She asked the president if she could send her "all literature available on the history of the American League of Women Voters, a copy of the present constitution and bylaws, the functions of the League, copies of past activities and programs and plans for future action, etc." In return, Mrs. Charles E. Heming mailed Ms.Colletti all that she asked. Box 2957 also encloses a membership list of Tarumi League of Women Voters. Judging from the fact the letter and the membership list are classified in the same GHQ/SCAP record box, this league should be established under Ms.Colletti's guidance in Hyogo prefecture. If the league indeed followed what the American League of Women Voters did, they probably did house-to-house visits, get-out-the-vote campaigns, and citizenship schools. Therefore, areas with lower women's turnout seem to draw more efforts in bringing women to elections.

In fact, Figure I.7 shows that the low-exposure group saw a greater increase in women's turnout and, therefore, the gap between high-exposure and low-exposure groups closed. Together with the narratives above, this suggests that the initial impact of radio exposure had a spillover effect through inter-district competitions. Albeit not being an ideal situation to causally estimate the long-run impact, this provides insights into how social changes can diffuse across space. As Figure I.8 shows, the gender gap in turnout closed in the 1960's and since then, men's and women's turnouts have co-moved.

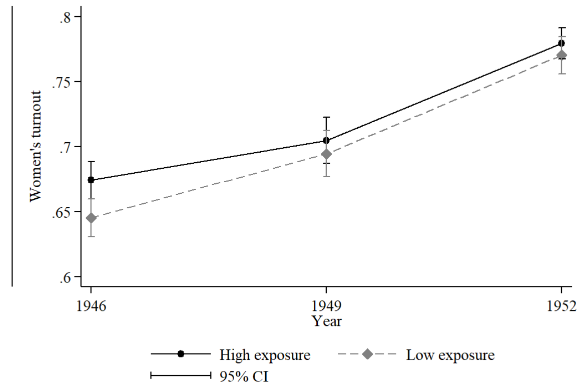


Figure I.7: The average women's turnout in the 1946, 1949 and 1950 elections by the degree of radio exposure. The radio exposure is measured by the 1946 radio subscription rate. Districts with above-the-median radio exposure are categorized as a high-exposure group, and vice versa. The vertical lines show confidence intervals. The 1947 election is not shown because the gender breakdown of district-level turnout is not available.

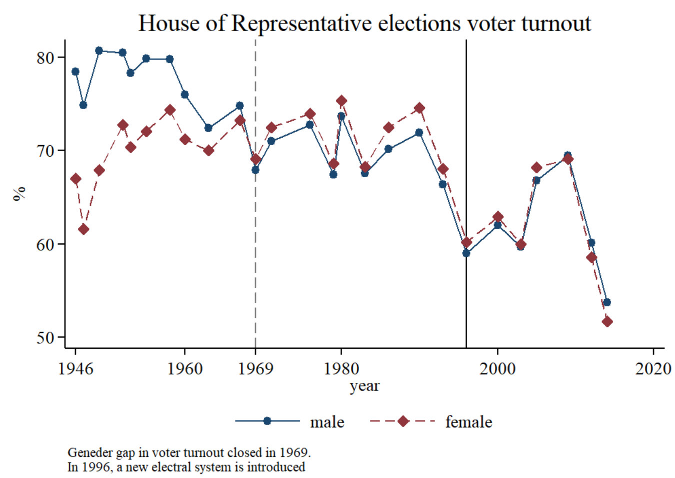
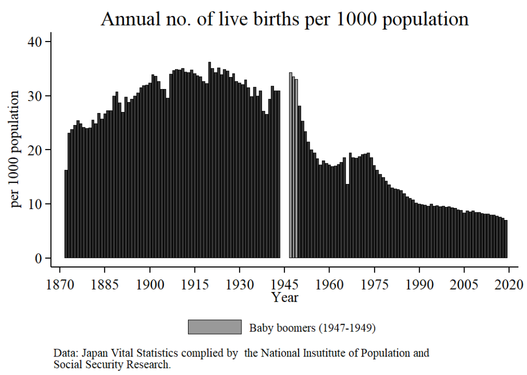
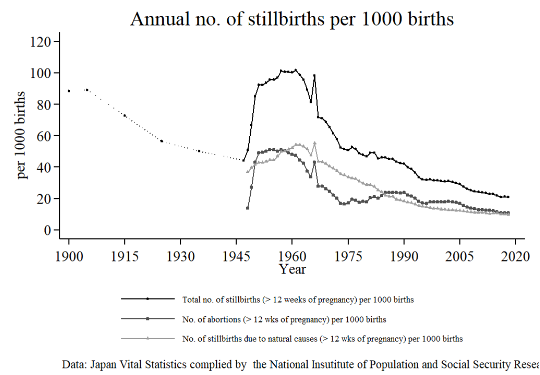


Figure I.8: House of Representatives Election Voter Turnout

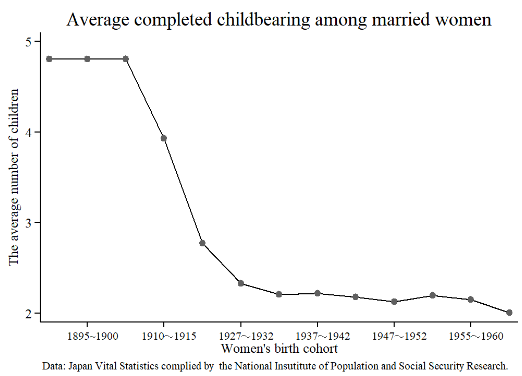
J Historical demographic trends in Japan



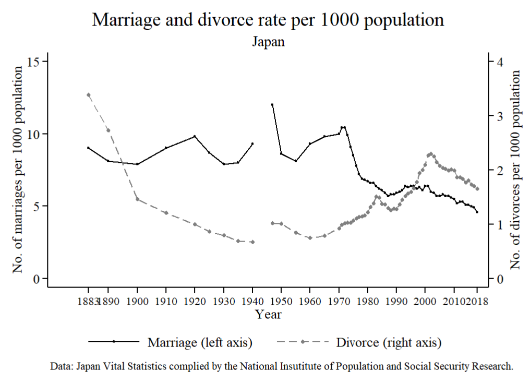
(a) No. of live births per 1000 population



(b) No. of stillbirths per 1000 births



(c) No. of live births per 1000 population



(d) No. of stillbirths per 1000 births

Figure J.9

K Birth rate by radio exposure

Table K.8

	(1) All mean/[std.dev.]	(2) High radio exposure mean/[std.dev.]	(3) Low radio exposure mean/[std.dev.]	(4) Diff. diff/(std.err.)
Crude birth rate in 1935 Mean 32.78 Std.dev. 4.21	32.780 [4.214]	32.825 [3.926]	32.762 [4.643]	-0.064 (0.41)
Crude birth rate in 1947 Mean 34.67 Std.dev. 3.15	34.674 [3.150]	34.781 [3.116]	34.700 [3.187]	-0.082 (0.30)
Crude birth rate in 1950 Mean 27.95 Std.dev. 4.72	27.945 [4.719]	27.417 [4.771]	28.374 [4.882]	0.957** (0.46)
Observations	663	221	221	442

Note: The crude birth rate is defined as the annual number of live births per 1,000 population. I residualize the 1946 radio subscription rate by regressing it on the distance to the transmitter and transmitter fixed effects. Then I define the *low-exposure* group as the bottom one third of the residual distribution, and *high-exposure* as the top one third of the residual distribution.

L The heterogeneous effect of greater exposure to women's radio on the birth rate based on the male to female ratio

Table L.9: The heterogeneous impact of greater exposure to women's radio on the crude birth rate based on male-to-female ratio

	Outcome: No. of births per 1000 in 1950	
	(1) Births per 1000 population 1950	(2) Births per 1000 population 1950
Radio subscription in std.dev. unit	-2.732***	-2.785***
	(0.664)	(0.678)
Male to female ratio (above median) × Radio subscription (std.dev.)		-0.0733
		(0.161)
R^2	0.702	0.698
Control variables	X	X
Observations	663	663

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The male to female ratio is defined as the number of men per a woman. The smaller male to female ratio means that men are more scarce. Data on the male to female ratio are drawn from Table 2, 3 and 5 of the 1950 Census. All regressions include the common set of control variables: distance decile bins, transmitter fixed effect, prefecture fixed effect, industrial composition, the number of households, the number of households per square km, city indicator, and bombing indicator.

Similar to Section 5.1, I explore the possibility of heterogeneous fertility impact based on the male to female ratio. As I discuss in Section 5.1, variation in the male-to-female ratio in the aftermath of WWII is as-good-as-random, and provides the opportunity to test the heterogeneous effect of radio exposure. I run the following regression:

$$\text{No. of births per } 1000_{j,1946} = \beta_0 + \beta_1 \text{radio exposure}_{j,1946} + \beta_2 \text{radio exposure}_{j,1946} \times \mathcal{I}(\mathcal{X}_j \geq med(\mathcal{X})) \\ + \beta_3 \mathcal{X}_j + \gamma x'_{j,1946} + u_{j,1946} \tag{4}$$

where $\mathcal{X}_j$ is no. of men per women.

Column 2 of Table L.9 shows the result from the regression of equation (4). Unlike the case of electoral turnout, there is no significant difference in the radio impact in areas with high and low male-to-female ratios.

M The heterogeneous effect based on women's education

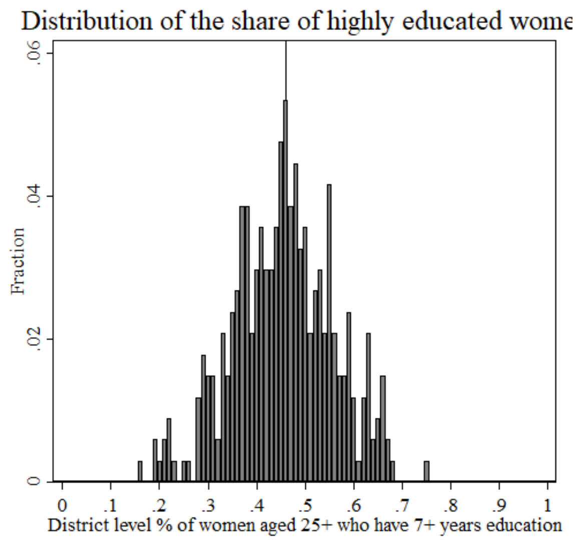


Figure M.10: Distribution of the share of highly educated women. A unit of observation is a district. The share is computed by dividing the number of women aged 25+ with 7+ years of schooling by the total number of women aged 25+. The vertical line indicates the median, which is 0.46. Data are drawn from the 1950 Census.

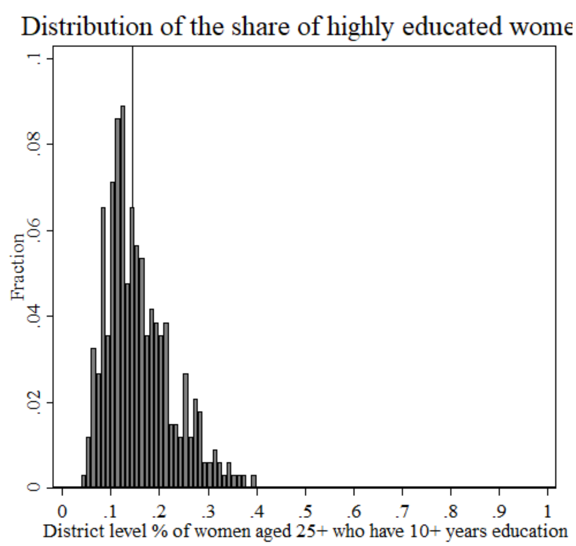


Figure M.11: Distribution of the share of highly educated women. A unit of observation is a district. The share is computed by dividing the number of women aged 25+ with 10+ years of schooling by the total number of women aged 25+. The vertical line indicates the median, which is 0.14. Data are drawn from the 1950 Census.

Table M.10: The heterogeneous impact of greater exposure to women's radio on turnout based on the share of highly-educated women

	Outcome: Women's turn out in 1946		
	(1) Women's turnout Mean 0.66 Std.dev. 0.08	(2) Women's turnout Mean 0.66 Std.dev. 0.08	(3) Women's turnout Mean 0.66 Std.dev. 0.08
Radio subscription in std.dev. unit	0.0238**	0.0262**	0.0239**
	(0.0110)	(0.0107)	(0.0110)
Share women w/ 7+ years education (above median) $\times$ Radio subscription (std.dev.)		-0.00378	
		(0.00398)	
Share women w/ 10+ years education (above median) $\times$ Radio subscription (std.dev.)			0.00100
			(0.00412)
R^2	0.756	0.769	0.768
Control variables	X	X	X
Observations	356	337	337

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the two stage least square estimates of the effect of radio exposure on women's turnout in the 1946 general election. Both Columns 1 and 2 include the common set of control variables: distance decile bins, transmitter fixed effect, prefecture fixed effect, industrial composition, the number of households, the number of households per square km, city indicator, and bombing indicator. Column 2 additionally includes the interaction between radio exposure and the indicator variable that takes 1 when the share of women aged 25 or above with higher education is above the median, which is 0.46. Higher education is defined as 7 or more years of education. Data are drawn from the 1950 Census. Furthermore, Column 3 uses an alternative definition of higher education: 10 or more years of schooling. The median percentage is 0.14. All regressions include the common set of control variables: distance decile bins, transmitter fixed effect, prefecture fixed effect, industrial composition, the number of households, the number of households per square km, city indicator, and bombing indicator.

Table M.11: The heterogeneous impact of greater exposure to women's radio on birth rate based on the share of highly-educated women

	Outcome: No. of births per 1000 in 1950		
	(1) Births per 1000 population 1950	(2) Births per 1000 population 1950	(3) Births per 1000 population 1950
Radio subscription in std.dev. unit	-2.732***	-2.580***	-2.587***
	(0.664)	(0.634)	(0.654)
Share women w/ 7+ years education (above median) × Radio subscription (std.dev.)		-0.398*	
		(0.212)	
Share women w/ 10+ years education (above median) × Radio subscription (std.dev.)			-0.346*
			(0.201)
R^2	0.702	0.695	0.699
Control variables	X	X	X
Observations	663	663	663

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the two stage least square estimates of the effect of radio exposure on women's turnout in the 1946 general election. Both Columns 1 and 2 include the common set of control variables: distance decile bins, transmitter fixed effect, prefecture fixed effect, industrial composition, the number of households, the number of households per square km, city indicator, and bombing indicator. Column 2 additionally includes the interaction between radio exposure and the indicator variable that takes 1 when the share of women aged 25 or above with higher education is above the median, which is 0.46. Higher education is defined as 7 or more years of education. Data are drawn from the 1950 Census. Furthermore, Column 3 uses an alternative definition of higher education: 10 or more years of schooling. The median percentage is 0.14. All regressions include the common set of control variables: distance decile bins, transmitter fixed effect, prefecture fixed effect, industrial composition, the number of households, the number of households per square km, city indicator, and bombing indicator.

N The long-run effect of radio exposure on births

This section examines the long-run impact of radio exposure on fertility and sees whether the fertility impact was a temporary shift or permanent reduction. I draw the annual birth rate, defined as the number of live births per 1,000 population, from prefecture yearbooks between 1949 and 1960 in five prefectures (Iwate, Chiba, Mie, Nara, and Tokushima). These are the only five prefectures that annually provide the birth rate to the best of my knowledge. I digitize these prefecture yearbooks and spatially merge them across years using municipality boundaries.[49]

I modify the regression model (3) on page 28 as follows

$$
\begin{aligned}
\text{Birth rate}_{j,t} =& \beta_0 + \beta_{1t}\text{radio exposure}_{j,1946} + \iota_t + \gamma_1\text{Birth rate}_{j,1935} + \gamma_2\text{Male-to-female ratio}_{j,1950} \\
&+ f(\text{distance to a nearby transmitter}_{j,1946}) + \nu_{\text{transmitter(j)}} + \Sigma_k \kappa_{t,k}\text{industries}_{jk,1950} \\
&+ \pi_{h1}\text{N of HH}_j + \pi_{h2}\frac{\text{N of HH}_j}{\text{SqKM}_j} + \delta_{\text{prefecture(j)}} + I_{j=\text{city}} + \psi_{\text{bombed(j)}} + u_{j,t}
\end{aligned} \tag{5}
$$

where the birth rate is the number of live births per 1,000 population in year t. I allow the impact of radio exposure (β_{1t}) to vary across time. I add two sets of control variables to the main model (3). First, year fixed effect ι_t takes into account the nationwide trend in fertility rate. Second, I allow coefficients on the industrial composition ($\text{industries}_{jk,1950}$ is the labor share in industry k in district j in 1950) to vary across time to capture industry-specific time trends. Industry-specific time trends accommodate the fact that postwar birth control first

[49] When analyzing the long-term effect on birth rates, I use a municipality as a unit of observation instead of using a district, which is a collection of municipalities. I do so to deal with major municipality mergers and consolidations, which make it difficult to maintain the same district boundaries over the period of my study. In Jaoan, the number of municipalities significantly declined from 9,868 (in October 1953) to 3,975 (in September 1956) due to municipality mergers and consolidations (http://www.soumu.go.jp/gapei/gapei2.html). Therefore, I apply municipality boundaries in 1960 to data in 1935 as well as in years between 1949 and 1960, and merge all of them to create a municipality-level panel dataset. This procedure requires me excluding municipalities that were split although such cases are very rare.

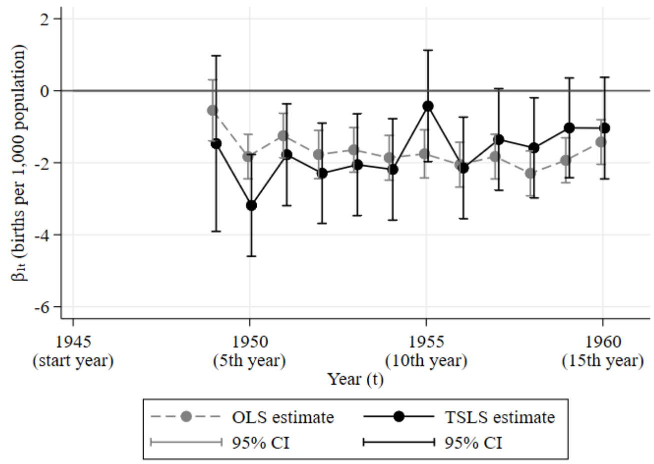


Figure N.12: The impact of radio exposure on the annual birth rate. Gray circles show the OLS coefficients for the crude birth rate in equation 5. The crude birth rate is defined as the annual number of marriages per 1,000 population. A vertical bar around each circle shows the 95 percent confidence interval. Similarly, black diamonds show the TSLS coefficients with confidence intervals.

emerged among wives of coal miners and factory workers (Tama 2006, Ogino 2008, Takagi 2012. Okubo (2011) reviews Ogino (2008) in English.). Other control variables remain the same as the main model (3).

Figure N.12 plots the TSLS coefficients ($\hat{\beta}_{1t}$) for the birth rate. I find negative impacts up until the 9th year (1954) from the onset of the women's radio programs, after which the impact starts to fade over time. In other words, in areas in which women are more exposed to women's radio programs, their fertility declines by around 1.88 per 1,000 on average. Note that changes are not driven by changes in marital behavior. Putting the result into context, the time period that I study saw a substantial decline in birth rate as Figure J.9a shows. The back-of-the-envelope calculation shows that the radio intervention contributes of 4.6 per 1,000 population out of an overall decline of 13.5 per 1,000 from prewar to 1960.[50] Since I find no reversal in the fertility impact, the radio exposure is likely

[50]I draw data from the National Institute of Population and Social Security Research. The prewar average birth rate is 30.8 per 1,000 population annually, which is the average between 1932 and 1937 (plus and minus two years of the base year 1935).

to have caused a permanent fertility decline but not a temporary delay. This is consistent with the fact that the complete fertility rate per woman in postwar Japan declined (Figure J.9c).

Despite differences in the sample coverage and a unit of observation, the results above are statistically similar to the results presented in Table 9 on page 54. On the one hand, the effect on the 1950 birth rate is -3.07 using the panel data above. On the other hand, the effect on the 1950 birth rate is -2.7 using the nation-wide, cross-section data on page 54. These estimates are not statistically indistinguishable. Such robustness provides a piece of evidence that the results presented in this section are less likely to suffer from the limited sample availability.

O Placebo test

Table O.12: The placebo effects of radio exposure

	(1) Men's turnout in 1942	(2) No. live births per 1000 population in 1935
Radio subscription in std.dev. unit	0.00355	-0.726
	(0.00576)	(0.458)
Observations	356	661
First stage F-stat		56.48
Distance control	decile bins	decile bins
Transmitter FE	X	X
N.of HH, HH density	X	X
WWII heavy damage	X	X
Prefecture FE	X	X
City indicator	X	X
Industrial composition	X	X
Male to female ratio	X	X
R-squared	1.00	0.83

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: X indicates that the regression controls for the respective variable. *Source*: Japan Vital Statistics reported by place of residence in 1935 ("*Shi cho son betsu jinko dotai tokei showa ju nen*") and the 21st House of Representatives election results. Since women did not have the right to vote in the pre occupation period, I use men's turnout as a proxy.

This section examines the placebo effect of radio exposure on electoral turnout and the number of birth per 1000 population in the pre-occupation period. In the absence of women's radio programs, no effects should be expected on those outcomes.

Table O.12 shows results from the regressions of equation (1). Column 1 reports the placebo effect on men's turnout in 1942, which I use to proxy the prewar political participation. I find no significant placebo effect. Column 2 reports the placebo effect on the number of live births per 1000 population in 1935. No placebo effect is found, either. The results provide a piece of evidence that the postwar radio effect is not spurious.