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Engines of Empowerment: Cattle Tending, the Milking Machine, and Women in Politics*

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Abstract

We provide new evidence on how a gender-biased, labor-saving technology—the milking machine—advanced one important dimension of gender equality: women's political representation. Our focus is mid-20th-century Finland, where mechanized milking reduced the time burden of a task traditionally performed by women and facilitated modernization of rural parts of the country. Using historical data, we estimate panel and instrumental-variable models that exploit temporal variation in the spread of milking machines and geographic variation in pre-determined comparative advantage in cattle farming. We find that municipalities with greater adoption of milking machines experienced significantly larger increases in the share of local council seats held by women between 1930 and 1972. These effects operated through time savings for women on dairy farms and rural economic development, against a backdrop of rising female off-farm employment, which together likely helped ease key constraints to women's political representation.

Keywords: agriculture, gender, political representation, technological change, women in politics

JEL: D72, J16, N54, P13, P16, Q16

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1 Introduction

During the twentieth century, women entered the public sphere like never before. Their growing role in the economy was the most significant transformation in labor markets during this period (Goldin 2006). Technological innovations played a key part in this: time-saving household innovations such as washing machines and electrification reduced domestic burdens and enabled greater female labor force participation (Greenwood et al. 2005; Dinkelman 2011; Ngai and Petrongolo 2017).

The century also saw a major expansion of women's political rights, including the right to vote and run for office. Just as their entry into the labor force transformed economies, women's entry into politics transformed democracies by altering who holds power and how it is exercised (Lott and Kenny 1999; Miller 2008; Wängnerud 2009; Moehling and Thomasson 2020). However, the factors underlying the historical rise in women's political representation are not well established. We address this gap by examining whether labor-saving technologies can expand women's access to elected office.

Few settings are as well-suited to investigate this issue as 20th-century rural Finland. Although women's share among local councilors was stagnant below 10% up until the 1950s, it doubled by the 1970s, setting the stage for continued growth toward nearly 40% by the 2000s. At the same time, rural municipalities underwent rapid agricultural modernization. One innovation in particular reshaped the daily lives of women on dairy farms: the milking machine. We ask whether the spread of this canonical case of a gender-biased, labor-saving technology—also considered to be a key contributor to structural transformation (Ager et al. 2026)—mattered for women's representation in politics.

Before the mechanization of milking started in the 1950s, hand-milking was a gendered task performed predominantly by women in Finland and many other parts of the world (Myrdal 2008; Morell 2009; Kaarlenkaski 2018). This changed with the introduction of the milking machine, as men gradually took over the milking duties. In Norway, Ager et al. (2026) show that this prompted young women to migrate to urban areas, followed by increases in educational attainment and earnings. We are instead interested in the community-level effects that the new technology had on the remaining women's political power.[1] We document that municipalities that had a greater degree of milking machine adoption also witnessed larger increases in political representation of women.

Estimating the causal effect of milking machine adoption on female representation is

[1] Unlike the younger cohorts who were displaced by the milking machine and may have been more likely to migrate to cities for education or work opportunities (Ager et al. 2026), the remaining women were likely older, married, and more embedded in family farms and local community networks (see also Myrskylä 1978).

an elusive quest. For example, a correlation between female representation and milking machine adoption could simply reflect reverse causality: local female leaders could bolster the adoption of the technology that liberates milkmaids and farmers' wives and daughters from the time-consuming task. We thus employ an instrumental variable approach coupled with municipality-level panel data on historical election results and agriculture, among other information. Our main instrumental variable strategy follows Ager et al. (2026). It exploits two sources of variation: (i) geographic variation in historical (pre-mechanization) prevalence of cattle farming stemming from a comparative advantage in animal husbandry versus crop cultivation across municipalities, and (ii) time variation coming from increased availability of milking machines over time.

Our main estimate suggests that the addition of one milking machine per 1,000 residents raised the share of council seats held by women by around 0.12 percentage points—a magnitude implying that roughly one new female councilor emerged for every 40 machines introduced per 1,000 residents. The finding that milking machine adoption had a positive effect on female representation is robust to various alternative specifications and estimation samples, and to an alternative IV approach that additionally exploits cross-sectional variation in the economic rationale for milking machine adoption. We also argue and show that our findings are not driven by other concurrent shocks such as population and economic shocks in the aftermath of World War II or electrification.

We further document that the gains in female representation were concentrated among the bourgeois parties. We find no evidence, however, that bourgeois women benefited from the new technology at the expense of socialist women. In other words, the technology expanded the overall pool of female politicians rather than merely redistributing women's seats across party lines.

From a theoretical perspective, our main finding is not trivial. If the milking machine displaced young women from agricultural labor and encouraged migration to urban areas—as Ager et al. (2026) document in Norway—we might instead expect a smaller pool of potential rural female candidates and even decreases in female representation.[2] Yet our evidence points in the opposite direction. We argue that this is because the milking machine relaxed fundamental constraints on women's political representation.

Our central mechanism is a supply-side one. By automating the most labor-intensive task on dairy farms—a task traditionally performed by women—the milking machine freed time for civic and political engagement among rural women whose schedules had previously been bound by daily milking. Using newly digitized candidate-list data from the Agrarian

[2] There is also evidence that exit can foster voice: Karadja and Prawitz (2019) show that emigration from Sweden to the U.S. increased the power of workers who stayed behind.

League (later the Center Party), the largest bourgeois party in rural Finland, for three elections in 1956, 1960, and 1972, we show that mechanization specifically increased the share of farmers' wives among the candidates without comparable effects on the broader female candidate share. The concentration of the effect in precisely the subgroup whose time was freed is suggestive of a time gains channel.

These dynamics unfolded alongside broader rural economic transformation. In addition to reducing women's on-farm work, mechanization contributed to farm consolidation and raised local fiscal capacity. This happened in the context of structural change in post-war rural Finland, with women expanding their participation in wage and service-sector employment. We view these patterns as enabling, rather than primary, mechanisms that likely complemented the time-savings channel by raising women's public visibility and integration into civic networks (Matland 1998; Iversen and Rosenbluth 2008, 2010). Consistent with this, we find suggestive evidence of a higher density of women's associations in municipalities with greater milking machine adoption.

The transfer of milking duties from women to men also blurred gendered work boundaries in dairy households (Rasila 2004; Morell 2009; Kaarlenkaski 2018), in line with Boserup's insight that agricultural technologies shape gender roles by determining who performs which tasks in production (Boserup 1970; Alesina et al. 2013). While we cannot directly measure norm change, the milking machine may have also prompted broader reconsideration of women's place in public life.

Our paper engages with three literatures. First, it speaks to research on women's political empowerment (see Wängnerud 2009 and Hessami and da Fonseca 2020). Women have long been underrepresented in elected office around the world. Much of the economics literature on this topic has focused on formal interventions, such as gender quotas, and the consequences of female representation (e.g., Chattopadhyay and Duflo 2004; Beaman et al. 2009; Besley et al. 2017; Bagues and Campa 2021; Bhalotra et al. 2023; Lee and Zanella 2024), while political scientists have emphasized the role of party gate-keeping, electoral systems, and voter biases (Krook 2010; Lawless and Fox 2010). However, the forces that historically drove increases in female representation remain largely uncharted. In particular, little is known about whether technological change can shift gendered patterns of political representation.

Second, we contribute to the literature on the gendered effects of technological change (Black and Spitz-Oener 2010; Cortés et al. 2024). In Norway, Ager et al. (2026) show that the milking machine displaced young women from dairy farming, producing a gendered shift from farm to non-farm work. A distinctive feature of the milking machine was that it transferred the core milking task from women to men, so that when structural change created new off-farm prospects, women were better positioned to take them up.[3] We add to this literature by showing that the same innovation also expanded the political opportunities of women in farming communities.

We highlight two mechanisms through which this gender-biased, labor-saving technology affected women's political representation. The first is the easing of time constraints, long recognized as a central barrier to women's political participation (Schlozman et al. 1994). This further links our study to evidence that domestic technologies have enabled women to engage in market work by reducing their time burdens at home (Greenwood et al. 2005; Dinkelman 2011; Ngai and Petrongolo 2017). The second is the reallocation from unpaid farm labor to off-farm employment, which may expand women's opportunities and incentives for civic engagement (Iversen and Rosenbluth 2008, 2010; Kjelsrud and Kotsadam 2023).[4]

Third, we identify a specific pathway through which economic development can change the balance of political power. Classical modernization theories, going back to Lipset (1959) and others, argue that technological progress can empower marginalized groups and bring about political change (see also Dasgupta 2018 and Inglehart and Norris 2003). However, causal evidence on these hypotheses remains scarce. We demonstrate that political inclusion can emerge not only from enfranchisement or mobilization, but also from economic changes that alter who has the opportunity to enter public life. In this sense, our findings speak to empirical and theoretical work on how development can expand women's rights and political agency (Duflo 2012; Doepke et al. 2012).

More broadly, our results highlight that technological change is not only an economic phenomenon but also a political one. In many cases, it has exacerbated labor market inequality (Autor et al. 1998; Acemoglu and Restrepo 2022; Moll et al. 2022) and fueled political conflict (Caprettini and Voth 2020; Molinder et al. 2021). By contrast, in our historical setting, mechanization reduced gender inequality in political representation. The milking machine thus illustrates how the distributive consequences of technological shocks can extend to the political arena, sometimes broadening inclusion rather than narrowing it.

[3] In many contexts, new economic opportunities are more likely to be captured by men (Bandiera et al. 2022), or agricultural mechanization shifts women into home production instead (Afridi et al. 2022). Moorthy (2024) similarly finds that the adoption of genetically engineered soy in Brazil reduced female agricultural earnings and employment without inducing female sectoral reallocation.

[4] At the same time, experimental evidence from Ethiopia shows no immediate effect of factory job offers on women's political participation, suggesting that impacts may depend on working conditions or emerge only in the longer run (Aalen et al. 2024).

2 Background

This section provides the historical and institutional context for our analysis. We first describe the development of cattle farming in Finland and the introduction of milking machines and then outline the evolution of women's political representation in Finnish local governments during the period of interest.

2.1 A Brief History of Cattle Farming in Finland

Finland was an exceptionally agrarian society until the 1950s compared to other Western European countries. Importantly for this paper, practicing cattle farming was not common in all regions of Finland. The eastern parts of the country typically concentrated on cultivation. This is often attributed to the suitability of these areas to so-called slash-and-burn or burn-beating (Soininen 1974)—a practice Boserup (1970) associates with greater presence of women in agriculture. This meant that farmers burned forests to make the soil richer and more fruitful for agricultural purposes. In contrast, other parts of the country relied heavily on the manure that cows produced. More advanced and productive techniques replaced burn-beating in eastern Finland in the twentieth century, but the region still focused on cultivation. The western and southern parts of the country have had better pastures than the eastern parts. Therefore, these areas have been particularly suitable for cattle tending.

The period 1950–1970 marked a profound transformation of the dairy sector, characterized by rapid adoption of milking machines (Kaarlenkaski 2018, p. 83). Agricultural censuses from 1930–1969 paint a clear picture of this change. There were virtually no milking machines before the 1940s, and in 1941, there were just slightly more than 300 milking machines in the whole country. By 1950, the number increased to 4,100. In 1959, there were already almost 28,500 milking machines and, by 1969, the number had grown to more than 80,000. In 1950, approximately 1% of all Finnish farms and 3% of farms that sent milk to dairies owned a milking machine, and by 1960 this number had risen to 9%. In 1980, the corresponding number was 80% (Kaarlenkaski 2018). The 1969 Agricultural Census shows that during the same time period, the quantity of milk sold to dairies almost doubled from around 1,570 million liters to about 2,950 million liters, even though there was no major change in the number of cows. Despite this, according to the 1975 Statistical Yearbook of Finland, milk prices did not fall during our study period but instead followed the same trend as other food products.

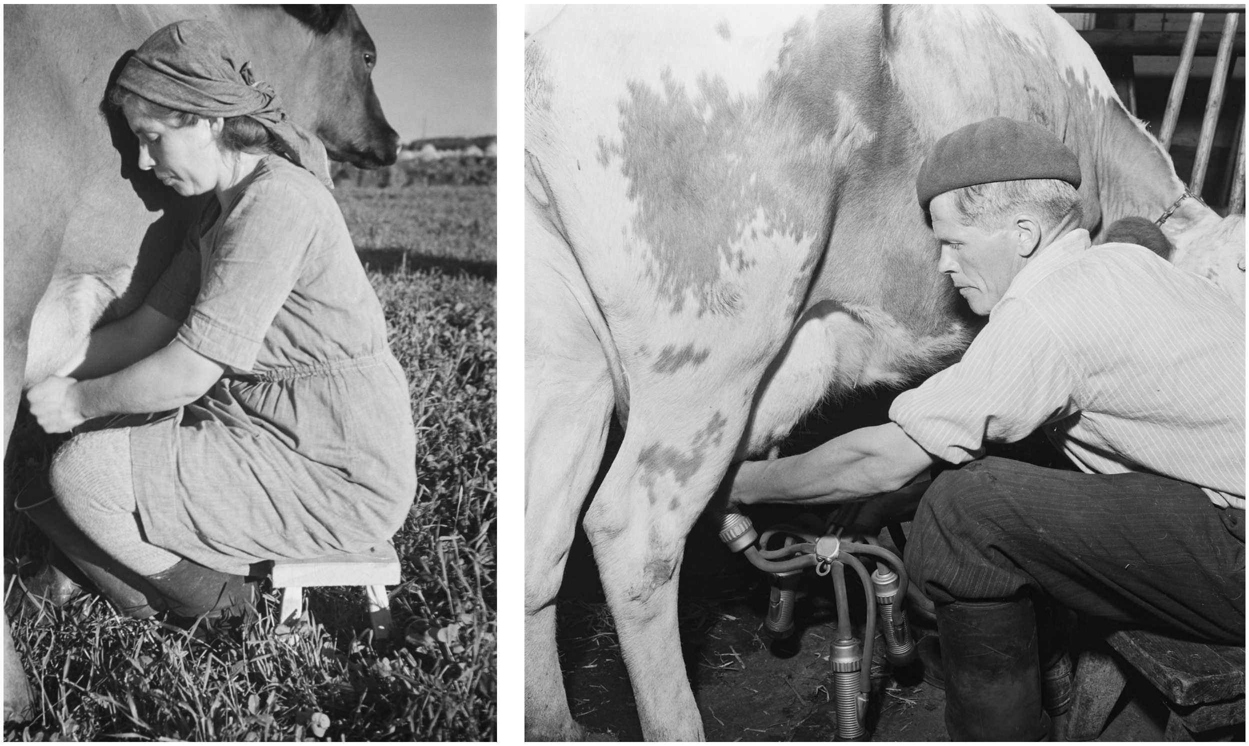
The introduction of milking machines changed the dairy production process. This is in part evident from the change in the number of workers in the agricultural sector: the percentage of people employed in agriculture decreased from 32% in 1960 to 9% twenty years later (Rasila 2004, p. 504-506). That said, we grant that the exodus of especially young women from rural municipalities had started already earlier. After World War II, there was a shortage of industrial labor, and industrial work offered better salaries than farm work. Kaarlenkaski (2018) analyzes qualitative interviews from 1969 and finds that a common reason for acquiring a milking machine was, in fact, the difficulty of finding young women to hire as milkmaids.

The new technology was labor-saving. Up until the introduction of milking machines, the most labor-intensive task of animal husbandry was hand-milking; it took up half of the work time in cattle keeping (Rasila 2004). Unlike many other tasks in agriculture, milking is done throughout the year. Sipilä (1949b) approximates that around the 1950s, producing one hundred kilograms of milk by manual milking took around 270 hours while producing the same quantity with a milking machine took around 120 hours. Given the expected production gains from the milking machine, Sipilä (1949a) estimates that acquiring a milking machine was beneficial for farms that had at least around ten cows. The time savings were arguably even greater with the more modern milking machines that arrived during the time period we focus on. The new technology even made it possible for one person to take care of the cattle alone (Siiskonen 1990, p. 91).

The milking machine disproportionately affected women. Milking by hand was considered a female task in many parts of the world (Forde 1963; Myrdal 2008), including Finland. Kaarlenkaski (2018) discusses the gendered attitudes towards hand milking and milking machines in Finland in the 1960s. She notes that cattle tending and milking by hand in particular were historically seen as women's work. "According to a common view, it was the introduction of milking machines that led men to start working in the cowshed," she writes (p. 77), and quotes one survey respondent saying that "'manly honor' was at stake if men touched the 'tits' of the cow" (p. 84). Figure 1 showcases these stereotypes in old photographs: Panel A shows a woman milking a cow by hand, whereas in Panel B, machine-milking is done by a man.[5]

In sum, the time-saving aspect meant that even if women continued to work with cattle,

[5]In 2004, the Finnish Literature Society organized a cow-themed writing competition called "Ei auta, sano nauta!" (literally, "No use, said the cow!"—a rhyming Finnish saying roughly equivalent to 'nothing to be done'). Contestant *Hilu* wrote in their essay: "In my childhood, men didn't go to the cowshed. Mother was the one who took care of and milked our cows. If she needed help, like in calving, it was one of us children who went to help her, not our father." The writing by *Karjahullu* illustrates that the attitudes towards taking care of cows were not quite positive: "[...] it was said that cattle tending was the shitwork that women do." Another quote from an essay by *Kyllikki* encapsulates the change that came with the milking machine: "When we bought a milking machine, my brother came to the cowshed as if attracted by a magnet and started to take care of milking work." The quotes are taken from Kaarlenkaski (2014).



(a) A woman milking a cow by hand.   **(b)** A man milking a cow with a machine.

Figure 1. Depictions of hand and machine milking.

Source: Museovirasto, photos taken by Matti Poutvaara (Panel A) and Pekka Kyytinen (Panel B).

they had more time, since their labor was substituted by the machine and men took over the milking activities. By changing the perception of who was suitable for the milking task, the introduction of the milking machine effectively blurred the definition of gender roles within dairy-farming households. Kaarlenkaski (2018) also notes that with the new technology, the status of milking was elevated: it was no longer seen as merely household work but recognized as productive farm work.

2.2 Female Representation in Finnish Local Governments

Finland is generally considered one of the pioneers of gender equality in politics. Women's presence in political life started in 1906 when all women and men were granted universal suffrage and the right to become electoral candidates in the national elections. Similar rights were extended to local elections slightly later, in 1918 and 1919, following the introduction of democratic local elections after the Finnish Civil War (Meriläinen et al. 2023).

Nonetheless, women's political representation in municipal governments was relatively low for a long time, even though they constituted roughly half of the electorate. We illustrate the development of women's participation in local politics in Figure 2, which shows the share of female candidates and elected representatives, and women's vote share in the entire country.[6]

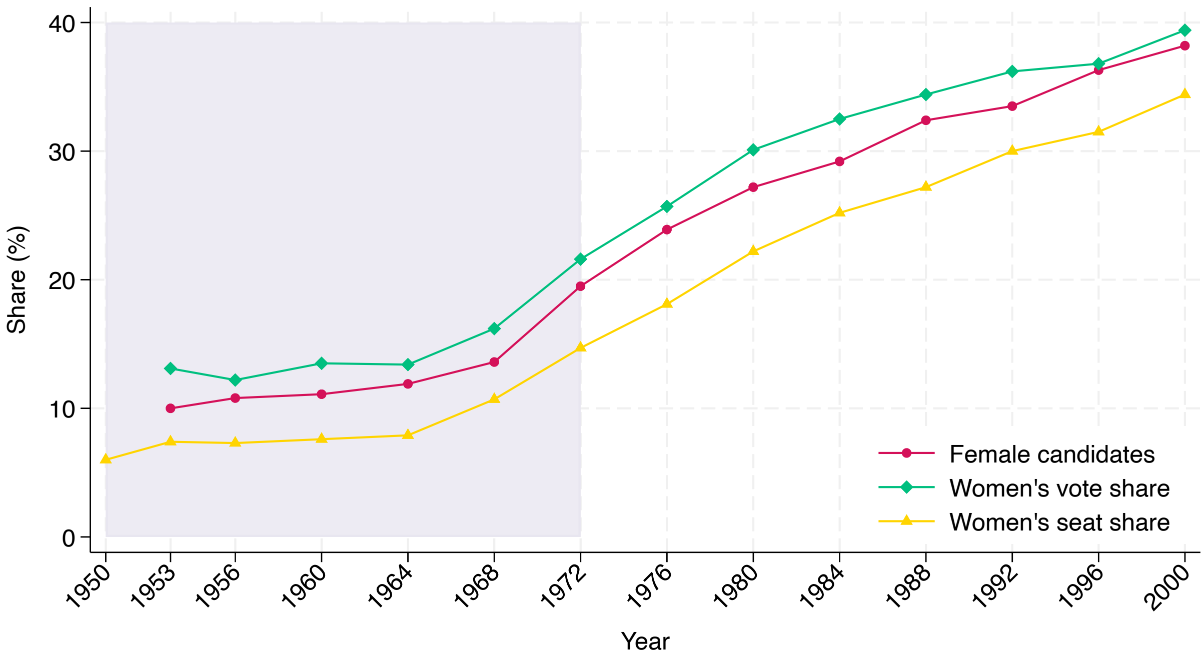


Figure 2. Evolution of female representation nationwide, 1950–2000

Our main focus is on the change between 1950 and 1972. The latter half of this time period marks the onset of a stable growth period in female representation. The supply of female candidates, as well as women's vote and seat shares, remained relatively low and stable throughout most of the time period, up until 1964. By the 1972 elections, the end of the time frame we study, the supply of female candidates and the seat share obtained by women had roughly doubled from what it was in 1950. This happened without formal gender quotas.

During the postwar period, municipalities played a central role in the Finnish welfare state and the provision of public services. Municipal governments were responsible for schools, health care, child care, social assistance, and much of infrastructure development. In rural

[6]Note that there are no systematically collected data on women in local politics available before the 1950s.

areas, municipalities were often the most important political arena, and membership in municipal councils offered one of the most accessible and visible forms of political leadership.

In Finland, elected local councilors are and have historically been "leisure politicians" who maintain their everyday job and take care of council work in their free time. They are elected using a proportional representation system. Before 1955, Finland employed a semi-open list system, in which voters primarily voted for pre-ordered lists of candidates nominated by political parties. Within their chosen list, they could also cast a preferential vote for a candidate. The open-list system, which remains in use today, was adopted in 1955 (Ylisalo et al. 2012). Since then, voters have been required to cast their votes directly for individual candidates affiliated with a party.

Countries with proportional representation systems, such as the one in Finland, tend to have more women in elected office (Wängnerud 2009; Gulzar 2021). Political scientists have argued that economic development and greater female labor force participation are more likely to translate into more female representation in politics in such contexts (Matland 1998; Iversen and Rosenbluth 2008, 2010). Moreover, comparative politics scholars typically associate preferential voting with better electoral chances for women (see, for instance, Golder et al. 2017). Since preference votes play a larger role under an open-list system than under a semi-open list system (Meriläinen and Tukiainen 2018), it is possible that the election reform contributed to increasing women's political representation by increasing the importance of the demand side. However, because the electoral system change was a common shock affecting the entire country, it does not pose a threat to the validity of our empirical strategy.

3 Data and Empirical Approach

This section describes our main data and key variables, and the empirical strategy we use to estimate the effect of milking machine adoption on women's political representation. We begin by outlining the construction of the dataset and present descriptive patterns, before turning to our identification approach.

3.1 Data and Descriptive Statistics

Our primary analysis is based on a municipality-level data set that covers information collected from official publications by Statistics Finland. We restrict our attention to rural municipalities that held elections and did not go through complex boundary reforms during our sample period. To account for simple municipal mergers where two or more municipalities merged, we aggregate the data so that we have constant units of observation.[7] This leaves us with an unbalanced panel with 1,283 observations in our main analyses, coming from 326 individual municipalities.

Local council composition. We first use information on local council composition in 1930, 1950, 1960, and 1972. These data were composed by Statistics Finland, and they contain information on the number of elected women, local council size, and seats obtained by bourgeois, socialist, and other parties. Bourgeois refers to non-socialist parties—primarily the Agrarian League, the National Coalition Party, and the Swedish People's Party—while socialist refers mainly to the Social Democratic Party and the Finnish People's Democratic League.[8]

The main increase in both women's representation and milking machine adoption took place 1950–1972. Women's seat share grew on average by around 8 percentage points from 1950 to 1972. This translates into almost two seats in a median-sized local council with 21 representatives.

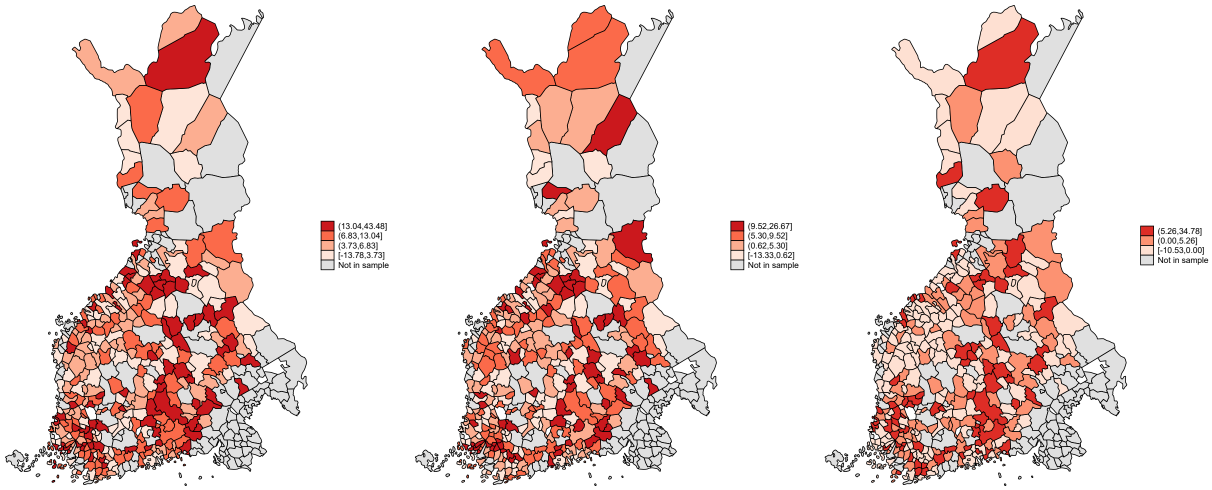
We use the municipality-level election data to map the increase in seat shares obtained by women between 1950 and 1972 in Figure 3. We show the changes separately for elected women in all parties (Panel A), bourgeois parties (Panel B), and socialist parties (Panel C). While the distribution of growth appears similar across municipalities for both socialist and non-socialist parties, the magnitude of the increase was greater in non-socialist parties. There are some municipalities where women's representation declined between 1950 and 1972, but these appear to be merely outliers in the data.

Data on female representation were not systematically reported in the official government publications before the 1950s. We thus collect reports on women elected to local councils from the newspaper *Toveritar*. In 1929, there were only 230 women serving on municipal councils in the entire country (less than 2% of all seats). Only about one in four municipal councils had at least one female member.[9]

[7]Elections were not held in localities where the number of candidates was equal to the council size and, thus, our data do not include these municipalities. After World War II, some areas were ceded to the Soviet Union. We omit both completely and partially ceded municipalities from our analysis. There was also a large wave of municipal mergers especially after the war, and we exclude municipalities that underwent complex mergers (e.g., parts of a municipality were merged to several other municipalities). This ensures that we can construct our variables in a coherent manner over time. In additional analyses, we show robustness to including cities and market towns or partly ceded municipalities, and excluding merger municipalities for which we have resorted to aggregating the data.

[8]Both groups include also miscellaneous small parties, and there are groups that do not fall in either category.

[9]See https://digi.kansalliskirjasto.fi/aikakausi/binding/956597/articles/80463891/images/123640971?scale=1.0 (accessed June 18, 2025).



(a) Change in women's representation (1950-1972). **(b)** Change in bourgeois women's representation (1950-1972). **(c)** Change in socialist women's representation (1950-1972).

Figure 3. Evolution of female representation by municipality, 1950–1972.

Notes: The maps plot the geographic distribution of the change in women's seat share in municipality councils between the years 1950 and 1972, following the pre-1930 municipality boundaries. We present the data for rural municipalities in our main estimation. For maps including cities, market towns, and partly ceded municipalities, see Online Appendix Figure OA2.

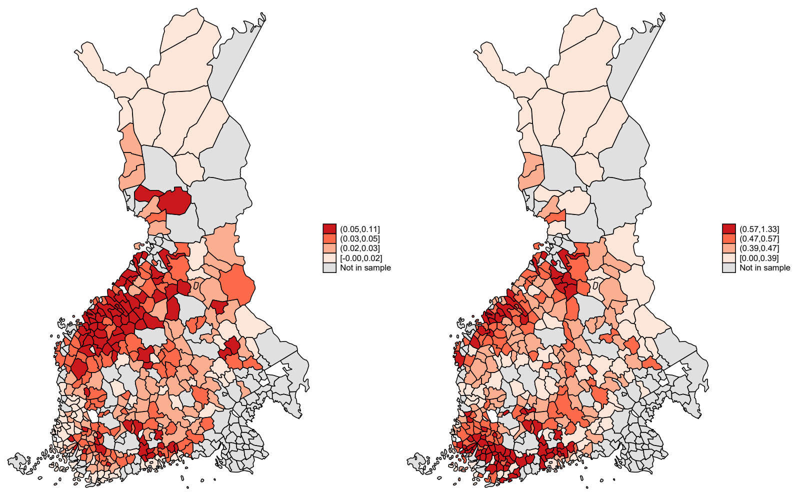
Milking machine adoption and historical cattle tending. Our treatment of interest is milking machine adoption. Using data from the 1950, 1960, and 1969 Agricultural censuses, we measure milking machine adoption as number of milking machines per 1930 capita.[10]

In our main regressions, we use a leave-one-out Bartik (1991) instrument that exploits the spatial variation in historical prevalence of cattle tending as well as the temporal variation in milking machine adoption. We measure historical prevalence of cattle tending as cows per capita in 1930, using the 1930 Agricultural Census, and milking machine adoption as the nation-wide number of milking machine per capita using Agricultural and Population censuses for 1950, 1960, and 1969.

Since milking machines were virtually nonexistent in and before the 1950s and widespread by the 1970s, the relevant variation occurs in that interval. We thus illustrate the geograph-

[10]We scale by the 1930 population to avoid endogenous scaling of the treatment, as technological change could also have sparked changes in, e.g., migration patterns between municipalities and, thus, population.

ical variation in milking machine adoption 1950–1969 as well as cows per capita in Figure 4.



(a) Milking machine adoption. **(b)** Cows per capita.

Figure 4. Milking machine adoption and historical cattle tending.

Notes: Panels A and B show the milking machine adoption in 1950–1969 (per 1930 capita) and the distribution of cows per capita, respectively. The data come from the agricultural censuses of 1930, 1950, and 1969. The maps follow the pre-1930 municipality boundaries. For maps including cities, market towns, and partly ceded municipalities, see Online Appendix Figure OA2.

Municipalities that saw the largest increases in milking machines during the years we investigate also had the highest number of cows per capita in 1930. These changes are consistent with historical patterns of agricultural specialization that were largely shaped by land suitability for slash-and-burn cultivation or the availability of good pasture lands.[11] Regions where shifting cultivation was viable had historically specialized in crop farming, while areas where it was less feasible developed a comparative advantage in cattle farming. This structural legacy persisted into the mid-20th century, plausibly also influencing the adoption of mechanized milking technology (Peltonen 2004).

[11] Appendix Figure OA1, borrowed from Soininen (1974), illustrates the geographic variation in slash-and-burn cultivation in the 1830s.

Candidate lists. We use newly digitized information on the Agrarian League (later the Center Party) candidates running in the municipal elections held in 1956, 1960, and 1972.[12] These data include candidate names and, in most (though not all) municipalities, occupations. We infer each candidate's gender from their name and use the occupation information to detect (male) farmers and farmers' wives (*emäntä*). Using these data, we then construct municipality-year measures of the total number of candidates expressed as percentages of council size, as well as share of female candidates, the share of male farmer candidates, and the share of farmers' wives among candidates, each defined relative to the total number of candidates.

Because the candidate lists stored in the archives of the Center Party do not include all municipalities in each election year, our sample is smaller in the corresponding analyses: we observe 185 municipalities in 1956, 134 in 1960, and 227 in 1972. However, all information is not systematically recorded across different municipalities, so the number of observations varies across the four different outcomes. We match the 1956 with the 1950 agricultural census data.

Covariates. In our regression analyses, we control for various background characteristics of the municipalities. First, we control for geographic characteristics by including region indicators and longitude and latitude coordinates of the municipality. Second, we use data on population size, share living in rural areas, and population employed in agriculture in the year 1920, reported in Statistics Finland's publication *Population by Industry and Commune, 1880-1975*. Third, we use information on the number of tractors and combine harvesters, and arable land area from the 1930 Agricultural Census. Finally, we use information on income and wealth of individuals who paid income and wealth taxes in 1931, obtained from Statistics Finland's publication *Tulo- ja omaisuusverotilastoa vuodelta 1931*. These data were collected and aggregated to the same constant units of observation that we use by Sarvimäki (2011).

3.2 Identification Strategy

FE specification. We are interested in the effect of milking machine adoption on women's representation in municipal councils. Our starting point is the following fixed-effects (FE)

[12] 1956 is the first election year for which there is a larger number of candidate lists available in the archive. Some of the candidate lists are typewritten, some handwritten. Online Appendix Figure OA3 provides one example, a clip from the 1960 local election candidate list in the municipality of Kuortane.

specification:

$$Y_{mt} = \alpha Milking\ machine\ adoption_{mt} + \lambda_m + \lambda_t + X_m' \gamma_t + \varepsilon_{mt}. \quad (1)$$

The outcome of interest, Y_{mt}, is women's local council seat share in municipality m in $t \in \{1930, 1950, 1960, 1972\}$. *Milking machine adoption*$_{mt}$ is milking machine per 1930 capita. α captures the relationship between milking machine adoption and share of women in local councils. λ_m and λ_t are municipality and year fixed effects, respectively. The municipality fixed effects net out all time-invariant, municipality-specific factors that may correlate with the outcome and the degree of milking machine adoption and the year fixed effects control for all country-wide shocks that affect all municipalities uniformly. X_m is a vector of control variables measured at the baseline and interacted with the year indicators, and ε_{mt} is the error term. We estimate equation (1) using OLS.

To account for potential heterogeneous trends correlated with both milking machine adoption and changes in women's representation, we include a vector of covariates to control for geography (region indicators, and longitude and latitude), population characteristics (the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920), agricultural factors (the number of tractors and combine harvesters per capita and arable land area in 1930), and measures of economic circumstances (taxed income and taxed wealth per taxpayer in 1931). Since these are time-invariant controls, we interact them with year fixed effects.

Despite the extensive set of covariates that aim to minimize the possibility of omitted variable bias, equation (1) may still yield biased estimates of α. The direction of the potential bias is ambiguous. It is not entirely clear whether the milking machine gave women a window of opportunity, or if increasing the presence of women in different spheres of society helped create demand for the technology. Such reverse causality might imply that municipalities with high rates of milking machine adoption were already on a different trajectory than those with low adoption.

Moreover, milking machine adoption is measured with error. The 1950 Agricultural Census covered all farms with at least two hectares of land, and information for smaller farms was collected separately during the 1950 Population Census. In 1969, however, the Agricultural Census focused on farms with at least one hectare of land, and so we lack data from smaller farms. While the choice not to collect data on smaller farms was driven by the fact that there were not many of those in 1969, we speculate that our measure understates the true adoption. This likely results in downward bias in our OLS estimates.

FE-IV approach. To mitigate these concerns, we employ an instrumental variable (IV) approach following Ager et al. (2026). We instrument milking machine adoption with a leave-one-out shift-share instrument. We define our instrument as

$$\textit{Milking machine exposure}_{mt} = \textit{Cows per capita}_{m,1930} \times \textit{Milking machines per capita}_{-m,t}. \tag{2}$$

Here, $\textit{Cows per capita}_{m,1930}$ captures the baseline cow intensity in municipality m in 1930 while $\textit{Milking machines per capita}_{-m,t}$ measures the national adoption of milking machines per capita, excluding municipality m, in year $t \in \{1930, 1950, 1960, 1969\}$.

The idea underlying the instrument is that municipalities with higher cow intensity in 1930 were more likely to adopt milking machines when they became available, while the national adoption predicts the timing of the adoption. The share component of our instrumental variable reflects historical differences in comparative advantage in animal husbandry versus crop cultivation across municipalities. These patterns were shaped by long-standing factors such as soil type, climate, and land use traditions, rather than contemporaneous political or social factors. The leave-one-out construction of the shifts ensures that the instrument captures the influence of the national trends in milking machine adoption rather than amplifying the variation driven by local cow intensity.[13]

The first-stage regression, which captures the effect of the shift-share instrument on municipality-level milking machine adoption, takes the following form:

$$\textit{Milking machine adoption}_{mt} = \beta_{FS}\textit{Milking machine exposure}_{mt} + \lambda_m + \lambda_t + X'_m\theta_t + \eta_{mt}. \tag{3}$$

Here, β_{FS} is the effect of the instrument on the explanatory variable, milking machines per 1930 capita by municipality. $\textit{Milking machine exposure}_{mt}$ is the leave-one-out shift-share instrument described in equation (2). λ_m and λ_t are municipality and year fixed effects, respectively, and X_{mt} is a vector of municipality-level controls measured at baseline and interacted with year fixed effects. η_{mt} is the error term.

The second stage of our 2SLS estimation is then:

$$Y_{mt} = \beta_{2SLS}\textit{Milking }\widehat{\textit{machine}}\textit{ adoption}_{mt} + \lambda_m + \lambda_t + X'_m\vartheta_t + \nu_{mt}, \tag{4}$$

where $\textit{Milking }\widehat{\textit{machine}}\textit{ adoption}_{m}$ are the fitted values from the first-stage regression in

[13] This empirical approach has the same spirit as that of Nunn and Qian (2011), who study the effects of the potato on economic development by coupling information on land suitability for potato cultivation with time variation in the introduction of the potato to the Old World, following the discovery of the Americas.

equation (3). β_{2SLS} is the coefficient of interest and identifies the causal effect of milking machine adoption on female political representation if two conditions hold. We discuss these conditions next.

Relevance. The first condition is instrument relevance which is empirically testable. We report the first-stage estimates, which are strong and precise, in Panel D of Table 1. Our shift-share instrument is predictive of the explanatory variable, milking machines per 1930 capita, as well as robust to different sets of control variables. Furthermore, the F-statistic associated with the first stage exceeds the rule-of-thumb value of 10 for weak instruments. Thus, we can conclude that the relevance condition is met.

Exclusion restriction. The second identifying assumption is the exclusion restriction. In the context of our shift-share instrument, it requires that the interaction between the leave-one-out technological shift and pre-determined local exposure affects women's political representation only through its effect on milking machine adoption. In our setting, identification relies primarily on the assumption that the baseline exposure shares are plausibly exogenous, conditional on municipality and year fixed effects and the covariates (Goldsmith-Pinkham et al. 2020; Borusyak et al. 2025).[14] We control for a rich set of covariates to absorb cross-sectional differences that could otherwise make initially dairy-intensive municipalities systematically different from other municipalities in ways that also affect women's political representation over time.

While the exclusion restriction is ultimately untestable, we conduct a placebo exercise to probe the validity of this assumption. To do so, we examine the relationship between 1930 cow intensity and changes in women's seat share during the pre-mechanization period (1929–1950). The results from this test are reported in Online Appendix Table OA1. Most importantly, we find that cows per capita in 1930 does not predict changes in female representation before the mechanization of milking, and a similar conclusion applies when we instrument the change in milking machines per capita (1950–1972) with cows per capita in 1930.

We further find no effects on the change in bourgeois women's, bourgeois parties', or socialist parties' seat share. However, socialist women's seat share indicates a negative pre-trend. We thus perform robustness checks in which we control for municipality-specific time trends and, reassuringly, find that this does not alter our results.

[14] Whether the leave-one-out component of a shift-share instrument can help construct exogenous shifts remains an open question (Borusyak et al. 2025). Given that we observe plausibly exogenous shares, however, the leave-one-out construction simply serves to strengthen our identification strategy.

4 Political Consequences of the Milking Machine

This section presents our main findings. We show that the milking machine had a positive effect on women's representation. This effect is driven by bourgeois women in particular but not at the cost of socialist women. We also find suggestive evidence of a positive overall effect on bourgeois parties' seat share, and there is also some indication of a negative effect on socialist parties' representation.

4.1 Effects on Women's Representation

FE estimates. Panel A of Table 1 illustrates the relationship between milking machine adoption and women's political representation in local councils 1930–1972. We show this relationship without any covariates and with different sets of controls. All specifications suggest a positive relationship, although the magnitude is smaller when no control variables are included. However, in our view, this is not too concerning: the baseline OLS regression in column (1) is likely to suffer from omitted variable bias, and the exclusion restriction in the IV analysis might only hold conditional on controls.

Let us focus on our preferred specification in column (5) which includes an extensive set of controls for geography, population, agriculture, and income. Conditional on these control variables, we see that having an additional milking machine per 1,000 citizens suggests a 0.03 percentage point increase in women's seat share in the local council. However, the estimates lack precision on any conventional levels.

We also assess the role of omitted variable bias in our OLS regressions by following the approach of Oster (2019). For all specifications in Panel A, the resulting $|\delta|$ is smaller than 1 which typically indicates that the selection on unobservables would not have to be large in order for omitted variables to explain the estimated effects. However, here the small δ likely simply reflects the lack of statistical significance.[15]

[15] To calculate Oster's δ, we follow the convention that R^2_{max} obtained from a hypothetical regression of the outcome on milking machine adoption and all possible covariates is equal to $1.3R^2$, where R^2 is from the actual regression that has the most explanatory power (Oster 2019).

Table 1. Milking machine adoption and women's seat share in municipal councils.

	Women's seat share				
	(1)	(2)	(3)	(4)	(5)
Panel A: FE-OLS					
Milking machine adoption	-0.006	0.012	0.022	0.033	0.030
	(0.020)	(0.025)	(0.027)	(0.028)	(0.029)
Within R^2	0.00	0.00	0.00	0.00	0.00
Oster's δ for $\beta = 0$		0.18	0.36	0.61	0.56
Panel B: Reduced form					
Milking machine exposure	0.330*	0.357*	0.432**	0.454**	0.464**
	(0.173)	(0.190)	(0.182)	(0.227)	(0.228)
Within R^2	0.00	0.00	0.01	0.00	0.00
Oster's δ for $\beta = 0$		0.95	1.37	1.61	1.69
Panel C: FE-IV					
Milking $\widehat{\text{machine}}$ adoption	0.095*	0.090*	0.121**	0.115**	0.116**
	(0.055)	(0.052)	(0.055)	(0.058)	(0.057)
First-stage F	47.11	62.11	68.34	95.95	94.82
Mean of dependent variable	6.18	6.18	6.18	6.18	6.18
Panel D: First Stage					
Milking machine exposure	3.477***	3.946***	3.569***	3.939***	4.001***
	(0.507)	(0.501)	(0.432)	(0.402)	(0.411)
Within R^2	0.16	0.26	0.21	0.19	0.19
Mean of dependent variable	13.30	13.30	13.30	13.30	13.30
N	1283	1283	1283	1283	1283
No. of clusters	326	326	326	326	326

Notes: The dependent variable is women's seat share in local councils 1930, 1950, 1960, and 1972 (Panels A–C), and milking machine adoption (Panel D). Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Panel D reports the first-stage estimates. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

FE-IV estimates. In Panel B, we move on to the reduced form of 2SLS, using milking machine exposure as an instrument for milking machine adoption.[16] We see that there is a

[16] Panel A of Online Appendix Figure OA4 visualizes findings from a permutation test, in which we permute the instrument 1,000 times and re-estimate our reduced-form specification. We find that the distri-

strong positive relationship between milking machine exposure and women's political representation. As we argued above, this relationship plausibly runs through the effect historical cattle tending had on milking machine adoption once such machines became available.

Panel C then presents the 2SLS estimates using our leave-one-out shift-share to instrument for milking machine adoption. Let us again focus on our preferred specification in column (5). The IV estimate implies that increasing the number of milking machines by one per 1,000 citizens raises women's seat share by approximately 0.12 percentage points ($p < 0.05$). A one standard deviation increase in milking machine adoption leads to a 2.3 percentage point increase in women's seat share on local councils. This is slightly more than one third of the dependent variable mean. To contextualize the magnitude of this estimated effect of milking machine adoption, consider a municipality with the median council size of 21 seats. A 0.12 percentage point increase in female representation corresponds to roughly one additional woman on the council for every 40 milking machines per 1,000 residents.

It is worth noting that our OLS estimates are smaller than our IV estimates. Part of this discrepancy may reflect the sources of bias in OLS estimates discussed above. However, it could also stem from the fact that, if milking machine adoption is uncorrelated with the error term conditional on the covariates, OLS recovers the average treatment effect (ATE), whereas IV identifies a local average treatment effect (LATE) for municipalities whose adoption was shifted by initial cow intensity. These complier municipalities were moderately specialized in cattle farming—neither advanced areas that would have adopted regardless (always-takers), nor crop-dominant areas unlikely to adopt at all (never-takers); they were those where cattle farming was sufficiently important for mechanization to be relevant, but not so advanced that adoption was inevitable, nor so marginal that adoption was unlikely. The IV estimate captures treatment effects in this subset of municipalities, and they may differ from the ATEs—and even be larger in magnitude, if the milking machine affected women more in such municipalities than in municipalities at large.

Robustness checks. We present a battery of additional robustness checks in Table 2, where we consider alternative estimation samples and specifications. First, the results are robust to alternative estimation samples: expanding the sample beyond rural municipalities to include cities and market towns where agriculture played a smaller role (column 1); including the set of municipalities that were partially ceded to the Soviet Union after World War II (column 2); and omitting municipalities that underwent municipal mergers during our sample period and thus require aggregation (column 3).

butions are systematically centered around zero, and estimates as extreme as ours are unlikely to occur by chance.

Second, our main finding is robust to alternative sets of controls. In column (4), we control for municipality-specific time trends. This specification absorbs a substantial share of the identifying variation, resulting in less precise estimates and a somewhat weaker first stage (with an F-statistic of 19.59), though the estimate remains positive.

A particular concern is that other concurrent events could confound our estimates. We address this issue by including a set of controls capturing municipality-level shocks related to World War II that may have affected women's political representation and may be correlated with dairy-farming intensity (column 5).[17] Specifically, we control for World War II casualties per capita, using data from Meriläinen et al. (2025), which capture gender-imbalanced mortality shocks that may have directly influenced the supply of female candidates. We also control for the number of displaced individuals resettled in each municipality following the war, drawing on Sarvimäki et al. (2022). In some municipalities, the resettlement created large-scale population inflows that may have altered local labor markets, demographics, and political dynamics. Lastly, we include a measure of the war reparations shock taken from Mitrunen (2024). The measure of Mitrunen (2024) is a Bartik-style metric that proxies for differential exposure to post-war industrialization and economic restructuring across municipalities. The estimate remains very similar to that from the main specification and is statistically significant at the 10% level.

In column (6), we use LASSO to select the control variables. For the 2SLS, we include the union of variables selected in the first stage and the reduced form. The estimate is of a similar magnitude as our estimates in Table 1 and statistically significant at the 10% level.

Lastly, we explore the robustness of our finding to using time-varying controls (column 7) instead of measuring them at the baseline. One particular issue that these robustness checks address is that there could have been other technology adoption during the period when milking machines were introduced, and this could have similarly affected female political representation. The estimated effect of milking machine adoption on women's political representation remains positive and significant at the 5% level.

The Online Appendix contains further robustness checks. Our baseline IV strategy assumes that the spatial variation in our instrument—historical cattle intensity—affects women's political representation only through milking machine adoption. If this spatial variation also had a direct effect on later political outcomes, the exclusion restriction would be violated. To account for this possibility, we follow Conley et al. (2012). We allow for

[17] A related concern is that electrification may confound our results. However, we view this as an unlikely confounder. First, 80 % of households had electricity before 1950, i.e., before the rapid increase in milking machine adoption (Heikkonen 1971). Yet we do not observe any systematic increases in female representation in the pre-mechanization period in our sample or in the aggregate data. Second, splitting the sample in regions that got electricity earlier and those that got electricity later yields estimates of a similar magnitude.

direct effects of the instrument on the outcome that are of the size $\pm s \times \pi$. We vary s between zero and one, and π is the reduced-form coefficient. We find a positive and significant effect at the 10% level even if there is an exclusion restriction violation that is equivalent to roughly one-tenth of the reduced-form effect. Online Appendix Figure OA5 shows the estimated bounds for different degrees of exclusion restriction violation.

Table 2. Robustness to alternative samples and specifications.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for municipality–specific trends	Additional controls	LASSO controls	Time-varying controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FE-OLS							
Milking machine adoption	0.026	0.036	0.039	0.024	0.028	0.014	0.009
	(0.027)	(0.028)	(0.032)	(0.046)	(0.029)	(0.028)	(0.031)
Within R^2	0.00	0.00	0.00	0.00	0.00	0.08	0.03
Oster's δ for $\beta = 0$	0.61	0.68	0.66	0.61	0.50		0.12
Panel B: Reduced form							
Milking machine exposure	0.432*	0.456**	0.649**	0.690	0.617*	0.503***	0.483**
	(0.227)	(0.229)	(0.303)	(0.419)	(0.323)	(0.192)	(0.225)
Within R^2	0.00	0.00	0.01	0.01	0.01	0.06	0.04
Oster's δ for $\beta = 0$	2.24	1.60	2.47	6.57	2.64		1.01
Panel C: FE-IV							
Milking $\widehat{\text{machine}}$ adoption	0.104*	0.123**	0.157**	0.249	0.165*	0.095*	0.161**
	(0.055)	(0.062)	(0.076)	(0.156)	(0.090)	(0.053)	(0.081)
First-stage F	96.79	71.96	76.88	19.59	42.49	95.93	36.97
Mean of dependent variable	6.67	6.14	6.10	6.18	6.11	6.18	6.18
N	1398	1338	985	1282	1157	1282	1280
No. of clusters	355	340	250	326	290	326	325
Geography	✓	✓	✓	✓	✓		✓
Income	✓	✓	✓	✓	✓		✓
Population	✓	✓	✓	✓	✓		
Agriculture	✓	✓	✓	✓	✓		
Displaced population					✓		
WWII casualties					✓		
War reparations shock					✓		
Population (time-varying)							✓
Agriculture (time-varying)							✓

Notes: The dependent variable is women's seat share in local councils in 1930, 1950, 1960, and 1972. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Alternative IV approach. We additionally adopt an alternative IV strategy that additionally exploits variation in the predicted share of farms with at least ten cows per capita in 1930—a proxy for the (early) economic feasibility of mechanization following the calculations of Sipilä (1949b). We estimate a specification with three shift-share instruments for milking machine adoption. Each combines the same national shift used in our main analysis—the leave-one-out adoption of milking machines per capita—with a different cross-sectional share: (i) cows per capita in 1930, (ii) the predicted share of farms with at least ten cows in 1930, and (iii) the interaction of (i) and (ii). The third instrument isolates variation coming specifically from municipalities that were both cattle-intensive and where farms were large enough for mechanization to be economically attractive. This alternative empirical approach yields estimates that are comparable with the results presented in the main text.[18]

4.2 Effects on Female Representation by Party Family

Did the milking machine affect women with different political affiliations uniformly? We examine this question in columns (1) and (2) of Table 3 where we use the bourgeois and socialist women's seat share as the dependent variables.

We find evidence of a positive effect of the milking machine on bourgeois women's seat share but no effect on socialist women's seat share. We conjecture that the effect on female representation runs through bourgeois parties, which is reasonable as the agricultural population had a close connection with such parties—especially the Agrarian League and later the Center Party. The null result on socialist women further suggests that bourgeois women did not gain representation at the cost of socialist women. The lack of an effect may reflect either a lack of spillovers, or be indicative of there being no confounding shocks that would have affected all women regardless of their partisanship in the same manner.

Online Appendix Table OA3 shows that the results for bourgeois women's seat share remain robust across different sets of control variables, and Online Appendix Table OA7 shows that the results are also robust to different samples or specifications.[19] We present the same robustness tests for socialist women in Online Appendix Tables OA4 and OA8.

4.3 Effects on Parties' Seat Shares

We next examine whether milking machine adoption influenced the overall electoral strength of bourgeois and socialist parties, shown in Columns (3) and (4) of Table 3. Bourgeois parties appear to have experienced gains in seat share. Moreover, we find negative (albeit

[18] In column (1) of Online Appendix Table OA2, we show that this interacted instrument is strongly predictive of milking machine adoption. Having more than one instrument for one endogenous variable also allows us to perform an over-identification test (Hansen's J-test). The resulting p-value is 0.69 for our main outcome, supporting the validity of the alternative IV approach.

[19] See also Online Appendix Figure OA4 for a permutation test and Panel B of Online Appendix Figure OA5 for the Conley et al. (2012) bounds for the bourgeois women's seat share.

statistically insignificant and smaller-magnitude) effects on socialist parties' seat share.

Online Appendix Table OA5 shows that the results for bourgeois parties' seat share remain robust across different sets of control variables, and Online Appendix Table OA9 shows that the results are also robust to different samples or specifications.[20] We present the same robustness tests for socialist parties in Online Appendix Tables OA6 and OA10.

These partisan effects shed light on where the gains in bourgeois women's representation come from. They also indicate that the mechanization of agriculture may have tilted political support toward bourgeois parties. The gains from this gendered technological change were not zero-sum within parties or between women from bourgeois and socialist parties. Rather than reflecting a simple redistribution of seats from socialist to bourgeois women or from bourgeois men to bourgeois women, the results suggest that bourgeois women advanced alongside their parties' overall expansion in electoral support. Given Finland's system of proportional representation with open lists, increases in party seat shares can benefit both male and female candidates within the same party, depending on how votes are distributed across the list. In this context, mechanization may have lifted the electoral fortunes of bourgeois parties as a whole, creating more seats to be filled and thus lowering the intra-party competition for entry.

[20]See also Online Appendix Figure OA4 for a permutation test and Panel C of Online Appendix Figure OA5 for the Conley et al. (2012) bounds for the change in bourgeois parties' seat share.

Table 3. Milking machine adoption and political representation by party.

	Bourgeois women's seat share	Socialist women's seat share	Bourgeois parties' seat share	Socialist parties' seat share
	(1)	(2)	(3)	(4)
Panel A: FE-OLS				
Milking machine adoption	0.006	0.028**	0.210***	-0.082**
	(0.022)	(0.014)	(0.053)	(0.036)
Within R^2	0.00	0.01	0.02	0.01
Oster's δ for $\beta = 0$	0.13	4.54	-31.37	4.84
Panel B: Reduced form				
Milking machine exposure	0.513***	0.028	1.419**	-0.057
	(0.191)	(0.124)	(0.641)	(0.316)
Within R^2	0.01	0.00	0.01	0.00
Oster's δ for $\beta = 0$	5.17	0.32	-5.87	0.47
Panel C: FE-IV				
$\widehat{\text{Milking machine adoption}}$	0.128**	0.007	0.355**	-0.014
	(0.050)	(0.031)	(0.156)	(0.079)
First-stage F	94.82	94.82	94.82	94.82
Mean of dependent variable	4.13	1.97	63.24	35.70
N	1283	1283	1283	1283
No. of clusters	326	326	326	326
Geography	✓	✓	✓	✓
Population	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓
Income	✓	✓	✓	✓

Notes: Dependent variables are indicated in column titles. They are the respective seat shares in local councils in 1930, 1950, 1960, and 1972. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

5 Mechanisms

In this section, we examine the channels through which the milking machine translated into gains in women's political representation. Our core argument is a supply-side one. By automating the most time-intensive dairy chore, the milking machine reduced agricultural women's household labor burden and reallocated at least some of this work to men (Kaarlenkaski 2018), freeing time for civic activity.

Importantly, these changes unfolded alongside broader rural economic transformation. Mechanization itself contributed to farm consolidation, while a move out of agriculture and rising wage employment, including for women, characterized the wider rural economy in this period. Such transformations likely raised women's earnings, visibility, and organizational participation (Matland 1998; Iversen and Rosenbluth 2008, 2010), and may also have made voters and local party branches more receptive to female candidates as part of a broader modernization process. This is particularly important given that voters hold key power over who gets elected in open-list systems (Jokela et al. 2025).[21] We see these accompanying changes as enabling, rather than primary, mechanisms. While the relaxation of time constraints appears to have been a key factor, it is unlikely to fully account for the broader increase in women's political representation on its own. We interpret these wider economic and social changes as complementary forces that likely amplified this effect.

5.1 Supply of Female Candidates

A crucial precondition for more women in elected office is having more female candidates. If time constraints were a binding barrier to women's political participation, we would expect the milking machine to have expanded the pool of female candidates, and specifically among the women whose time it freed. We leverage our candidate lists data to produce a direct test of this hypothesis.

Table 4 reports estimates for four outcomes constructed from these data: the total number of candidates fielded by the Agrarian League/the Center Party expressed as percentages of council size (column 1), the share of candidates who were women (column 2), the share of male farmers (column 3), and the share of farmers' wives (column 4).[22]

[21] Note, however, that we do not find statistically significant effects on female turnout (see Online Appendix D.1).

[22] Our candidate-list data are available only for a subset of the municipalities in our main estimation sample, with the column (4) regression based on 231 municipalities rather than the full 326. We also do not observe similarly fine-grained occupational information for those who were ultimately elected, so we cannot directly trace whether the additional farmers' wives running for office translated into farmers' wives sitting on councils.

Column (1) shows no detectable effect of milking machine adoption on the overall size of the candidate pool. In column (2), we observe a positive albeit statistically insignificant effect on the share of female candidates. The estimates for (male) farmers in column (3) are negative but statistically insignificant and small in magnitude—note that in our sample, more than two thirds of the candidates were male farmers. By contrast, column (4) shows a positive effect on the share of farmers' wives among candidates. This estimate is significant at the 10% level, and it indicates that adding one milking machine per 1,000 residents raised the share of farmers' wives among candidates by 0.22 percentage points. Equivalently, a one standard deviation increase in milking machine adoption increases farmers' wives' candidate share by 4.51 percentage points—more than half of the dependent variable mean (7.7%).

Farmers' wives were women whose primary work at cattle farms was typically cattle tending and hand-milking; they are the group for whom the mechanization shock directly freed up time. The absence of a comparable effect on the broader female candidate share (column 2) makes it difficult to read this pattern as anything other than time gains driving candidacy.

To make the contrast concrete, consider two rural municipalities at opposite ends of the cattle-intensity distribution. Kemijärvi, where cattle farming was historically uncommon and milking-machine adoption modest, saw the Agrarian League field a single female candidate out of 52 in the 1956 municipal election; by 1972, the share had reached only 15% (9 of 62). In Pulkkila, a cattle-intensive municipality where milking machines spread rapidly between 1950 and 1969, the Agrarian League fielded two female candidates out of 28 in 1956—but by 1972, women accounted for one third of the Center Party's candidates (10 of 30), the vast majority of them farmers' wives. The contrast carries through to electoral outcomes: women's seat share rose by 17 percentage points in Pulkkila over 1950–1972, against no change in Kemijärvi.[23]

The claim that time constraints were experienced as a genuine barrier to civic participation is corroborated by historical survey evidence. Köppä (1982) reports on a 1980 survey of 776 Finnish farming couples. Half of farmers' wives who said they could not participate in organizational activities (which includes political parties, co-operatives, producer organizations, and civic associations) to their desired extent named livestock care as the single most important obstacle. In fact, it was far ahead of small children, housework, or distance and transport.

[23]In 1972, four women held positions in Pulkkila's 17-seat council, compared with two in Kemijärvi's 31-seat council.

Table 4. Milking machine adoption and candidate supply.

	Total candidates	Women's share	Farmers' share	Farmers' wives share
	(1)	(2)	(3)	(4)
Panel A: FE-OLS				
Milking machine adoption	-0.055	-0.022	-0.038	0.009
	(0.255)	(0.033)	(0.085)	(0.038)
Within R^2	0.00	0.00	0.00	0.00
Oster's δ for $\beta = 0$	-0.39	-0.26	0.55	0.18
Panel B: Reduced form				
Milking machine exposure	0.461	0.202	-0.446	0.697*
	(2.387)	(0.362)	(0.911)	(0.368)
Within R^2	0.00	0.00	0.00	0.02
Oster's δ for $\beta = 0$	1.06	0.36	0.97	8.51
Panel C: FE-IV				
$\widehat{\text{Milking machine adoption}}$	0.144	0.065	-0.139	0.220*
	(0.741)	(0.116)	(0.279)	(0.124)
First-stage F	45.77	42.12	16.67	27.81
Mean of dependent variable	151.36	11.25	76.30	7.67
N	671	661	497	546
No. of clusters	263	260	213	231
Geography	✓	✓	✓	✓
Population	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓
Income	✓	✓	✓	✓

Notes: Dependent variables are indicated in column titles. The total number of candidates is expressed as percentages of council size; other variables are expressed as a percentage share of candidates. The outcomes are measured in 1956, 1960, and 1972. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

5.2 Women's Work and Civic Life in Rural Finland

In this section, we show that the milking machine reduced the time women spent working on dairy farms. This happened against a backdrop of gendered structural change in rural Finland—one in which women were increasingly visible in off-farm employment and wage work. Together, these shifts likely raised women's civic engagement, consistent with the increase in associational activity in milking-machine-affected municipalities of which we also find suggestive evidence below.

Less female labor on farms. There are no detailed time-use surveys from the time period that our study concerns, but the 1959 Agricultural Census does report the number of working days performed by farmer men and women and their male and female household members. In Table 5, we show that milking machine adoption is associated with a lower female share of working days both for farmers and their family members (columns 1 and 2). The point estimates are large and statistically significant.

Columns (3) and (4) analyze the share of labor supplied by farmer women and their female household members outside of the farm. The IV estimate in column (3) is essentially zero, but this is unsurprising given that very few farmer women supplied any labor outside the farm to begin with (the dependent variable mean is just 0.04). The estimate in column (4), for female household members, is also near zero and statistically insignificant. We thus cannot say with confidence whether the time freed from on-farm work was redirected into off-farm labor. What our results do show is that women in dairy-farming households worked less on the farm, consistent with the time savings channel.[24]

[24] A potential "freed-up time" channel could also operate through reduced fertility if mechanization led women to have fewer children. We examined the number of births recorded in each municipality as a crude proxy for fertility and found no evidence of a differential fertility decline in areas with higher baseline dairy farming intensity. Thus, changes in childbearing are unlikely to explain our findings. Another channel through which the milking machine could have enhanced female political representation is education. While we lack education data, two considerations reduce concern. First, rural municipal councils in Finland have historically been composed largely of individuals with secondary, not tertiary, education. Second, women who may have pursued further education due to time freed by mechanization were likely to migrate to urban areas, as shown in Norway by Ager et al. (2026).

Table 5. Milking machine adoption and female share of labor at and outside of farms.

	Female farmers' share of total labor at farm	Female family members' share of total labor at farm	Female farmers' share of total labor outside farm	Female family members' share of total labor outside farm
	(1)	(2)	(3)	(4)
Panel A: OLS				
Milking machine adoption	-0.001***	-0.001**	0.0002	0.002***
	(0.0002)	(0.0002)	(0.0002)	(0.001)
R^2	0.22	0.31	0.16	0.60
Oster's δ for $\beta = 0$	1.40	-6.90	1.52	1.85
Panel B: Reduced form				
Milking machine exposure	-0.008**	-0.009***	0.001	0.003
	(0.004)	(0.003)	(0.002)	(0.005)
R^2	0.20	0.32	0.16	0.58
Oster's δ for $\beta = 0$	0.80	1.88	3.43	-1.43
Panel C: IV				
Milking $\widehat{\text{machine}}$ adoption	-0.002**	-0.002***	0.0002	0.001
	(0.001)	(0.001)	(0.0004)	(0.001)
First-stage F	24.59	24.59	24.59	24.59
Mean of dependent variable	0.17	0.82	0.04	0.36
N	356	356	356	356
Geography	✓	✓	✓	✓
Population	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓
Income	✓	✓	✓	✓

Notes: Dependent variables are indicated in column titles and measured in 1959. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Robust standard errors are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Gendered aggregate sectoral change. The decline in women's on-farm work unfolded against broader sectoral shifts visible in the aggregate data. Figure 5 indicates that agriculture dominated rural employment in 1950 but had contracted sharply by 1970. Men's family labor in agricultural employment also declined, but they retained larger shares in own-account and wage worker roles. The period saw a marked expansion of service sector employment, particularly for women, driven largely by growth in retail and trade (from 26%

to 38% of female service sector jobs). Manufacturing and construction absorbed a growing share of male employment, while women's participation in these sectors remained small.

While we do not attribute these aggregate trends to milking machine adoption directly, they describe the environment in which the political effects we estimate played out. This was a period in which women's economic independence, public visibility, and integration into civic networks were arguably on the rise across rural Finland—conditions under which female political representation might plausibly expand (Iversen and Rosenbluth 2008, 2010). The combination of women's growing presence in the wider rural economy and the locally freed time on dairy farms may be what was needed for women to enter local politics in larger numbers in milking-machine-affected municipalities.

Figure 5. Change in sectoral employment shares by gender in rural Finland, 1950-1970.

Notes: The figure shows the distribution of the economically active population across broad sectors, further broken down by employment type (family labor, own-account work, wage work). The data are from the 1950 and 1970 Population Censuses, and they include only rural municipalities (*maalaiskunnat*).

Prevalence of women's associations. The decline in women's engagement in agricultural labor freed time for civic participation. In Online Appendix Table OA12, we study women's associational activity using data collected from the Finnish Patent and Registration Office.[25] We focus on associations that existed by 1972 and examine the share of women's associations—such as women's clubs and local chapters of national women's organizations

[25]These data are only available for municipalities that still exist today. See https://yhdistysrekisteri.prh.fi/advancedSearch?userLang=en (accessed June 23, 2025).

identified on the basis of the association's name—relative to all associations founded in a given municipality. The reduced form and IV estimates point to a positive relationship between milking machine adoption and the prevalence of women's associations.

Offering qualitative support for our finding, Köppä (1982) documents that women in cattle farms tended to participate more in organizational activities in 1980 (including party organizations) than women in other types of farms. Furthermore, he reports that participation increased with the degree of mechanization.

5.3 Rural Economic Change

Additional evidence suggests that the milking machine also contributed to rural economic development and rising prosperity, with the potential to strengthen the material conditions for women's political participation.

First, Online Appendix Figure OA7 reports coefficient estimates for the share of farms within each size bracket (the format in which the agricultural census data are reported) in 1930–1970. The estimates exhibit an S-shape: in areas with higher pre-1950 dairy farming intensity, the share of farms below 10 hectares declined more sharply, while the share above 10 hectares increased more markedly, with coefficients for the 15–19.99, 20–24.99, and 30–49.99 hectare categories significant at the 5% level. This is consistent with farm consolidation driven by rising agricultural incomes. Economies of scale from consolidation may also have reduced labor demand, beyond the direct labor-saving effect of the milking machine.

Columns (1) and (2) of Online Appendix Table OA13 point to declines in the share of population living in agricultural households and the share of population employed in agriculture, suggestive of a movement out of agriculture in milking-machine-affected municipalities. However, the point estimates are small in magnitude and statistically insignificant, so we cannot draw strong conclusions about the role of milking mechanization in driving structural change. Column (3), however, provides clearer evidence of rising prosperity. It shows that municipalities that adopted more milking machines experienced larger increases in per capita tax revenue, primarily derived from labor income taxes.[26]

These results are consistent with mechanization driving income gains at the municipal level. Classical modernization perspectives suggest that such changes can open new political opportunities for underrepresented groups (Lipset 1959). From the scope of conventional theories of economic voting, rural communities becoming richer helps explain why bourgeois

[26]Some of this increase in fiscal capacity may reflect the expansion of the female tax base (Jensen 2022). This shift could have heightened women's demands for social infrastructure and strengthened their incentives to support female representatives able to advance these preferences. As Hessami and da Fonseca (2020) point out, women in office are more likely to prioritize such spending; but for such policies to take root, municipalities must first have the fiscal base to support them.

parties in particular benefited from the technological change. Furthermore, income gains and poverty reduction often disproportionately benefit women—although political representation tends to lag behind other dimensions of gender equality (Duflo 2012).

5.4 Change in Local Norms

For women to actually get elected, parties had to nominate them and voters had to vote for them. The patterns we have documented may have been accompanied by shifts in local attitudes about women's place in public life. Cultural norms are typically stable but can change in response to major shocks (Giuliano and Nunn 2021). Shifts in women's economic position are one source of such change (Fernández 2013; Xue 2025).

A distinctive feature of our setting is that the milking machine did not raise women's measurable economic contribution; if anything, it displaced women from a productive task they had long performed. What may have changed instead was the gendered identity of the task itself: as men took over machine-milking, a domain previously coded as women's work was redefined, softening the gendered division of labor within dairy-farming households. Kaarlenkaski (2018) documents this transition in detail. As one interviewee in a qualitative study from 1969 put it: "Mechanization has brought about the fact that division of work is not so strict anymore, men are also able to put the laundry into the machine, or milk the cows [...]." To the extent that this kind of role-blurring prompted broader reconsideration of women's roles in the community, the relevant shift was in the boundaries of what counted as "women's work" rather than in women's demonstrated economic value.[27]

6 Concluding Remarks

What forces drove increases in women's political representation historically? This paper shows that the milking machine, a labor-saving technology affecting men and women differently, sparked an increase in women's political representation in rural Finland during the mid-twentieth century. Using panel data and an instrumental variable approach, we show that milking machine adoption between 1930 and 1969 increased women's seat share on municipal councils.

Our estimates show that an additional milking machine per one thousand inhabitants led to an increase of 0.12 percentage points, and that these gains were concentrated among

[27]Consistent with this, Köppä (1982) found broad cross-gender support among farming couples for expanding women's share in producer cooperatives, advisory organizations, and local government around early 1980s, with the binding constraints identified as structural rather than attitudinal.

women in bourgeois parties. We find no precise effects for women on socialist parties, suggesting that bourgeois women's gains did not come at the expense of socialist women, and that technology indeed can reshape gender representation in local councils.

The evidence points to time gains as a key mechanism. Newly collected data on electoral candidates show that milking machine adoption raised the share of farmers' wives among Agrarian League/Center Party candidates—precisely the group whose time the technology freed—without affecting the overall size of the candidate pool or the share of male farmer candidates. Consistent with this, agricultural census data indicate that mechanization reduced women's share of working days on dairy farms. We also find suggestive evidence that milking machine adoption is associated with a higher prevalence of women's associations, indicating that freed-up time translated into broader civic engagement.

These time gains unfolded against broader rural transformation. The milking machine itself contributed to farm consolidation and rising municipal fiscal capacity, both signs of rural economic development in affected municipalities. Women were also becoming more visible in wage and service sector employment as part of a wider gendered structural change in post-war rural Finland, and the gendered division of labor within dairy-farming households was itself blurring as men took over milking. Together, these accompanying shifts may have made constraints on women's entry into municipal politics easier to overcome.

More broadly, our results highlight that technological change can influence political representation. As automation, artificial intelligence, and robotics reshape labor markets today, understanding how such transformations affect the composition of political leadership is essential for anticipating their full societal impact.

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Online Appendix

(Not for Publication)

A Additional Information on Our Data

This appendix contains additional figures related to our data and empirical approach. The map in Figure OA1 shows the prevalence of slash-and-burn farming in Finland in the 1830s. This historical farming practice explains much of the variation in our instrumental variable, cattle density in 1930, as we discussed in the main text.

In Panels A and B of Figure OA2, we map our main treatment variable—milking machine adoption over 1950-1969—and cows per capita in 1930—the spatial variation in our shift-share instrument—also for cities, market towns, and partly ceded municipalities. We exclude these localities in our main analysis but present additional robustness checks in which they are included. Panels C, D, and E show the geographic distribution of the change in female representation (all women, bourgeois women, and socialist women) including these same additional municipalities.

Finally, Figure OA3 shows an example of the candidate list data from the municipality of Kuortane. The first column indicates candidate occupation. In this case, all candidates are farmers (*maanvilj.*). The second column indicates candidate name. We use the first names to classify candidates by sex. Some candidate lists also include additional information that we do not use in this paper; here the third column contains each candidate's address.

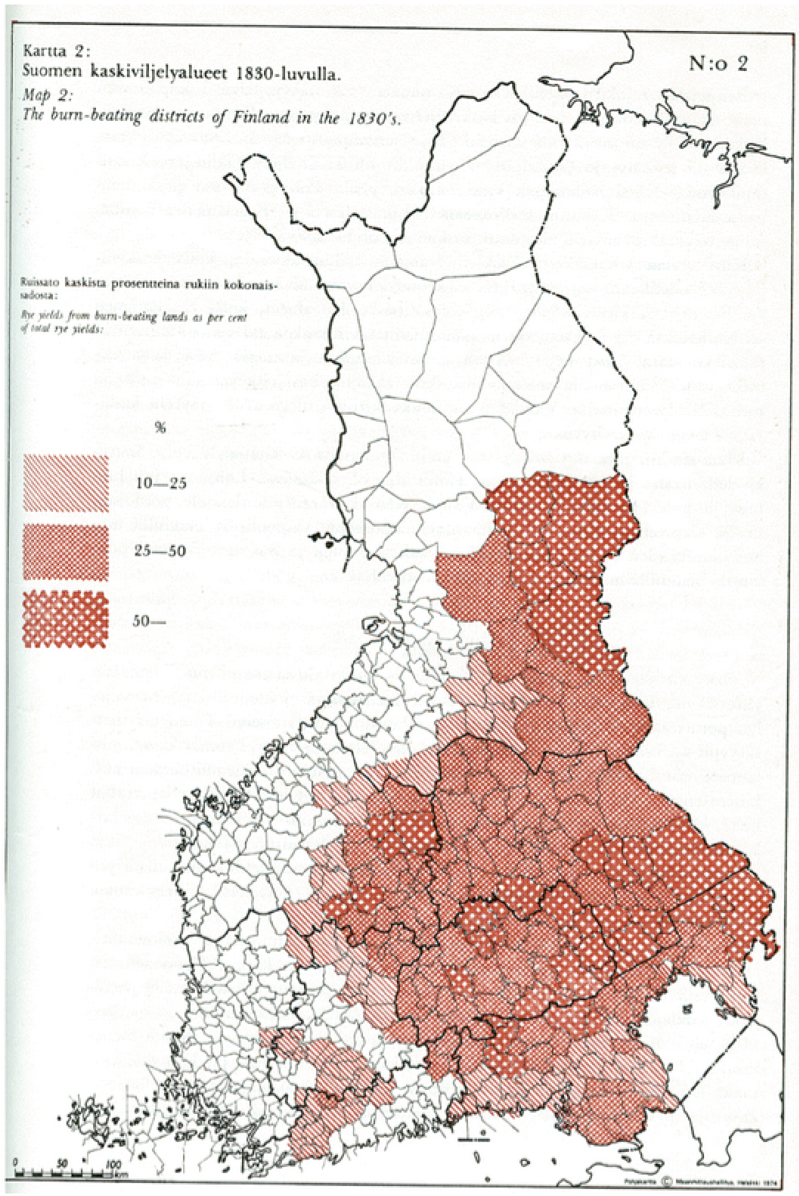
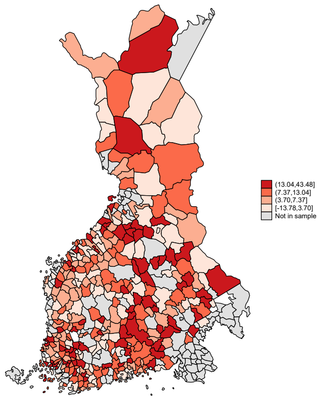
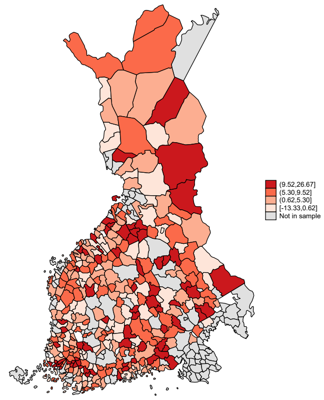


Figure OA1. Slash-and-burn farming in the 1830s.

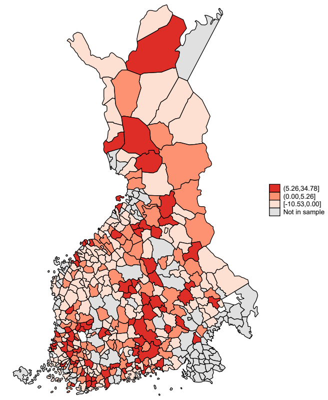
Notes: The figure comes from Soininen (1974). It shows rye yields from slash-and-burn lands as a share of total rye yields. In the 1800s, rye was the most important source of caloric intake in Finland.



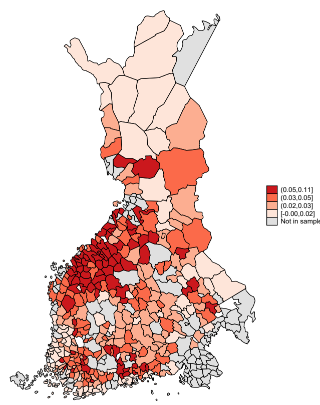
(a) Change in women's representation.



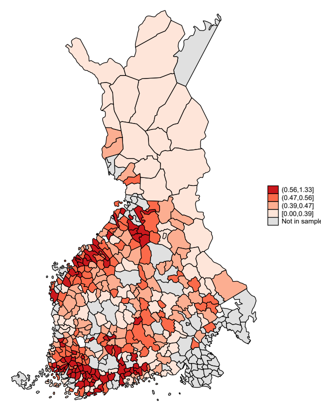
(b) Change in bourgeois women's representation.



(c) Change in socialist women's representation.



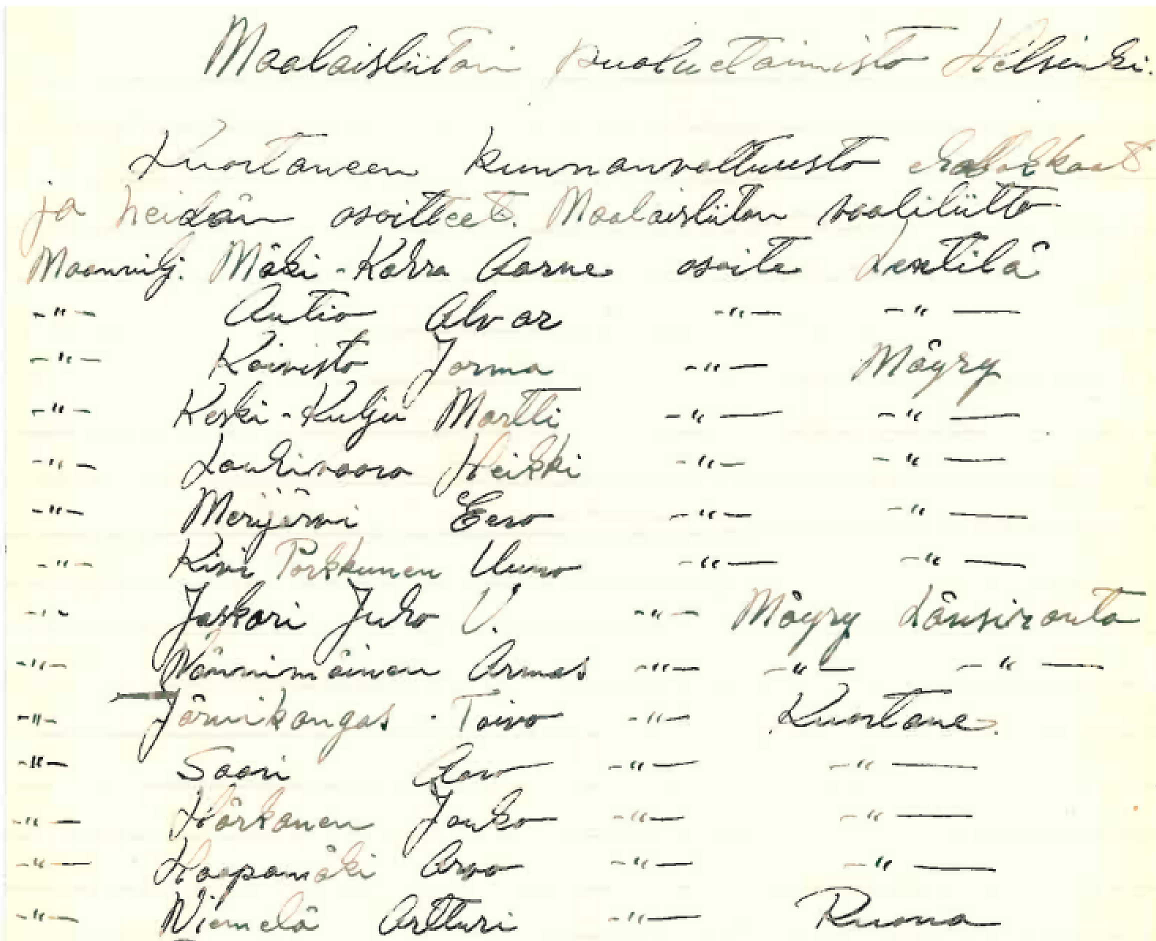
(d) Milking machine adoption (1950-1969).



(e) Cows per capita (1930).

Figure OA2. Maps—cities, market towns, and partly ceded municipalities included.

Notes: Panels A, B, and C illustrate the geographic distribution of the change in women's seat share between the years 1950 and 1972. Panels D and E show the milking machine adoption in 1950–1969 and the distribution of cows per capita, respectively. The data come from the agricultural censuses of 1930, 1950, and 1969. The maps follow pre-1930 municipal division to which we aggregate our data.



Maalaisliiton puoluetoimisto Helsinki.

Kuortaneen kunnanvaltuusto ehdokkaat ja heidän osoitteet. Maalaisliiton vaaliliitto

Maanvilj. Mäki-Kahra Aarne osoite Lentilä
-"- Autio Alvar -"- -"-
-"- Koivisto Jorma -"- Mäyry
-"- Keski-Kuljo Martti -"- -"-
-"- Laurinsaara Heikki -"- -"-
-"- Merijärvi Eero -"- -"-
-"- Kivi Torkkunen Uuno -"- -"-
-"- Jaskari Juho V. -"- Mäyry Länsiranta
-"- Vänninmäinen Armas -"- -"- -"-
-"- Järvikangas Toivo -"- Kuortane
-"- Saari Aaro -"- -"-
-"- Härkönen Jouko -"- -"-
-"- Haapamäki Arvo -"- -"-
-"- Niemelä Artturi -"- Ruona

Figure OA3. An example of the candidate data (1960 local election in Kuortane).

B Instrument Validity

In this appendix, we present additional results to support the validity of our instrumental variable strategy. It hinges on two assumptions: relevance and the exclusion restriction. The relevance condition is upheld, clear from the fact that the first stage is robust across different sets of control variables (see Panel D of Table 1).

The second identifying assumption is that the instrument affects later female political representation only through its effect on milking machine adoption. Formally, this exclusion restriction requires that, conditional on controls and the time and municipality fixed effects, the instrument is uncorrelated with unobserved determinants of female political representation.

Table OA1 reports estimation results for our outcome variables for which we have data before milking machine adoption. We do not find any effects on the change in bourgeois women's, bourgeois parties', or socialist parties' seat share. However, socialist women's seat share indicates a negative pre-trend. As we have only two periods of data, we examine pre-trends by running a first-difference regression. The outcome variables are constructed as the change between 1930 and 1950. The treatment variable is the change in milking machines per capita between 1950 and 1969, and the instrument is constructed in the same manner as in other specifications.

Table OA1. Pre-trends in representation: milking machine adoption in 1950–1969 and change in female representation in 1930–1950.

	Δ Women's seat share	Δ Bourgeois women's seat share	Δ Socialist women's seat share	Δ Bourgeois parties' seat share	Δ Socialist parties' seat share
	(1)	(2)	(3)	(4)	(5)
Panel A: FD-OLS					
Milking machine adoption	-0.005	0.009	-0.003	0.169***	-0.130***
	(0.033)	(0.030)	(0.010)	(0.054)	(0.048)
R^2	0.09	0.06	0.18	0.19	0.29
Oster's δ for $\beta = 0$	0.19	-0.55	0.25	3.88	3.43
Panel B: Reduced form					
Milking machine exposure	-0.001	0.232	-0.208**	-0.042	0.179
	(0.226)	(0.215)	(0.083)	(0.490)	(0.472)
R^2	0.09	0.06	0.19	0.16	0.27
Oster's δ for $\beta = 0$	-0.01	2.40	11.55	-0.05	-0.24
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	-0.000	0.061	-0.055**	-0.011	0.047
	(0.057)	(0.054)	(0.022)	(0.124)	(0.120)
First-stage F	75.25	75.25	75.25	75.25	75.25
Mean of dependent variable	2.85	1.37	1.42	-1.82	2.95
N	323	323	323	323	323
Geography	✓	✓	✓	✓	✓
Population	✓	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	✓
Income	✓	✓	✓	✓	✓

Notes: The dependent variables are indicated in the column titles and measured as changes between 1930 and 1950. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Robust standard errors are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

C Robustness Checks

This appendix presents additional robustness checks for our main findings. Let us begin with the estimation results for the overall female seat share. First, Figure OA4 shows reduced-form estimates from an exercise in which we permute the instrument 1,000 times and examine the probability that a randomly drawn estimate would be as extreme as the true estimate. The permutation test suggests that observing our estimate is highly unlikely when the instrument is shuffled randomly, for overall women's seat share, as well as bourgeois women's seat share.

Second, to account for potential violations of the exclusion restriction, we follow Conley et al. (2012), allowing for bounded direct effects of the instrument on the outcome and constructing confidence intervals accordingly. We allow for symmetric direct effects of the instrument on the outcome that are of the size $s \times \pi$ where we vary s between zero and one and π is the reduced-form coefficient. We use the union of confidence intervals (UCI) approach which yields conservative yet informative estimates under explicit assumptions about the direction and magnitude of potential violations. Panel A of Figure OA5 shows the estimated bounds. The bounds suggest a positive and significant effect at the 10% level even if there is an exclusion restriction violation that is equivalent to roughly one-tenth of the reduced-form effect.

Third, we extend our IV strategy by augmenting the model with the predicted share of farms with at least ten cows in 1930—a proxy for the economic feasibility of mechanization following the calculations of (Sipilä 1949b)—and its interaction with cattle intensity.[1] We then construct the predicted share of farms with at least ten cows by assuming a Poisson distribution and a mean that is equal to the average number of cows per farm in 1930. This allows us to better isolate exogenous variation in adoption where the returns to milking machines were highest, consistent with a treatment-on-the-treated logic.

Having multiple instruments allows us to perform an overidentification test. The p-value resulting from Hansen's J-test is around 0.69, supporting the validity of our 2SLS estimation.

Let us now move on to robustness checks for bourgeois and socialist women's seat share and bourgeois and socialist parties' seat share. Tables OA3, OA4, OA5, and OA6 report the estimates for different sets of control variables. We find that the results for bourgeois women and bourgeois parties remain robust across different specifications. The results for socialist women and socialist parties are perhaps less robust but overall support our main interpretation that there is suggestive evidence of a positive—albeit statistically insignificant—effect

[1] Note that introducing these additional instruments makes the exclusion restriction more layered (i.e., it requires that all variables are exogenous and interact with the outcome only through milking machine adoption).

for socialist women and a negative—but also statistically insignificant—effect for socialist parties.

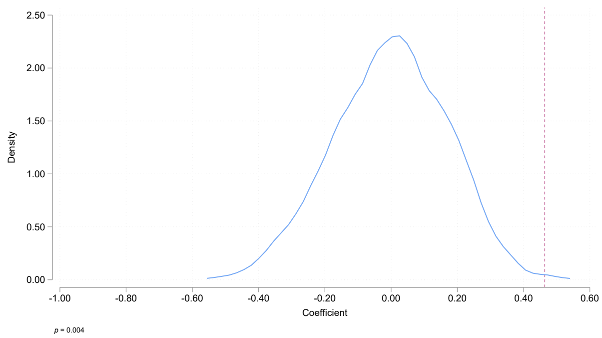
In Tables OA7, OA8, OA9, and OA10, we consider alternative estimation samples and specifications. The results for bourgeois women and bourgeois parties are robust to expanding the data beyond rural municipalities and including cities and market towns (column 1), including the set of municipalities that were partially ceded to the Soviet Union after the Second World War (column 2), omitting municipalities that went through municipal mergers during our sample period and thus require aggregating the data (column 3), controlling for the 1930-1950 trend in the outcome (column 4). In column (5), we include the set of controls meant to capture municipality-level shocks related to World War II that may have affected women's political representation and may be correlated with dairy-farming intensity, and we also control for covariates selected using LASSO (column 6). Lastly, we explore the robustness of our finding to using time-varying controls (column 7) instead of measuring them at the baseline.

In these robustness checks, we continue to find some evidence of a positive effect on socialist women's political representation and a negative effect on socialist parties' seat share overall. However, as in the analyses we report in the main text, these estimates are not statistically significant. Moreover, using the three-year panel and FE-IV as the estimation strategy brings the point estimates close to zero.

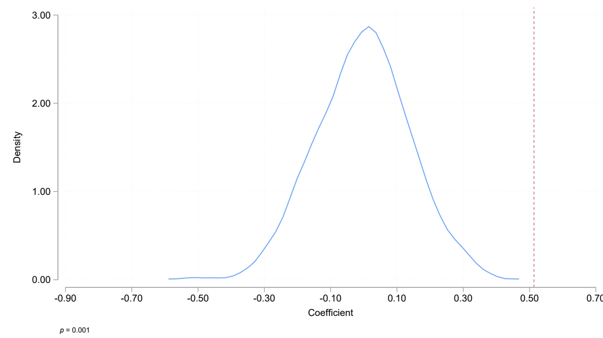
In Figure OA4 we also show results from the permutation test discussed above. We confirm the findings for bourgeois women and bourgeois parties.

Columns (3)-(6) of Table OA2 report 2SLS estimates obtained using our auxiliary IV strategy introduced above. The estimation results resonate with our main findings. However, while the overidentification test is passed for the change in bourgeois and socialist women's seat share and socialist parties' seat share, we note a potential violation for the change in bourgeois party seat share.

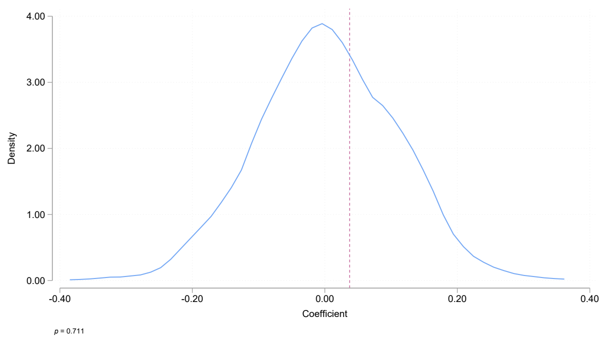
Finally, for the two outcomes that exhibit clearer statistically significant effects, we also report the Conley et al. (2012) bounds. These can be found in Panels B and C of Figure OA5. We find that even with violations of the exclusion restriction that match about 10% of the reduced-form effect, there is still a positive effect that is statistically significant at the 10% level.



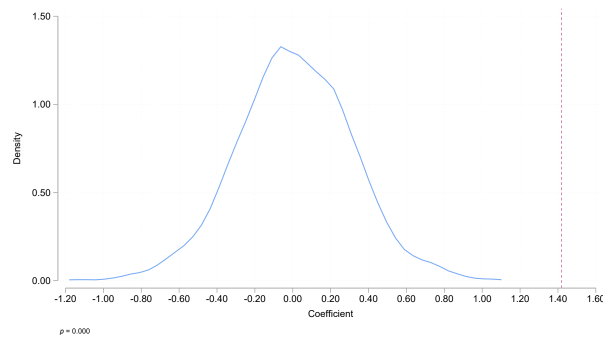
(a) Change in women's seat share.



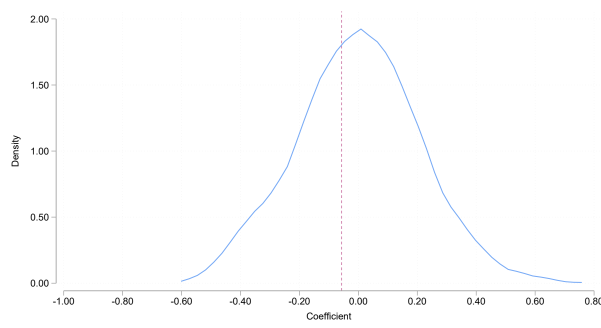
(b) Change in bourgeois women's seat share.



(c) Change in socialist women's seat share.



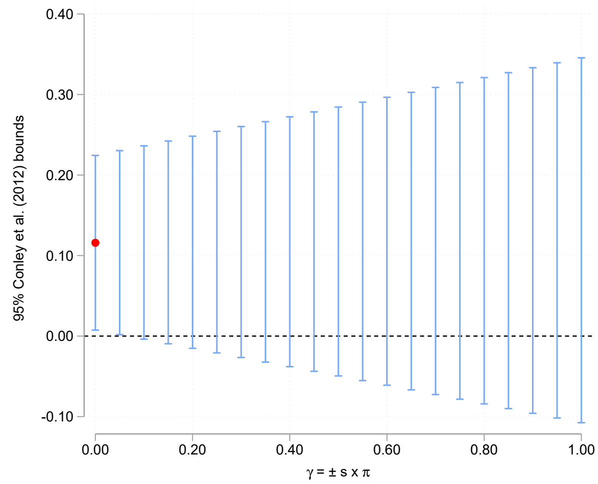
(d) Change in bourgeois parties' seat share.



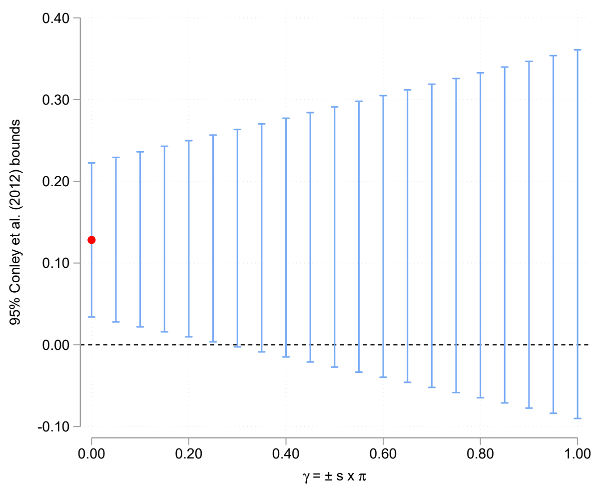
(e) Change in socialist parties' seat share.

Figure OA4. Permutation tests.

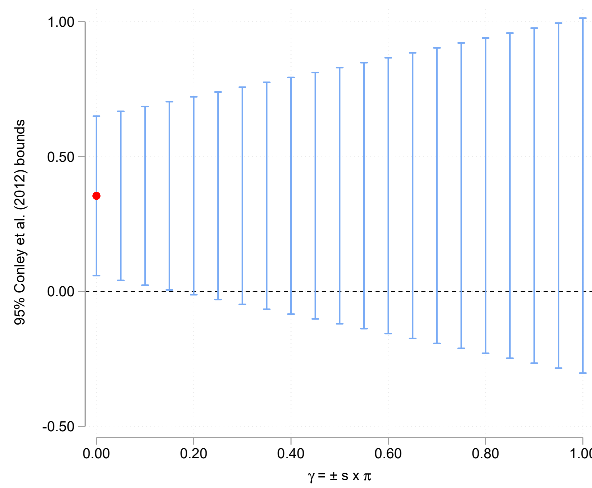
Notes: The figure plots the distribution of reduced-form estimates obtained by reshuffling the instrument 1,000 times. The vertical line marks the actual reduced-form estimate. The *p*-value indicates the probability that a randomly drawn estimate from the resulting distribution would be as extreme as the actual estimate. The estimations include the full set of controls.



(a) Women's seat share.



(b) Bourgeois women's seat share.



(c) Bourgeois parties' seat share.

Figure OA5. Bounds for the 2SLS estimates—women's seat share.

Notes: The figure shows Conley et al. (2012) 95% bounds for the 2SLS estimates for all women's seat share, bourgeois women's seat share, and bourgeois parties' seat share, allowing for small violations (γ) to the exclusion restriction. We set γ to be s times the reduced-form relationship and vary s. $\gamma = 0$ corresponds to no violation at all. The specification includes the full set of control variables.

Table OA2. Regression results using an alternative IV approach.

	Milking machine adoption	Women's seat share	Bourgeois women's seat share	Socialist women's seat share	Bourgeois parties' seat share	Socialist parties' seat share
	(1)	(2)	(3)	(4)	(5)	(6)
Milking machine exposure	4.280***					
	(0.514)					
Economic Feasibility Exposure	8.425					
	(29.728)					
Milking machine exposure × Economic Feasibility Exposure	-0.881					
	(1.308)					
Milking machine adoption		0.112*	0.127**	0.006	0.369**	-0.010
		(0.059)	(0.051)	(0.031)	(0.160)	(0.079)
First-stage F		31.31	31.31	31.31	31.31	31.31
Mean of dependent variable	13.30	6.18	4.13	1.97	63.24	35.70
p-value of Hansen J-statistic		0.69	0.88	0.83	0.02	0.17
N	1283	1282	1283	1283	1283	1283
No. of clusters	326	326	326	326	326	
Geography	✓	✓	✓	✓	✓	✓
Population	✓	✓	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	✓	✓
Income	✓	✓	✓	✓	✓	✓

Notes: The dependent variables are shown in column titles. Column (1) reports first-stage estimates obtained using three instruments, and columns (2)-(6) report 2SLS estimates. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Robust standard errors are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA3. Robustness to alternative controls—bourgeois women's political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FE-OLS					
Milking machine adoption	0.019	0.015	0.011	0.011	0.006
	(0.019)	(0.017)	(0.021)	(0.022)	(0.022)
R^2	0.00	0.00	0.00	0.00	0.00
Oster's δ for $\beta = 0$		0.42	0.24	0.25	0.13
Panel B: Reduced form					
Milking machine exposure	0.562***	0.650***	0.605***	0.528***	0.513***
	(0.137)	(0.144)	(0.153)	(0.194)	(0.191)
R^2	0.02	0.02	0.01	0.01	0.01
Oster's δ for $\beta = 0$	5.02	16.40	9.76	5.56	5.17
Panel C: FE-IV					
Milking $\widehat{\text{machine}}$ adoption	0.162***	0.165***	0.170***	0.134***	0.128**
	(0.048)	(0.043)	(0.049)	(0.051)	(0.050)
First-stage F	47.11	62.11	68.34	95.95	94.82
Mean of dependent variable	4.13	4.13	4.13	4.13	4.13
N	1283	1283	1283	1283	1283
No. of clusters	326	326	326	326	326
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is bourgeois women's seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA4. Robustness to alternative controls—socialist women's political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FE-OLS					
Milking machine adoption	-0.001	-0.013	0.016	0.026*	0.028**
	(0.015)	(0.010)	(0.014)	(0.014)	(0.014)
R^2	0.00	0.00	0.00	0.01	0.01
Oster's δ for $\beta = 0$		-0.06	1.51	3.77	4.54
Panel B: Reduced form					
Milking machine exposure	-0.151	-0.177	-0.037	0.022	0.028
	(0.108)	(0.124)	(0.095)	(0.119)	(0.124)
R^2	0.00	0.00	0.00	0.00	0.00
Oster's δ for $\beta = 0$	-0.69	-0.92	-0.32	0.24	0.32
Panel C: FE-IV					
Milking $\widehat{\text{machine}}$ adoption	-0.043	-0.045	-0.010	0.006	0.007
	(0.031)	(0.030)	(0.027)	(0.030)	(0.031)
First-stage F	47.11	62.11	68.34	95.95	94.82
Mean of dependent variable	1.97	1.97	1.97	1.97	1.97
N	1283	1283	1283	1283	1283
No. of clusters	326	326	326	326	326
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is socialist women's seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA5. Robustness to alternative controls—bourgeois parties' political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FE-OLS					
Milking machine adoption	0.232***	0.194***	0.200***	0.213***	0.210***
	(0.051)	(0.050)	(0.047)	(0.054)	(0.053)
R^2	0.03	0.03	0.02	0.02	0.02
Oster's δ for $\beta = 0$		-14.54	-53.28	-27.01	-31.37
Panel B: Reduced form					
Milking machine exposure	0.857	1.450**	1.346**	1.676**	1.419**
	(0.529)	(0.608)	(0.581)	(0.698)	(0.641)
R^2	0.01	0.02	0.02	0.02	0.01
Oster's δ for $\beta = 0$	-9.33	-5.03	-5.80	-5.08	-5.87
Panel C: FE-IV					
Milking $\widehat{\text{machine}}$ adoption	0.246*	0.368**	0.377**	0.426**	0.355**
	(0.144)	(0.142)	(0.156)	(0.174)	(0.156)
First-stage F	47.11	62.11	68.34	95.95	94.82
Mean of dependent variable	63.24	63.24	63.24	63.24	63.24
N	1283	1283	1283	1283	1283
No. of clusters	326	326	326	326	326
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is bourgeois parties' seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA6. Robustness to alternative controls—socialist parties' political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FE-OLS					
Milking machine adoption	-0.133***	-0.089***	-0.100***	-0.087**	-0.082**
	(0.032)	(0.028)	(0.033)	(0.035)	(0.036)
R^2	0.02	0.01	0.01	0.01	0.01
Oster's δ for $\beta = 0$		15.80	6.92	5.32	4.84
Panel B: Reduced form					
Milking machine exposure	-0.305	-0.468	-0.125	-0.135	-0.057
	(0.277)	(0.312)	(0.259)	(0.306)	(0.316)
R^2	0.00	0.00	0.00	0.00	0.00
Oster's δ for $\beta = 0$	2.97	9.69	1.12	1.27	0.47
Panel C: FE-IV					
Milking $\widehat{\text{machine}}$ adoption	-0.088	-0.118	-0.035	-0.034	-0.014
	(0.076)	(0.074)	(0.072)	(0.078)	(0.079)
First-stage F	47.11	62.11	68.34	95.95	94.82
Mean of dependent variable	35.70	35.70	35.70	35.70	35.70
N	1283	1283	1283	1283	1283
No. of clusters	326	326	326	326	326
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is socialist parties' seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA7. Robustness to alternative samples and specifications—bourgeois women's representation.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for municipality–specific trends	Additional controls	LASSO controls	Time-varying controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FE-OLS							
Milking machine adoption	0.012	0.008	0.019	0.010	0.002	0.010	-0.008
	(0.021)	(0.022)	(0.026)	(0.035)	(0.021)	(0.020)	(0.023)
Within R^2	0.00	0.00	0.00	0.00	0.00	0.07	0.04
Oster's δ for $\beta = 0$	0.34	0.19	0.45	0.31	0.04		-0.12
Panel B: Reduced form							
Milking machine exposure	0.529***	0.513***	0.643***	0.499	0.660**	0.653***	0.643***
	(0.188)	(0.190)	(0.239)	(0.340)	(0.282)	(0.163)	(0.171)
Within R^2	0.01	0.01	0.01	0.00	0.01	0.05	0.05
Oster's δ for $\beta = 0$	9.24	4.95	10.01	6.70	13.49		3.42
Panel C: FE-IV							
Milking $\widehat{\text{machine}}$ adoption	0.127***	0.138**	0.156**	0.180	0.177**	0.120***	0.215***
	(0.047)	(0.054)	(0.062)	(0.126)	(0.083)	(0.040)	(0.071)
First-stage F	96.80	71.96	76.89	19.75	42.49	105.20	36.94
Mean of dependent variable	4.35	4.13	4.28	4.13	4.06	4.13	4.13
N	1399	1339	986	1283	1158	1283	1281
No. of clusters	355	340	250	326	290	326	325
Geography	✓	✓	✓	✓	✓		✓
Income	✓	✓	✓	✓	✓		✓
Population	✓	✓	✓	✓	✓		
Agriculture	✓	✓	✓	✓	✓		
Displaced population					✓		
WWII casualties					✓		
War reparation shocks					✓		
Population (time-varying)							✓
Agriculture (time-varying)							✓

Notes: The dependent variable is bourgeois women's seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA8. Robustness to alternative samples and specifications—socialist women's representation.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for municipality–specific trends	Additional controls	LASSO controls	Time-varying controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FE-OLS							
Milking machine adoption	0.019	0.032**	0.027	0.017	0.027	0.018	0.023
	(0.015)	(0.014)	(0.019)	(0.022)	(0.016)	(0.014)	(0.016)
Within R^2	0.00	0.01	0.01	0.00	0.00	0.10	0.06
Oster's δ for $\beta = 0$	3.17	6.27	2.74	1.79	4.75		1.88
Panel B: Reduced form							
Milking machine exposure	-0.030	0.023	0.081	0.301	0.046	-0.024	-0.018
	(0.133)	(0.125)	(0.161)	(0.219)	(0.168)	(0.108)	(0.117)
Within R^2	0.00	0.00	0.00	0.00	0.00	0.06	0.05
Oster's δ for $\beta = 0$	-0.36	0.26	0.86	-43.18	0.57		-0.12
Panel C: FE-IV							
Milking $\widehat{\text{machine}}$ adoption	-0.007	0.006	0.020	0.108	0.012	-0.001	-0.006
	(0.032)	(0.034)	(0.039)	(0.081)	(0.045)	(0.030)	(0.039)
First-stage F	96.80	71.96	76.89	19.75	42.49	91.15	36.94
Mean of dependent variable	2.25	1.94	1.76	1.97	1.98	1.97	1.97
N	1399	1339	986	1283	1158	1283	1281
No. of clusters	355	340	250	326	290	326	325
Geography	✓	✓	✓	✓	✓		✓
Income	✓	✓	✓	✓	✓		✓
Population	✓	✓	✓	✓	✓		
Agriculture	✓	✓	✓	✓	✓		
Displaced population					✓		
WWII casualties					✓		
War reparation shocks					✓		
Population (time-varying)							✓
Agriculture (time-varying)							✓

Notes: The dependent variable is socialist women's seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA9. Robustness to alternative samples and specifications—bourgeois parties' seat share.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for municipality–specific trends	Additional controls	LASSO controls	Time-varying controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FE-OLS							
Milking machine adoption	0.214***	0.203***	0.181***	0.059	0.172***	0.205***	0.229***
	(0.051)	(0.053)	(0.059)	(0.075)	(0.053)	(0.048)	(0.068)
Within R^2	0.03	0.02	0.02	0.00	0.02	0.18	0.05
Oster's δ for $\beta = 0$	-45.86	-35.92	-91.65	3.43	16.75		53.14
Panel B: Reduced form							
Milking machine exposure	1.368**	1.351**	1.508*	2.322*	0.608	1.139**	1.259*
	(0.621)	(0.640)	(0.810)	(1.313)	(0.746)	(0.548)	(0.739)
Within R^2	0.01	0.01	0.01	0.02	0.00	0.12	0.04
Oster's δ for $\beta = 0$	-6.64	-6.15	-5.40	-10.84	18.91		-12.13
Panel C: FE-IV							
$\widehat{\text{Milking machine adoption}}$	0.328**	0.364**	0.366*	0.836*	0.163	0.328***	0.421*
	(0.145)	(0.169)	(0.197)	(0.483)	(0.200)	(0.126)	(0.230)
First-stage F	96.80	71.96	76.89	19.75	42.49	105.51	36.94
Mean of dependent variable	62.65	63.39	64.25	63.24	63.40	63.24	63.23
N	1399	1339	986	1283	1158	1283	1281
No. of clusters	355	340	250	326	290	326	325
Geography	✓	✓	✓	✓	✓		✓
Income	✓	✓	✓	✓	✓		✓
Population	✓	✓	✓	✓	✓		
Agriculture	✓	✓	✓	✓	✓		
Displaced population					✓		
WWII casualties					✓		
War reparation shocks					✓		
Population (time-varying)							✓
Agriculture (time-varying)							✓

Notes: The dependent variable is bourgeois parties' seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA10. Robustness to alternative samples and specifications—socialist parties' seat share.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for municipality–specific trends	Additional controls	LASSO controls	Time-varying controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FE-OLS							
Milking machine adoption	-0.103***	-0.080**	-0.092**	0.044	-0.099**	-0.123***	-0.067*
	(0.035)	(0.036)	(0.042)	(0.053)	(0.039)	(0.034)	(0.035)
Within R^2	0.01	0.01	0.01	0.00	0.01	0.21	0.05
Oster's δ for $\beta = 0$	6.70	4.63	5.94	-3.49	5.75		2.31
Panel B: Reduced form							
Milking machine exposure	-0.230	-0.016	-0.195	-0.287	0.238	-0.529*	0.327
	(0.300)	(0.324)	(0.330)	(0.646)	(0.413)	(0.290)	(0.342)
Within R^2	0.00	0.00	0.00	0.00	0.00	0.12	0.05
Oster's δ for $\beta = 0$	2.29	0.13	1.85	11.81	-1.31		-1.32
Panel C: FE-IV							
Milking $\widehat{\text{machine}}$ adoption	-0.055	-0.004	-0.047	-0.103	0.064	-0.128*	0.109
	(0.072)	(0.087)	(0.080)	(0.234)	(0.112)	(0.069)	(0.119)
First-stage F	96.80	71.96	76.89	19.75	42.49	105.51	36.94
Mean of dependent variable	36.37	35.60	34.91	35.70	35.73	35.70	35.71
N	1399	1339	986	1283	1158	1283	1281
No. of clusters	355	340	250	326	290	326	325
Geography	✓	✓	✓	✓	✓		✓
Income	✓	✓	✓	✓	✓		✓
Population	✓	✓	✓	✓	✓		
Agriculture	✓	✓	✓	✓	✓		
Displaced population					✓		
WWII casualties					✓		
War reparation shocks					✓		
Population (time-varying)							✓
Agriculture (time-varying)							✓

Notes: The dependent variable is socialist parties' seat share. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

D Additional Results for the Mechanisms

This appendix contains additional results for the mechanisms section.

D.1 Voter Turnout

We analyze municipality-level data on female voter turnout in parliamentary elections between 1950 and 1971 collected from election results published by Statistics Finland. While we lack corresponding data for municipal elections, changes in parliamentary turnout can still reflect evolving patterns of political engagement.

Women used to be less likely to vote than men but their turnout levels caught up to men's by the 1970s (see Figure OA6). We find only weak evidence of a positive relationship between milking machine exposure and the change in women's turnout; the relationship is positive but not statistically significant. We show the estimation results in Table OA11 which also reports the estimation results for men, for whom the estimates are also positive and even larger than for women. This suggests that mechanization may not have significantly altered women's participation as voters.

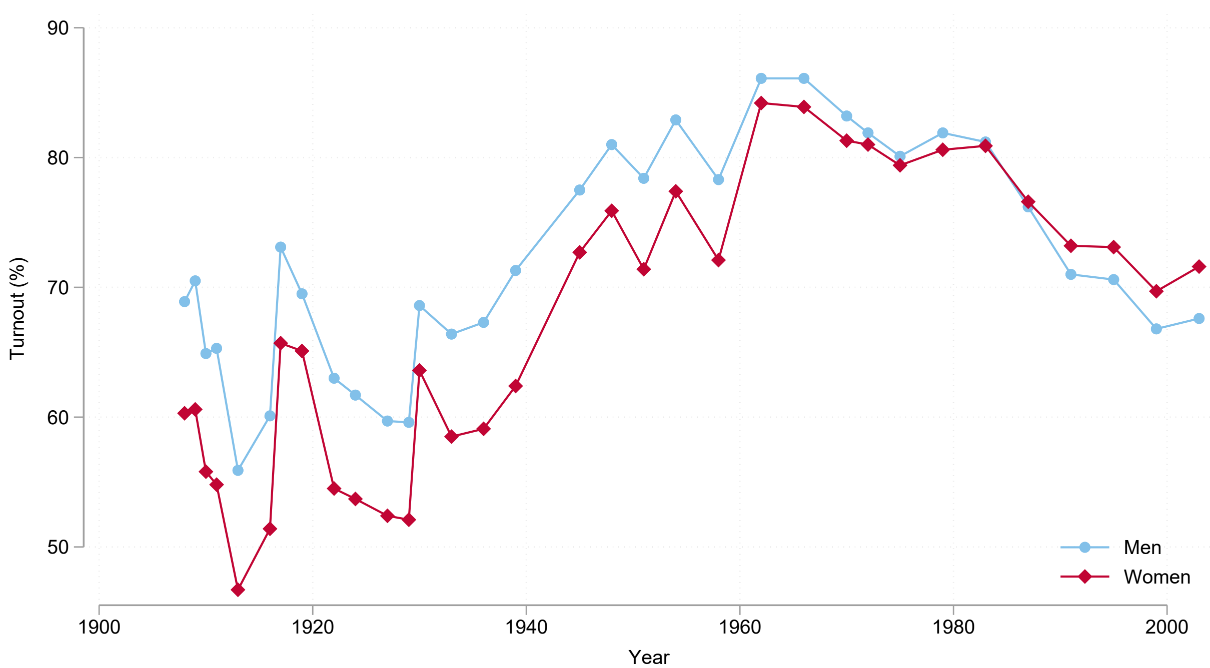


Figure OA6. Trends in voter turnout over time.

Table OA11. The milking machine and voter turnout by gender.

	Women's turnout	Men's turnout
	(1)	(2)
Panel A: FE-OLS		
Milking machine adoption	0.001	-0.003
	(0.023)	(0.025)
Within R^2	0.00	0.00
Oster's δ for $\beta = 0$	0.04	-0.07
Panel B: Reduced form		
Milking machine exposure	0.306	0.204
	(0.216)	(0.249)
Within R^2	0.01	0.01
Oster's δ for $\beta = 0$	1.83	1.34
Panel C: FE-IV		
Milking $\widehat{\text{machine}}$ adoption	0.082	0.054
	(0.059)	(0.066)
First-stage F	65.89	65.89
Mean of dependent variable	76.52	81.63
No. of clusters	365	365
N	730	730
Geography	✓	✓
Population	✓	✓
Agriculture	✓	✓
Income	✓	✓

Notes: The dependent variable is the change in women's and men's turnout in columns (1) and (2), respectively. Panel A reports OLS estimates, Panel B shows the reduced form of IV, and Panel C reports the IV estimates. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Robust standard errors are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

D.2 Women's Associations

In Table OA12, we study women's associational activity using data collected from the Finnish Patent and Registration Office. We focus on associations that existed by 1972 and examine the share of women's associations—such as women's clubs and local chapters of national women's organizations identified on the basis of the association's name—relative to all associations founded in a given municipality. The reduced form and IV estimates point to a positive relationship between milking machine adoption and the prevalence of women's associations.

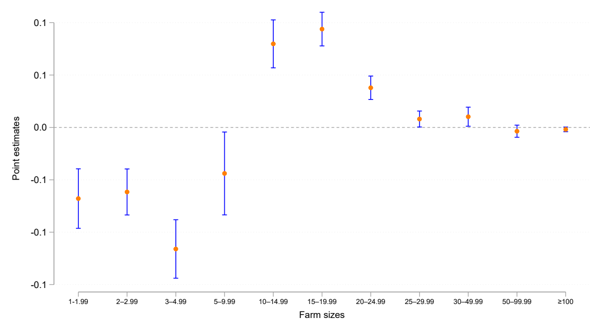
Table OA12. Prevalence of women's associations in the 1970s.

	OLS	Reduced form	2SLS
	(1)	(2)	(3)
Milking machine adoption	0.054*		
	(0.030)		
Milking machine exposure		0.253*	
		(0.142)	
Milking $\widehat{\text{machines}}$ per capita			0.064*
			(0.037)
R^2	0.18	0.17	0.18
First-stage F			72.24
Mean of dependent variable	5.15	5.15	5.15
N	217	217	217
Geography	✓	✓	✓
Population	✓	✓	✓
Agriculture	✓	✓	✓
Income	✓	✓	✓

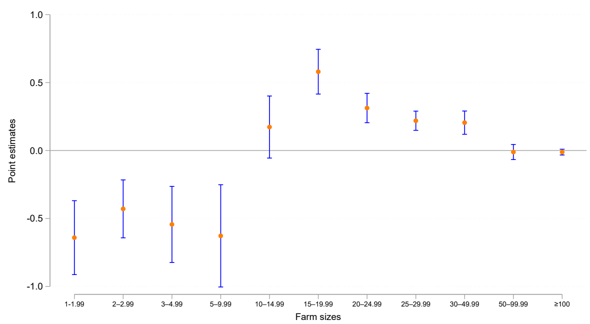
Notes: The dependent variable is the share of women's associations out of all associations in 1972. Column (1) reports OLS estimates, Column (2) reports the reduced form of IV, and Column (3) reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators, indicators for cities and market towns, and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Robust standard errors are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

D.3 Rural Economic Change

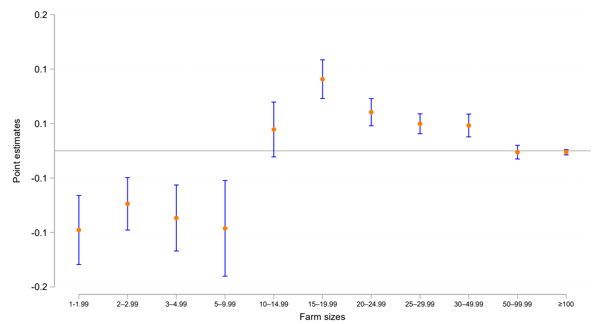
This appendix presents the two exhibits referenced in Section 5.3. Figure OA7 shows estimated effects of milking machine adoption on the share of farms in each size bracket between 1930 and 1970, using our three main specifications. Table OA13 reports estimates for three measures of rural economic change: the share of population living in agricultural households, the share employed in agriculture, and the logarithm of per capita tax revenue.



(a) FE-OLS.



(b) Reduced form.



(c) FE-IV.

Figure OA7. Share of farms in each size bin.

Notes: Panel A shows the OLS estimates for the relationship between milking machine per 1930 capita and the share of farms in each size bin. Panel B plots the reduced-form estimates, and Panel C shows the corresponding 2SLS estimates. All specifications include the full set of controls. We also show 95% confidence intervals constructed using standard errors clustered at the municipality level.

Table OA13. The milking machine and rural development.

	Share of population living in agricultural households	Share of population employed in agriculture	ln(Tax revenue per capita)
	(1)	(2)	(3)
Panel A: FE-OLS			
Milking machine adoption	0.056**	0.020	0.001
	(0.023)	(0.019)	(0.003)
Within R^2	0.01	0.00	0.00
Oster's δ for $\beta = 0$	-1.40	-0.38	0.75
Panel B: Reduced form			
Milking machine exposure	-0.057	-0.204	0.038***
	(0.182)	(0.178)	(0.014)
Within R^2	0.00	0.00	0.01
Oster's δ for $\beta = 0$	0.22	0.64	4.79
Panel C: FE-IV			
Milking $\widehat{\text{machine}}$ adoption	-0.017	-0.059	0.012**
	(0.053)	(0.052)	(0.004)
First-stage F	67.55	67.55	48.58
Mean of dependent variable	58.03	31.55	6.85
N	1283	1283	614
No. of clusters	326	326	307
Geography	✓	✓	✓
Population	✓	✓	✓
Agriculture	✓	✓	✓
Income	✓	✓	✓

Notes: Dependent variables are indicated in column titles. Columns 1 and 2 uses population statistics data from 1930, 1950, 1960 and 1972; column 3 uses municipality revenue data from 1950 and 1972. Panel A reports OLS estimates, Panel B reports the reduced form of IV, and Panel C reports the 2SLS estimates using milking machine exposure as an instrument for the number of milking machines per capita. Geographic controls include region indicators and longitude and latitude. Population controls include the logarithm of total population, the share of employed population, and the share of population employed in agriculture, all measured in 1920. Agriculture controls include the number of tractors, arable land area, and the number of combine harvesters in 1930. Income controls include taxed income and taxed wealth per taxpayer in 1931. Standard errors clustered at the municipality level are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.