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ENGINES OF EMPOWERMENT: CATTLE TENDING, THE MILKING MACHINE, AND WOMEN IN POLITICS

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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 1950 and 1972. These effects operated through time savings, rural economic development, and an increase in women's employment off the farm, which together 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 mid-20th century rural Finland. This period marked the beginning of a sustained increase in female political representation. 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. 2023)—mattered for women's representation in politics.

Before the mechanization of milking started in the 1950s, milking by hand was a task in the feminine sphere 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. (2023) 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 experienced a greater degree of milking machine adoption also witnessed larger increases in political representation of women over 1950–1972.

[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. 2023), the remaining women were likely older, married, and more embedded in family farms and local community networks (see also Myrskylä 1978).

Estimating the causal effect of milking machine adoption on female representation is 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 a time-consuming task. We thus employ first-difference and instrumental variable approaches that use municipality-level panel data on historical election results and agriculture, among other information. Our main instrumental variable strategy follows Ager et al. (2023) and exploits geographic variation in historical prevalence of cattle farming stemming from a comparative advantage in animal husbandry versus crop cultivation across municipalities and time variation coming from increased availability of milking machines over time.

Our first-difference OLS estimates suggest that a one standard deviation increase in milking machine adoption is associated with an increase of around 1.2 percentage points in women's seat share. A simple back-of-the-envelope calculation, taking this estimate as the average treatment effect, hints that milking machine adoption can explain around one-tenth of the overall increase in female representation in rural Finland over 1950-1972. The IV estimates further show that, in complier municipalities, the addition of one milking machine per 1,000 residents raised the share of council seats held by women by around 0.3 percentage points—a magnitude implying that roughly one new female councilor emerged for every 16 machines introduced per 1,000 residents. We further adopt an alternative IV strategy where we augment the set of instrument with the predicted historical prevalence of farms with at least ten cows—a threshold for when there was an economic rationale for acquiring a milking machine (Sipilä 1949a)—and its interaction with the prevalence of cattle tending. This strategy gives us similar estimates as the approach of Ager et al. (2023).[2]

The gains in female representation were concentrated among the bourgeois parties, and we find no evidence that they came 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. (2023) document in Norway—we might instead expect a smaller pool of potential rural female candidates and even decreases in female representation.[3] Yet our evidence points in the opposite direction. We argue that this is because the milking machine relaxed fundamental constraints to women's political representation.

[2]We also present evidence supporting the validity of our IV strategies: the first stages are strong, and the instruments are not correlated with the pre-milking machine trend in female representation.

[3]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.

Mechanization not only freed women from the most time-consuming task on dairy farms, but also transferred this work to men, making cattle tending increasingly masculinized (Rasila 2004; Morell 2009; Kaarlenkaski 2018). This blurring of gendered work boundaries could have contributed to an expansion of women's political inclusion. First, it aligns with Boserup's classic insight that agricultural technologies shape gender roles by determining who performs which tasks in production (Boserup 1970). These have lasting consequences for women's social and economic position (Alesina et al. 2013). Second, these changes occurred against the backdrop of rural economic development, which may have amplified cultural change in favor of female political empowerment (e.g., Inglehart and Norris 2003, p. 159).

Building on these insights, we examine how mechanization reshaped women's political representation through changes in time use, the rural economy, and local gender norms. We show that the milking machine contributed to farm consolidation, reduced reliance on agriculture, and expanded women's off-farm work. By reducing household labor demands and enabling women to take up paid work off the farm, mechanization plausibly increased their economic independence, public visibility, and engagement in civic organizations. Consistent with this, we find suggestive evidence of a higher density of women's associations in municipalities with greater milking machine adoption. These are factors known to strengthen both the supply of female candidates and the incentives for parties to nominate and voters to elect them (Matland 1998; Iversen and Rosenbluth 2008, 2010). We also document that the effects of the milking machine were particularly pronounced in municipalities where female political presence had previously been weak, hinting that mechanization helped shift local gender norms where they were not yet as permissive.

We conclude by studying two further aspects of the link between mechanization and women's political representation. We find suggestive evidence that greater milking machine adoption translated into modest increases in education and social care expenditures. Moreover, there is indication that the political gains persisted for decades.

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, 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. (2023) 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.[4] 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 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).[5]

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.

[4] 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).

[5] 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 down forest areas to make the soil richer and more fruitful for farming purposes. In contrast, other parts of the country heavily relied on the manure that cows produced. More advanced and productive techniques replaced burn-beating in eastern Finland in the 20th century, but the region still concentrated on cultivation. The western and southern parts of the country have had better pasture lands than the eastern parts. Therefore, these areas have been particularly suitable for cattle tending.

We are primarily interested in the twenty-year period starting from 1950. These two decades are characterized by rapid adaptation of new farming technology, especially milking machines (Kaarlenkaski 2018, p. 83). 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 (Statistics Finland 1930–1969). 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 disrupted the dairy production process. This is 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). 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.[6]

[6] 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).

In sum, the time-saving aspect meant that even if women continued to work with cattle, they had more time, since their labor was substituted by the machine. 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 and rural communities more broadly. 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 guaranteed for 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 Panel A of Figure 2 which shows the share of female candidates and elected representatives, and women's vote share in the entire country. Our main focus is on the change between 1950 and 1972, the time period that marks the onset of a stable growth 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 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. 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 setting.

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 a sample of 327 municipalities in our main analyses.

[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.

Local council composition Our main outcome variable comes from data on the composition of elected councils from two local elections: one in 1950, and another in 1972. These data were composed by Statistics Finland, and 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]

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 changes in the seat share obtained by women between 1950 and 1972 in Figure 2. We show the changes separately for elected women in all parties (Panel B), bourgeois parties (Panel C), and socialist parties (Panel D). 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.

The official election statistics do not report female representation in local councils before the year 1950, when the large-scale adoption of milking machines began. We thus supplement our data with reports on women in local politics collected 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]

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

In our main regressions, we use historical prevalence of cattle tending as an instrument for the milking machine adoption. We measure this as cows per capita in 1930, constructed using the 1930 Agricultural Census.

[8] Both groups include also miscellaneous small parties, and there are groups that do not fall in either category. We do not examine these non-socialist and non-bourgeois parties separately in this paper, as these groups tend to be very small and they are not even present in all municipalities.

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

[10] We scale the difference by the 1950 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.

In Figure 3, we illustrate the rich geographic variation in milking machine adoption between 1950 and 1969 and cows per capita in 1930. 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).

Comparing these maps with those in Figure 2, we see that the share of female representatives from non-socialist parties grew more in dairy-intensive areas. In general, dairy-intensive areas appear to have experienced greater growth in women's representation, providing descriptive support to our hypothesis.

Covariates In our regression analyses, we control for various background characteristics of the municipalities. First, we use data on population size, the share of economically active population, and population employed in agriculture in the year 1920, reported in Statistics Finland's publication *Population by Industry and Commune, 1880-1975.* Second, 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). Third, we use information on the number of tractors and combine harvesters, and arable land area from the 1930 Agricultural Census.

3.2 Identification Strategy

FD specification We are interested in the effect of milking machine adoption on women's share of seats in municipal councils. Our starting point is the following first-difference (FD) specification:

$$Y_m = \alpha \textit{Milking machine adoption}_m + X_m' \gamma + \varepsilon_m. \tag{1}$$

The outcome of interest, Y_m, is the change (in percentage points) in women's seat share between 1950 and 1972 in municipality m. $\textit{Milking machine adoption}_m$ is the change in

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

milking machines between 1950 and 1969 per 1950 capita. α captures the relationship between milking machine adoption and the change in the share of women in local councils. X_m is a vector of control variables, and ε_m is the error term. We estimate (1) using OLS.

Since milking machines were virtually nonexistent in and before the 1950s and widespread by the 1970s, the relevant variation occurs in that interval. A first-difference estimator between 1950 and 1972 captures the full effect of treatment over the years in which milking machines diffused across municipalities. With two time periods, the FD specification is effectively the same as a fixed effects regression with municipality and time fixed effects. That is to say, we net out all time-invariant, municipality-specific factors that may correlate with the outcome and the degree of milking machine adoption and all country-wide shocks that affect all municipalities uniformly.[12]

This specification is akin to a difference-in-differences approach with a continuous treatment, where the identifying assumption is that the outcomes would have followed the same trends in absence of milking machine adoption. To account for potential heterogeneous trends correlated with both milking machine adoption and changes in women's representation, we also 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). When there are only two periods of data, this is numerically identical to controlling for municipality and year fixed effects and covariates interacted with a year indicator. We explore robustness to different sets of controls and selecting the covariates using LASSO.

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 some error. The 1950 Agricultural Census covered all farms with at least two hectares of land, and information for smaller

[12] The first-difference specification is also more convenient in our IV analysis which we introduce below. However, in a robustness check, we show that a fixed-effects specification using all three years of data (1929, 1950, and 1972), which further allows clustering the standard errors at the municipality level, yields the same conclusions in terms of effect magnitude and statistical significance.

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.

FD-IV approach To mitigate these concerns, we employ an instrumental variable (IV) approach. In our baseline approach, we instrument milking machine adoption between 1950 and 1969 with cows per capita in 1930. Besides the time variation in milking machine availability, our identification exploits cross-sectional geographic variation in initial exposure to cattle farming, which 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.[13]

This IV strategy follows that of Ager et al. (2023), who construct a shift-share instrument to study the impact of milking machines on young milkmaids in Norway. However, unlike Ager et al. (2023), we do not multiply the share (cows per capita in 1930, our main instrument) with a shift (country-wide milking machine adoption per capita). With only two time periods, interacting the share with the shift would merely rescale the first-stage and reduced-form coefficients by the same constant and leave the 2SLS estimates unaffected. In a robustness test, however, we show that the results remain qualitatively unchanged if we instead use data from three elections and the shift-share variant instrument.

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

$$\textit{Milking machine adoption}_m = \beta_{FS} \textit{Cows per capita } (1930)_m + X_m' \theta + \eta_m. \tag{2}$$

Here, β_{FS} is the effect of the instrument on the explanatory variable, change in milking machines per capita at the municipality level. *Cows per capita* $(1930)_m$ is the number of cows per capita in a municipality, m, in 1930. X_m is a vector of municipality-level controls, and η_m is the error term.

[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.

The second stage of our 2SLS estimation is then

$$Y_m = \beta_{2SLS} \widehat{\textit{Milking machine adoption}}_m + X_m'\vartheta + \nu_m, \quad (3)$$

where $\widehat{\textit{Milking machine adoption}}_m$ are the fitted values from the first-stage regression in equation (2). β_{2SLS} is the coefficient of interest and identifies the causal effect of milking machine adoption on female political representation if two conditions hold. The first one is relevance, which is empirically testable. Panel A of Figure 4 visualizes the first stage using a full set of control variables. Our instrument is predictive of the explanatory variable, change in milking machines per capita at the municipality level. Thus, we can conclude that the relevance condition is met. Furthermore, the F-statistic associated with the first stage exceeds the rule-of-thumb value of 10 for weak instruments. In Online Appendix Table OA1, we show that the first-stage relationship is robust across different sets of control variables.

The second identifying assumption is that pre-existing cow intensity in 1930 affects later female political representation only through its effect on milking machine adoption. Formally, this exclusion restriction requires that, conditional on controls X_m, the instrument is uncorrelated with unobserved determinants of female political representation:

$$\mathbb{E}[\nu_m \mid \textit{Cows per capita } (1930)_m, X_m] = \mathbb{E}[\nu_m \mid X_m].$$

The controls absorb much of the cross-sectional heterogeneity that could confound the relationship between initial cow intensity and later female representation. While the exclusion restriction is ultimately untestable, it would require that historical cow intensity independently predicts women's seat share several decades later through channels unrelated to mechanization, after accounting for observed pre-treatment differences.

To probe the validity of our exclusion restriction, we conduct a placebo analysis examining the relationship between 1930 cow intensity and changes in women's seat share during the pre-mechanization period (1929–1950). If historical cow intensity proxy unobserved factors that independently influence female political representation, we would expect to observe a relationship already before the widespread adoption of milking machines. We find no such relationship: cow intensity in 1930 does not predict changes in female representation in the pre-treatment period. The relationship in Panel B of Figure 4 is virtually flat. We also estimate the effect of milking machine adoption on the change in women's seat share 1930-1950 using 2SLS and find no statistically significant effect (see column 1 of Online Appendix Table OA2). This strengthens the case that our instrument affects female political representation primarily through its effect on milking machine adoption.

Online Appendix Table OA2 further reports estimation results for our other outcome variables for which we have data before milking machine adoption. We do not find any effects on the change in bourgeois parties' seat share, or socialist parties' seat share. However, there is a marginally significant positive effect on the 1929–1950 trend in bourgeois women's seat share, and socialist women's seat share indicates a negative pre-trend. We thus perform robustness checks in which we control for the 1929–1950 trend in each outcome of interest and, reassuringly, find that this does not alter our results.

Alternative IV approach We also extend our IV strategy by augmenting the model with the predicted number of farms per capita with at least ten cows in 1930—a proxy for the (early) economic feasibility of mechanization following the calculations of (Sipilä 1949b)—and its interaction with cattle intensity. This allows us to isolate exogenous variation in adoption where the returns to milking machines were highest.

In column (1) of Online Appendix Table OA3, we show that the interaction between the historical prevalence of cattle tending and sufficiently large farms is strongly predictive of milking machine adoption. The first-stage F-statistic is around 15. Column (2) shows that the 2SLS estimate using the pre-milking machine adoption change in women's seat share as the outcome is close to zero and statistically insignificant. Furthermore, having more than one instrument for one endogenous variable allows us to perform an overidentification test (Hansen's J-test). The resulting p-value is 0.17 for our main outcome. These observations support the validity of our alternative IV approach.

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 some indication of a positive effect of the milking machine on bourgeois parties' representation in local councils.

4.1 Effects on Women's Representation

FD estimates Panel A of Table 1 illustrates the relationship between milking machine adoption during 1950-1969 and the change in women's political representation in local councils between the years 1950 and 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 covariates for geography, population, agriculture, and income. Conditional on these control variables, we see that having an additional milking machine per 1,000 citizens is associated with a 0.07 percentage point increase in women's seat share in the local council. ($p < 0.10$). A simple back-of-the-envelope calculation using this estimate suggests that about one-tenth of the growth in female representation in rural Finland over 1950-1972 can be attributed to the milking machine.

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 δ is larger than 1 which indicates that the selection on unobservables would have to be large in order for omitted variables to explain the estimated effects.[14] However, the concern about reverse causality discussed above remains.

Reduced-form estimates In Panel B, we move on to the reduced form of 2SLS, using cows per capita as an instrument for milking machine adoption during the period when the new technology started to become more common.[15] We see that there is a strong positive relationship between the historical intensity of cattle tending and the change in 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.

We further compute Oster's δ for the reduced-form specification. We again find that the resulting δs are systematically larger than one.

FD-IV estimates Panel C then presents the 2SLS estimates using the historical prevalence of cattle as an instrumental variable for milking machine adoption. Let us again focus on our preferred specification in column (5). The IV estimate is about four times the size of the OLS estimate and statistically significant at the 5% level. The estimated coefficient implies

[14] 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).

[15] 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 distributions are systematically centered around zero, and estimates as extreme as ours are unlikely to occur by chance.

that increasing the number of milking machines by one per 1,000 citizens raises women's seat share by approximately 0.29 percentage points.

Column (3) of Online Appendix Table OA3 presents results using our alternative IV strategy described above. The 2SLS estimate is around 0.23, which is in line with the results presented here.

To contextualize the magnitude of this estimated effect of milking machine adoption, consider a municipality with the median council size of 21 seats. A 0.29 percentage point increase in female representation corresponds to roughly one additional woman on the council for every 16 milking machines per 1,000 residents. Furthermore, a one standard deviation increase in milking machine adoption leads to an around 5.2 percentage point increase in women's seat share in local councils. Given that the mean increase in women's seat share is 8.08 percentage points in our data, this corresponds to a more than 60% effect relative to the mean. The 2SLS estimate suggests that as much as half of the increase in women's seat share could be attributed to the exogenously induced adoption of the milking machine. Our alternative IV strategies point to somewhat smaller, but still sizable, aggregate effects. Although one should take these numbers with a grain of salt for reasons we discuss below, our results indicate that milking machine diffusion had a meaningful impact on women's political representation at the local level.

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, which may differ from the ATE—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 expanding the data beyond rural municipalities and including cities and market towns (column 1) where agriculture was practiced to a lesser extent than in rural parts of Finland.

Second, the results are robust to including the set of municipalities that were partially ceded to the Soviet Union after World War II (column 2). Third, we continue to observe a positive effect of the milking machine on women's representation if we omit municipalities that went through municipal mergers during our sample period and thus require aggregating the data (column 3). Note, however, that this sample is more limited in size, the effects are less precisely estimated, and the first stage is weak with an F-statistic equal to 6.07. Third, in column (4), we include a control for the 1930-1950 trend in female representation. The results are robust to this alternative specification. Fourth, we use LASSO to select the control variables in column (5). For the 2SLS, these control variables are selected as the union of the LASSO covariates included in the first stage and the reduced form. The estimates are unaffected by choosing the controls with LASSO.

Finally, in columns (6) and (7) we treat our data as a panel and estimate a fixed effects specification with municipality and time fixed effects, using all three years of data (1929, 1950, and 1972). Besides municipality and year fixed effects, we include our full set of baseline controls interacted by the year indicators. In column (6), we use cows per capita in 1930 interacted with indicators for the years 1950 and 1972 as the instruments. The estimates remain similar to those obtained from the FD specification. This is to be expected—as the reduced-form results in Panel B suggest, the estimates are primarily driven by the changes that occurred between 1950 and 1972. Online Appendix Figure OA3 similarly shows that this time period is the key in the first stage. Furthermore, the level of statistical significance is also barely affected by the clustering of the standard errors. In column (7), we follow the shift-share IV approach of Ager et al. (2023) and interact cows per capita in 1930 (the share) with the nation-wide milking machine adoption per capita (the shift). Whether we use the plain share instrument or the shift-share instrument makes little difference in terms of estimation results.

In Online Appendix Table OA4, we report regression results using alternative scalings of our treatment. In our main analyses, we measure population-level exposure to the milking machine with the change in the number of milking machines between 1950 and 1969 divided by the 1950 population. One concern is that the instrument could affect population trends even before 1950. In column (1), we scale the exposure metric and the instrument by the 1930 population. The results are similar to the main estimates. As further robustness checks, in columns (2) and (3), we use the number of farms and the number of people living in agricultural households as the denominator. The scaling does matter for the magnitude of the estimates, but the interpretation remains qualitatively unchanged.

Our baseline IV strategy assumes that historical cattle intensity affects women's political representation only through milking machine adoption. If the historical cattle density in

1930 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 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-fifth of the reduced-form effect. Online Appendix Figure OA5 shows the estimated bounds for different degrees of exclusion restriction violation.

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 change in bourgeois and socialist women's seat share between the years 1950 and 1972 as dependent variables.

The estimates are positive in the FD specification (Panel A), reduced form (Panel B), and 2SLS (Panel C) for both party families. However, they are notably larger and stronger in terms of statistical significance for bourgeois women (column 1). To put the 2SLS estimates into perspective, a one standard deviation increase in milking machine adoption leads to an increase in bourgeois women's representation equivalent to three-fourths of the mean. The 2SLS estimate is significant at the 5% level.

The 2SLS for socialist women in column (2) point to a smaller effect size, although the estimate is not statistically significantly different from that for bourgeois women in column (1). A one standard deviation increase in milking machine adoption leads to a slightly less than half of the mean increase in socialist women's representation. However, this estimate is imprecise.

Online Appendix Table OA5 shows that the results for bourgeois women's 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.[16] We present the same robustness tests for socialist women in Online Appendix Tables OA6 and OA10. Moreover, columns (4)-(9) in Online Appendix Table OA4 show estimation results using alternative scalings of our instrument and the endogenous variable, and columns (3) and (4) of Online Appendix Table OA3 document robustness to an alternative IV approach.

[16] 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 change in bourgeois women's seat share.

4.3 Effects on Parties' Seat Shares

We next examine whether milking machine adoption influenced the overall electoral strength of bourgeois and socialist parties. Columns (3) and (4) of Table 3 present these estimates. The results show a partisan asymmetry: bourgeois parties experienced substantial gains in seat share, while socialist parties lost ground.

Online Appendix Table OA7 shows that the results for bourgeois parties' seat share remain robust across different sets of control variables, and Online Appendix Table OA11 shows that the results are also robust to different samples or specifications.[17] We present the same robustness tests for socialist parties in Online Appendix Tables OA8 and OA12. Lastly, columns (10)-(15) in Online Appendix Table OA4 show estimation results using alternative scalings of our instrument and the endogenous variable, and columns (5) and (6) of Online Appendix Table OA3 illustrate robustness to an alternative IV approach.

These partisan effects shed light on where the gains in bourgeois women's representation come from. 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.

4.4 Availability of Female Candidates

The availability of female candidates—which requires women who are willing to run and parties that are willing to nominate them as candidates—is an important precondition for more women getting elected. While there are no systematic historical data on the candidates in local elections, let us exemplify this point with observations from two municipalities: Kemijärvi and Pulkkila.

Kemijärvi was not a cattle-farming municipality; neither did it experience a large degree of milking machine adoption or increase in female representation. In the 1956 municipal election, the Agrarian League (later the Center Party) fielded only one female candidate (out of 52 candidates in total). The representation of female candidates did increase by

[17] 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.

the 1972 election, with nine out of 62 candidates (about 15%) being women. However, the increase was not large compared with Pulkkila, a historically cattle-intensive location where milking machines were adopted to a greater extent between 1950 and 1969. In Pulkkila, the Agrarian League fielded two female candidates (out of 28 candidates in total) in 1956. In 1972, one third of the Center Party candidates were women (ten out of thirty)—a vast majority of them being farmers or farmers' wives.[18]

5 Mechanisms

In this section, we document three plausible factors behind the positive effects on female representation. First, 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 market and civic activity. Given that the country was predominantly agricultural and many women were also employed in agriculture, this change concerned a large share of the female population in more cattle farming intensive municipalities.

Second, these time savings coincided with broader rural economic transformation—farm consolidation, a move out of agriculture, and rising wage employment. This likely contributed to increasing women's earnings, visibility, and organizational participation, which can be important in fostering their political representation (Matland 1998; Iversen and Rosenbluth 2008, 2010). Third, the gains in representation were concentrated in municipalities with little prior female presence. This observation is consistent with the shock relaxing restrictive gender norms (Giuliano and Nunn 2021; Alesina et al. 2013; Fernández 2011), possibly through changing women's role in rural Finland—also beyond women involved in agriculture.

Both supply- and demand-side mechanisms may underlie these effects. On the supply side, milking machine adoption reduced time constraints—particularly for women in rural farming households—and plausibly had its largest impact among bourgeois-party women, who often came from farming households and whose prior representation lagged that of socialists. On the demand side, voters—who hold key power over who gets elected in open-list systems (Jokela et al. 2025)—may have become more receptive to women in office as part of a broader modernization process, and local party branches—which serve as gate-keepers deciding which candidates are presented to voters—may have strategically

[18] What is more, women's seat share increased by 17 percentage points between 1950 and 1972 in Pulkkila; in 1972, four women held positions in the 17-seat local council. In Kemijärvi, women's seat share remained unchanged, with only two women holding positions in the 31-seat local council in 1972.

responded to changing social and economic conditions and voter preferences by promoting female candidates.[19] In what follows, we examine each link in this causal chain in turn.

5.1 Time Gains and Women's Shift to Off-Farm Work

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. We use these data to measure the female share of farm and non-farm labor supply. In Table 4, 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).

While the time liberated from farm work could have bolstered agricultural women's political participation, Iversen and Rosenbluth (2008, 2010) argue that such time savings matter particularly when they propel women into jobs that improve earnings, autonomy, and public visibility.[20] Columns (3) and (4) of Table 4 analyze the share of labor supplied by farmer women and their female household members outside of the farm. The estimates for farmer women are positive but small in magnitude and statistically insignificant, but the IV estimate for other female household members is large and significant at the 10% level. We conjecture that due to the milking machine, female members of farming households were able to supply more work outside of the farm.[21] This mirrors evidence that labor-saving household appliances in post-war America freed women for market work (e.g., Greenwood et al. 2005).

5.2 Rural Economic Change

Next, we show that milking machine adoption was accompanied by changes in the rural economy consistent with rising incomes and structural transformation. Classical

[19]Having said that, we do not find statistically significant effects on female turnout (see Online Appendix D.2).

[20]Female labor based in subsistence agriculture raises neither civic skills nor campaign resources; indeed, countries where large proportions of women work in the fields record no link between labor-force participation and seats held by women (Matland 1998).

[21]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. (2023).

modernization perspectives suggest that such changes can open new political opportunities for underrepresented groups. Furthermore, from the scope of conventional theories of economic voting, rural communities becoming richer helps to understand why bourgeois parties (instead of socialist parties) overall benefited from the milking machine.

Structural change and gendered reallocation of employment In columns (1) and (2) of Table 5, we ask how the share of population employed in agriculture and the share of population living in agricultural households evolved between 1950 and 1970. The IV estimates are large, negative, and statistically significant, indicating that the introduction of the milking machine radically changed the agricultural composition of municipalities and contributed to structural change at the municipal level.[22]

We also examine the differences in sectoral composition of work by gender in rural municipalities using aggregate data from the 1950 and 1970 population censuses. Figure 5 indicates that agriculture dominated rural employment in 1950 but had contracted sharply—especially work performed by female members of farming households—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.

These patterns reflect a shift away from agricultural production toward wage employment in non-agricultural sectors. While we are not able to directly contribute these aggregates to a milking-machine effect, it is plausible that women leaving dairy farming in response to mechanization (Table 4) followed a similar pattern.

Farm consolidation Figure 6 reports coefficient estimates from our three specifications, using as outcomes the change in the share of farms within each size bracket (the format in which the agricultural census data are reported) between 1950 and 1970. The estimates exhibit an S-shape, providing evidence that milking machine adoption led to an increase in farm sizes. 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 over 1950–1970. Coefficients for the 15–19.99, 20–24.99, and 30–49.99 hectare categories

[22] We scale all outcomes by the baseline (1950) population or number of farms to avoid introducing post-treatment variation in the denominator. This choice ensures that estimated effects reflect changes in the numerator rather than mechanically combining these with treatment-induced changes in population or farm counts.

are significant at the 5% level. This may reflect farm consolidation, likely 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.[23]

Expansion of local fiscal capacity We also observe that municipalities with greater milking machine adoption experienced larger increases in local fiscal capacity, as measured by per capita tax revenue (column 3 of Table 5), primarily derived from labor income taxes. We interpret this as an indicator of the expanding capacity of the local state to raise and allocate resources. This rise in revenues likely reflects two distinct forces. First, economic growth and rising incomes—consistent with our evidence on farm consolidation (Figure 6)—expanded the resources available for taxation. This same rise in prosperity helps explain why bourgeois parties in particular benefited from the technological change. Second, structural change broadened the pool of taxable wage employment by moving more people into jobs that are easier to tax (Jensen 2022).

Importantly, if women disproportionately gained off-farm work in response to the mechanization of milking, some of the observed increase in fiscal capacity must reflect the expansion of the female tax base. 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. In this sense, rising fiscal capacity did not merely accompany structural transformation—it provided the material conditions for women's economic participation to translate into political influence.

5.3 Prevalence of Women's Associations

The decline in women's agricultural family labor freed time for civic participation, while the shift into non-agricultural work may also have increased incentives to engage in public life. Iversen and Rosenbluth (2008, 2010) point out that a "missing middle" between employment and political representation of women are organizations that channel resources into candidate pipelines and signal an electorate worth courting.

In Table 6, we study women's associational activity using data collected from the Finnish Patent and Registration Office.[24] We focus on associations that existed by 1972

[23]Income gains and poverty reduction often disproportionately benefit women, although political representation tends to lag behind other dimensions of gender equality (Duflo 2012).

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

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 (per capita in 1972) and the prevalence of women's associations.[25]

5.4 Change in Local Norms

The socioeconomic changes we have documented thus far could have altered not just the time and other resources women have or their own interest to participate in politics, but also more general expectations about women's place in public life. That is to say, mechanization may also have operated as a social shock that reshaped norms around female leadership from below. Cultural norms are typically stable but can change permanently in response to major shocks (Giuliano and Nunn 2021)—and as the findings in the previous section and in Ager et al. (2023) show, the milking machine was indeed a major shock to rural communities.

The result that the milking machine did bolster female representation already speaks in favor of this hypothesis. Historical accounts of the milking machine further support the idea that the milking machine transformed what was considered women and men's work and productive labor. For example, Kaarlenkaski (2018) quotes one interviewee in a qualitative study from the year 1969 who said: "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 [...]." As such, the milking machine represents a rare instance in which a technology that displaced women's labor ultimately benefited them. Men directly assumed the role previously performed by women, thereby blurring gendered divisions of labor and potentially creating spillovers to other dimensions of gender equality.

To further explore the possibility that the novel technology helped relax the norm constraint, we examine whether the effect of milking machine adoption depends on pre-existing levels of female political inclusion. In municipalities where women already held political office in 1950, gender norms were arguably more permissive and thus, effects should be stronger in municipalities that had lower levels of female political representation.

In Table 7, we estimate heterogeneous effects by baseline female representation in the reduced form. In column (1), we use a continuous measure for women's seat share in 1950,

[25] Köppä (1982) reports on a survey about agricultural men and women's participation in different kinds of organizations in the early 1980s. Supporting our argument, he finds that women in cattle farms tend to participate more in organizational activities (including party organizations) than women in other types of farms. Furthermore, he documents that participation increases with the degree of mechanization. In the same survey, women who state they are not able to participate in organizational activities most commonly say that this is because of time-consuming cattle tending.

and in column (2), we construct an indicator that takes on the value one if there was at least one woman in the local council in 1950 and zero otherwise.[26] We see that the positive effects are driven by municipalities with lower female representation in 1950 (or none at all). Women's seat share increased less during 1950-1972 in municipalities where there were more women in the local council to begin with, and the interaction between our instrument and women's seat share in 1950 is negatively correlated with the change in women's seat share between 1950 and 1972. This supports our argument that the adoption of the milking machine indeed contributed to a change in local norms.

6 Discussion

In this section, we discuss two additional aspects related to the milking machine and the increase in female representation over the years 1950 and 1972. First, did these changes translate into policy effects? Second, did they translate into more persistent effects on female representation?

6.1 Consequences for Policy

The finding that labor-saving technological change contributed to increased female political representation is important in its own right, as it speaks to the determinants of political inequality. Moreover, descriptive representation matters not only as a measure of inclusion, but also because it translates into substantive representation and policy responsiveness (see Hessami and da Fonseca 2020 for a review of this literature). The mechanisms proposed in this literature range from gender differences in policy preferences to the introduction of new perspectives and priorities when women enter political office. In the Finnish context, where local councils hold considerable autonomy over service provision, increases in female representation may have contributed to measurable changes in spending patterns.[27]

We find suggestive evidence that there were downstream effects on the allocation of municipal resources. We illustrate the reduced-form relationship between the prevalence of cattle farming and changes in different spending outcomes in Figure 7. These patterns suggest a positive relationship between per capita spending growth on education and social

[26] To aid interpreting the continuous-by-continuous interactions in column (1) of Table 7, Online Appendix Figure OA6 shows the predicted outcome variables (predicted at the means of the covariates) for different values of the instrument and women's seat share in 1950.

[27] Further work has documented in the context of present-day Finnish local councils that the characteristics of politicians have an impact on policy outcomes (Hyytinen et al. 2018; Meriläinen 2022).

care and welfare. The reduced-form relationship is marginally significant for these outcomes. For the change in per capita healthcare expenditures, the relationship is virtually flat.[28]

6.2 Persistence

Our analysis highlights that the adoption of milking machines played an important role in shaping female political representation during the period of mechanization in the 1950s to 1970s. Furthermore, even in more recent years, we observe significant variation in female representation across the country. These remarks raise the question of whether the early changes had lasting consequences for women's representation in local politics.

To shed light on this possibility, we examine municipal-level data on female representation in local councils following the 2000 municipal election.[29] The effects of milking machine adoption on women's political representation appear to persist over the long run. We find that municipalities that saw greater increases in female representation over the years 1950 and 1979 and municipalities with greater exposure to mechanization during the 1950s and 1960s exhibit systematically higher levels of female representation in local politics even after the 2000 local elections (see Figure 8). In Online Appendix Table OA15 we further show suggestive evidence that in these municipalities, parties also field more female candidates and voters show greater voter support for female candidates, on average.

These long-run patterns are consistent with the idea that the milking machine not only altered women's roles in the short run but also contributed to more durable social and cultural changes, including changes in local gender norms.

To explore whether the long-term changes in political representation associated with milking machine adoption also shaped how citizens' attitudes towards political inclusion, local leadership and governance, we turn to survey data from the 1996 (Borg 2000). We focus on a set of ten questions that tap into core dimensions of democratic life: citizens' perceived ability to influence municipal politics, their understanding of local decision-making, their trust in politicians, and their views on party responsiveness and accountability.

In Online Appendix Figure OA8, we document that respondents from historically more mechanized municipalities express higher agreement with statements reflecting political voice and responsiveness, and lower agreement with statements indicating alienation or disillusionment. Specifically, we find statistically significant positive effects on agreement with the statements that "everybody who wants to can have a say in the affairs of one's

[28] For detailed estimation results, see Online Appendix Table OA14.

[29] These data are obtained from the Finnish Ministry of Justice. The data are at the candidate level and contain information on candidates sex, election status, and the number of votes they obtained. We aggregate these variables to the municipality level to obtain measures of the share of female candidates, women's vote share, and the seat share acquired by female candidates.

home municipality," "I understand important questions in municipal politics rather well," and that "there is at least one party which tries to promote my interests in municipal politics." Conversely, agreement with the more cynical claims that "I have no say in what the municipal council decides" and "parties are only interested in people's votes, not in their opinions" is lower.

7 Concluding Remarks

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 a first-difference approach and further exploiting cross-municipality differences in pre-mechanization with cattle intensity as an instrument, we find that milking machine adoption between 1950 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 $0.07 - 0.29$ percentage points. Simple back-of-the-envelope calculations suggest that the milking machine explains more than one-tenth of the seat gains of women in rural Finland. These gains were concentrated among bourgeois women and accompanied by an overall expansion in bourgeois parties' seat shares, indicating that the technology reshaped both gender and partisan representation in local councils.

The evidence points to a combination of supply- and demand-side mechanisms. Mechanization freed rural women from the most time-consuming farm task while reallocating part of it to men, altering gender roles in agriculture. At the same time, it contributed to rural economic growth and structural transformation, including farm consolidation, a decline in agricultural employment, and an expansion of wage work—particularly for women. These changes likely boosted both the supply of female candidates and the incentives for parties to nominate and for voters to elect them. The largest gains occurred in municipalities with little prior female political presence, suggesting that the technology helped relax social constraints on women's political leadership.

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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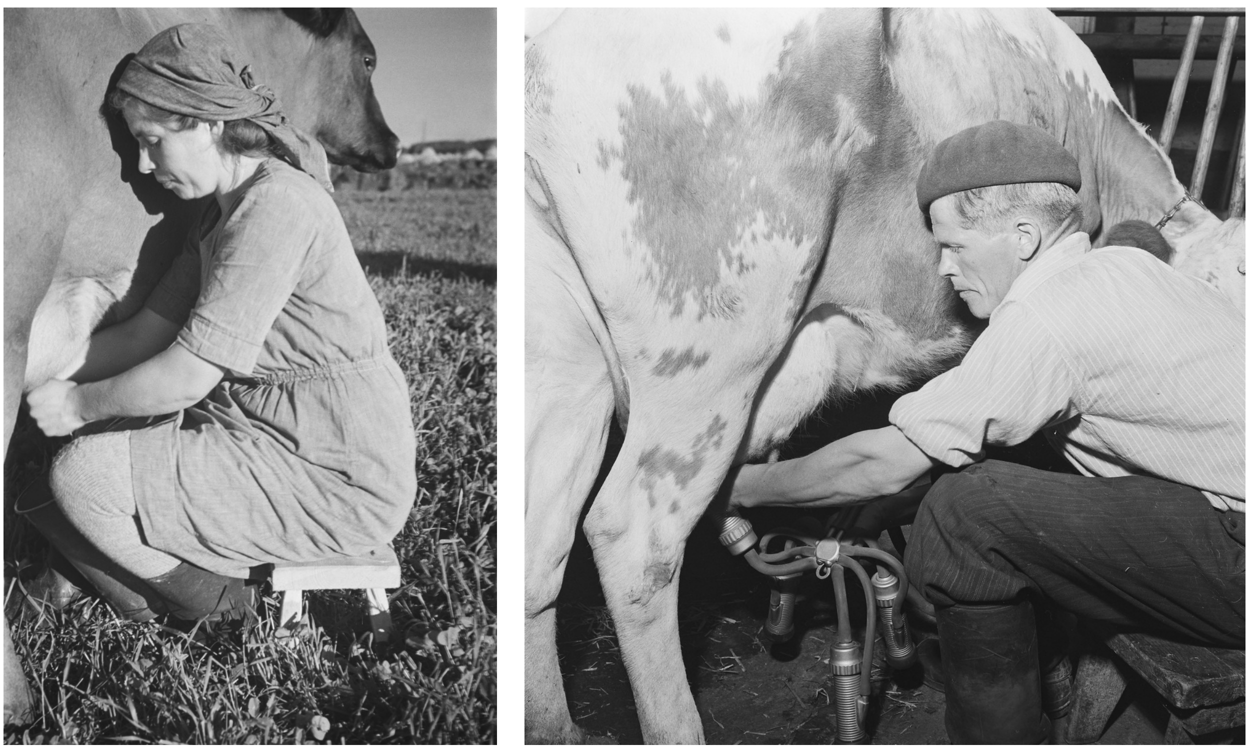
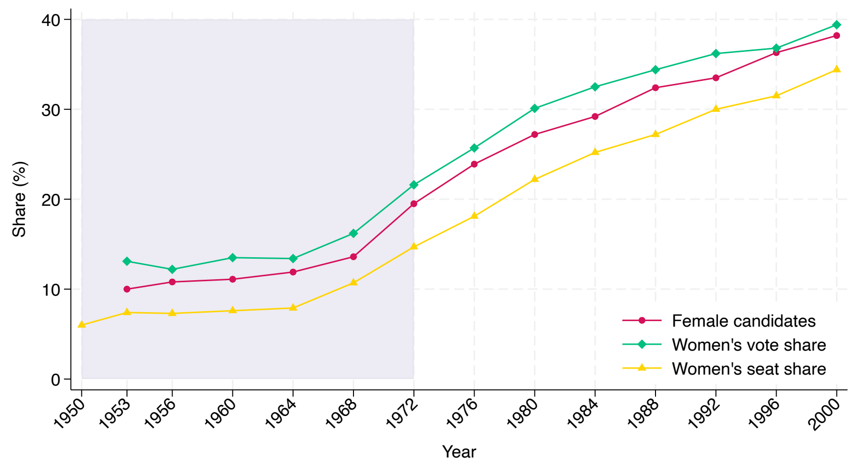
Figures and Tables



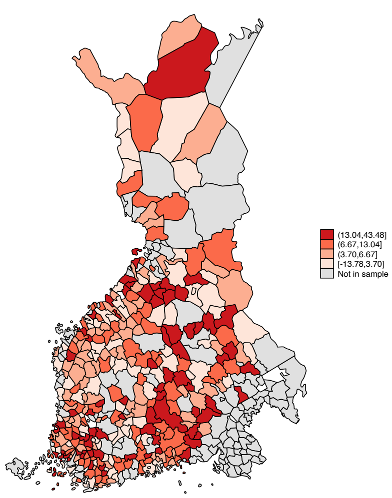
(a) A woman milking a cow by hand. **(b)** A man milking a cow with a machine.

Figure 1. Depictions of hand and machine milking.

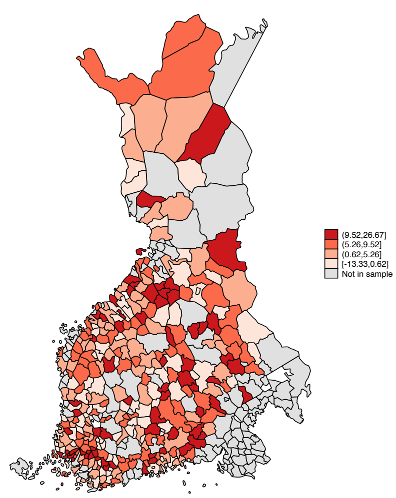
Source: Museovirasto, photos taken by Matti Poutvaara (Panel A) and Pekka Kyytinen (Panel B).



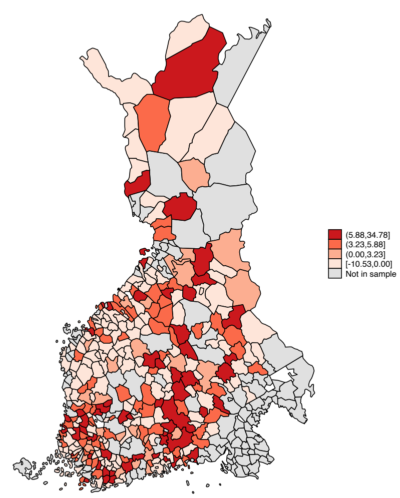
(a) Evolution of female representation nationwide, 1950-2000.



(b) Change in women's representation (1950-1972).



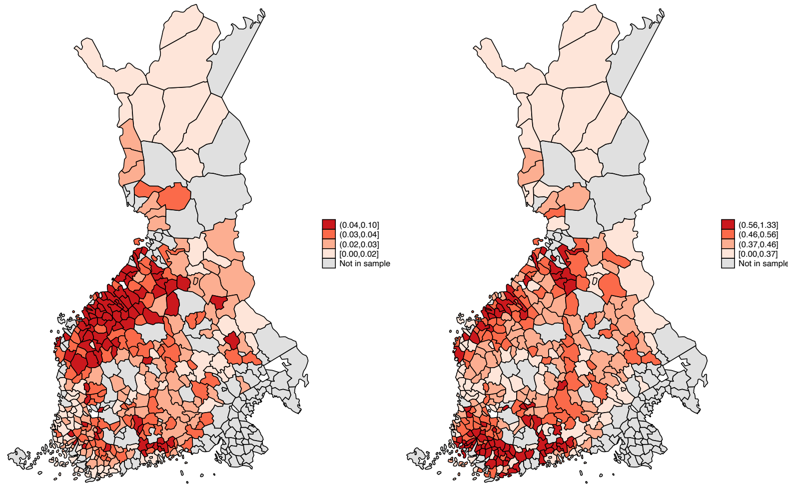
(c) Change in bourgeois women's representation (1950-1972).



(d) Change in socialist women's representation (1950-1972).

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

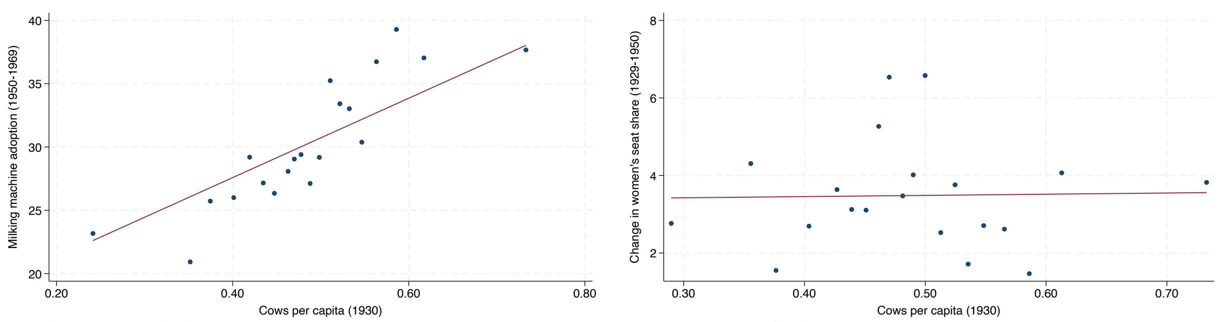
Notes: Panel A shows the evolution of female representation in local councils nationwide from 1950 to 2000. The maps in Panels B, C, and D plot the geographic distribution of the change in women's seat share in municipality councils between the years 1950 and 1972, following the pre-1930 municipality 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.



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

Figure 3. Milking machine adoption and historical cattle tending.

Notes: Panels A and B 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 the pre-1930 municipality boundaries. For maps including cities, market towns, and partly ceded municipalities, see Online Appendix Figure OA2.



(a) Historical prevalence of cattle tending and milking machine adoption in 1950–1969.

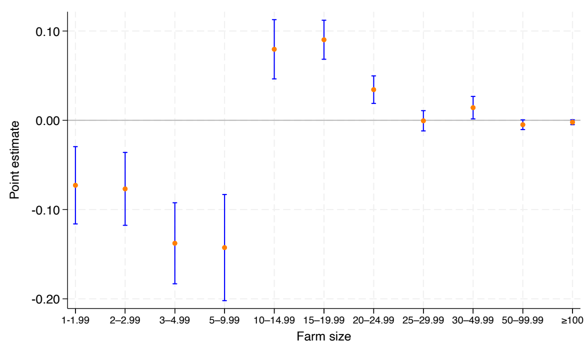
(b) Historical prevalence of cattle tending and trend in female representation in 1929–1950.

Figure 4. Graphical illustration of instrument validity.

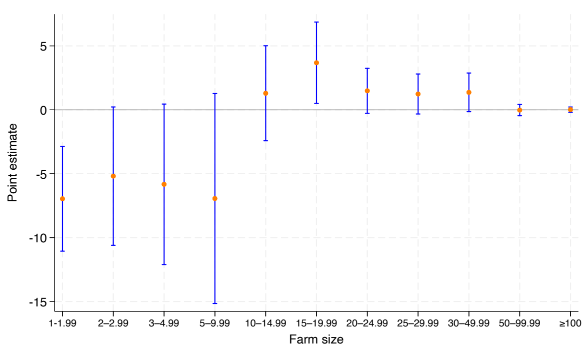
Notes: The figures illustrate the first-stage relationship between cows per capita in 1930 and the change in the number of milking machines per capita between 1950 and 1969 (Panel A) and the reduced-form relationship between the number of cows per capita in 1930 and the change in women's seat share between 1929 and 1950 (Panel B). We show binned averages and a linear fit, netting out the full set of control variables.

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

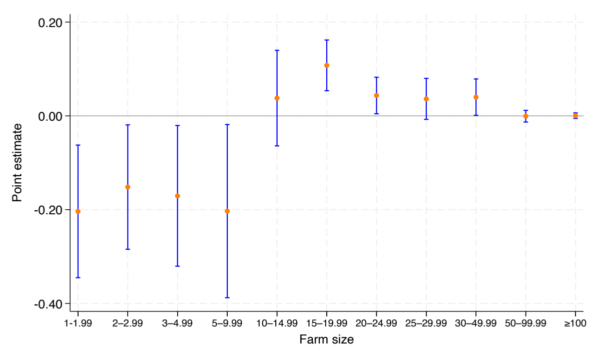
Notes: The figure shows the distribution of the economically active population across broad sectors, further broken down by employment type (family labor, own-account work, wage work). The data are from the 1950 and 1970 Population Censuses, and they include only rural municipalities (*maalaiskunnat*).



(a) FD-OLS.



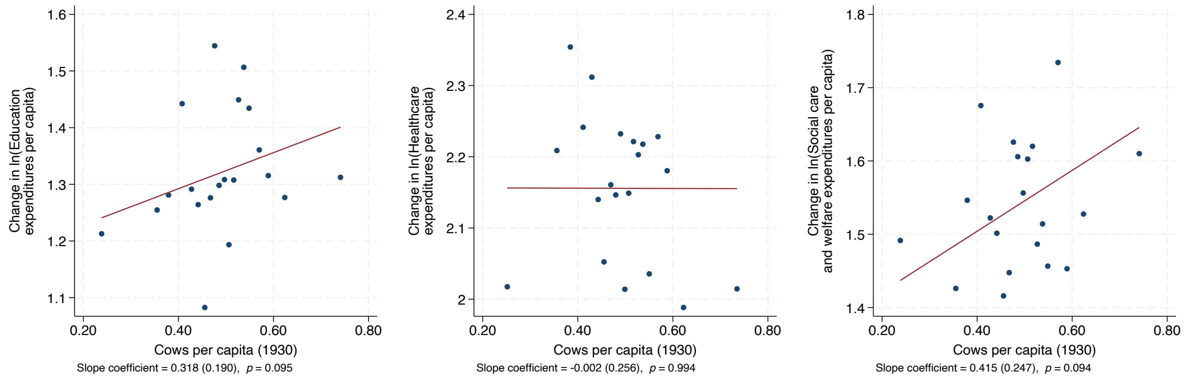
(b) Reduced form.



(c) FD-IV.

Figure 6. Change in the share of farms in each size bin (1950-1969).

Notes: Panel A shows the OLS estimates for the relationship between milking machine adoption and the change in the share of farms in each size bin. Panel B plots the estimates of the effect of our instrument on the outcome (reduced form). Panel C shows the corresponding 2SLS estimates. All specifications include the full set of controls. We also show 95% confidence intervals constructed using robust standard errors.



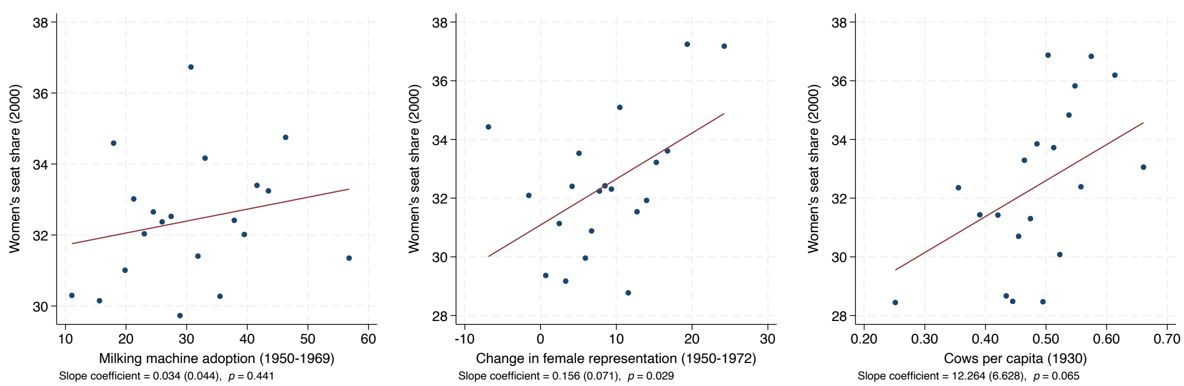
(a) Education.

(b) Healthcare.

(c) Social care and welfare.

Figure 7. Policy effects.

Notes: The figures illustrate reduced form regressions using the log change in education expenditures per 1950 capita (Panel A), log change in healthcare expenditures per 1950 capita (Panel B), and log change in social care and welfare expenditures per 1950 capita (Panel C) as the outcomes. We show binned averages and a linear fit, netting out the full set of control variables.



(a) Milking machine adoption.

(b) Historical change in women's representation.

(c) Reduced-form.

Figure 8. Persistence.

Notes: The figures plot women's seat share in 2000 against milking machine adoption (Panel A), historical change in women's representation (Panel B), and historical prevalence of cattle tending (Panel C). We show binned averages and a linear fit, netting out the full set of control variables.

Table 1. Regression results: Milking machine adoption and changes in political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FD-OLS					
Milking machine adoption	0.007	0.058	0.058	0.066*	0.067*
	(0.025)	(0.035)	(0.039)	(0.039)	(0.040)
R^2	0.00	0.07	0.07	0.08	0.08
Oster's δ for $\beta = 0$		-1.75	-2.53	-2.58	-2.68
Panel B: Reduced form					
Cows per capita (1930)	5.035*	6.873**	6.519**	8.530***	9.100***
	(2.993)	(3.089)	(2.965)	(2.984)	(3.089)
R^2	0.01	0.07	0.08	0.08	0.08
Oster's δ for $\beta = 0$		-9.16	50.45	50.94	144.31
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	0.125	0.167*	0.200*	0.262**	0.290**
	(0.084)	(0.089)	(0.112)	(0.121)	(0.134)
First-stage F	18.62	17.29	13.97	12.04	10.58
N	327	327	327	327	327
Mean of dependent variable	8.08	8.08	8.08	8.08	8.08
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is the change in women's seat share in local councils between 1950 and 1972. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 2. Robustness to alternative samples and specifications.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for 1929-1950 trend	LASSO controls	Panel + clustered SEs	Shift-share instrument
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FD-OLS and FE-OLS							
Milking machine adoption	0.063*	0.065*	0.077*	0.081**	0.077**		
	(0.037)	(0.037)	(0.043)	(0.034)	(0.033)		
Milking machines per 1950 capita						0.075**	
						(0.035)	
R^2	0.10	0.07	0.12	0.27	0.07	0.72	
N	356	341	252	324	324	976	
Mean of dependent variable	8.03	8.09	8.83	8.14	8.14	6.13	
Panel B: Reduced form							
Cows per capita (1930)	8.884***	8.652***	13.896***	8.718***	8.643***		
	(3.059)	(3.011)	(3.702)	(2.997)	(3.235)		
Cows per capita (1930) × 1[Year = 1950]						0.346	
						(2.615)	
Cows per capita (1930) × 1[Year = 1972]						8.833***	
						(3.295)	
Milking machine exposure							0.502***
							(0.179)
R^2	0.11	0.07	0.14	0.27	0.08	0.72	0.72
N	356	341	252	324	324	976	976
Mean of dependent variable	8.03	8.09	8.83	8.14	8.14	6.13	6.13
Panel C: FD-IV and FE-IV							
Milking $\widehat{\text{machine}}$ adoption	0.268**	0.285**	0.495**	0.206***	0.223**		
	(0.126)	(0.138)	(0.232)	(0.080)	(0.095)		
Milking $\widehat{\text{machines per}}$ 1950 capita						0.187**	0.188**
						(0.074)	(0.076)
First-stage F	10.51	10.12	6.07	18.58	17.99	22.31	21.64
N	356	341	252	324	324	976	976
Mean of dependent variable	8.03	8.09	8.83	8.14	8.14	6.13	6.13
Geography	✓	✓	✓	✓		✓	✓
Population	✓	✓	✓	✓		✓	✓
Agriculture	✓	✓	✓	✓		✓	✓
Income	✓	✓	✓	✓		✓	✓

Notes: The dependent variable is the change in women's seat share in local councils between 1950 and 1972 in columns (1)-(5) and the seat share in columns (6) and (7). Panel A reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel B reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 in columns (1)-(5); column (6) uses standard errors clustered at the municipality level. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table 3. Regression results: Milking machine adoption and changes in political representation by party.

	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)
Panel A: FD-OLS				
Milking machine adoption	0.030	0.036*	0.243***	-0.141***
	(0.030)	(0.022)	(0.068)	(0.045)
R^2	0.12	0.09	0.33	0.30
Oster's δ for $\beta = 0$	2.65	-1.28	2.97	18.99
Panel B: Reduced form				
Cows per capita (1930)	7.542***	2.286	13.627	-4.528
	(2.451)	(1.784)	(8.309)	(3.519)
R^2	0.13	0.08	0.30	0.28
Oster's δ for $\beta = 0$	1.98	-1.34	-7.76	-1.83
Panel C: FD-IV				
Milking $\widehat{\text{machine}}$ adoption	0.241**	0.073	0.435*	-0.144
	(0.110)	(0.055)	(0.236)	(0.116)
First-stage F	10.58	10.58	10.58	10.58
N	327	327	327	327
Mean of dependent variable	5.58	2.34	4.61	-6.91
Geography	✓	✓	✓	✓
Population	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓
Income	✓	✓	✓	✓

Notes: Dependent variables are indicated in column titles and measured as changes between the years 1950 and 1972. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 4. The milking machine 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 machines per capita	-1.246***	-0.511***	0.131	2.830***
	(0.243)	(0.184)	(0.177)	(0.964)
R^2	0.21	0.35	0.18	0.62
Oster's δ for $\beta = 0$	1.77	-3.89	0.87	1.52
Panel B: Reduced form				
Cows per capita	-0.040**	-0.025*	0.007	0.041
	(0.018)	(0.014)	(0.013)	(0.025)
R^2	0.17	0.35	0.18	0.56
Oster's δ for $\beta = 0$	2.24	-17.95	1.70	0.49
Panel C: IV				
Milking $\widehat{\text{machines}}$ per capita	-1.762**	-1.120	0.329	1.808*
	(0.851)	(0.801)	(0.594)	(0.991)
First-stage F	6.71	6.71	6.71	6.71
N	323	323	323	323
Mean of dependent variable	0.16	0.82	0.04	0.35
Geography	✓	✓	✓	✓
Population	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓
Income	✓	✓	✓	✓

Notes: Dependent variables are indicated in column titles and measured in 1959. Panel A reports OLS estimates for milking machines per capita, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the 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.

Table 5. Rural development.

	Δ Share of population living in agricultural households	Δ Share of population employed in agriculture	Δ ln(Tax revenue per capita)
	(1)	(2)	(3)
Panel A: FD-OLS			
Milking machine adoption	-0.046	-0.034*	0.003
	(0.029)	(0.018)	(0.003)
R^2	0.48	0.44	0.13
Oster's δ for $\beta = 0$	0.71	0.74	-0.92
Panel B: Reduced form			
Cows per capita (1930)	-7.637**	-6.596***	0.610***
	(3.322)	(2.148)	(0.197)
R^2	0.49	0.46	0.13
Oster's δ for $\beta = 0$	1.79	1.40	-21.00
Panel C: FD-IV			
Milking $\widehat{\text{machine}}$ adoption	-0.244**	-0.210***	0.019**
	(0.097)	(0.062)	(0.009)
First-stage F	10.58	10.58	9.88
N	327	327	314
Mean of dependent variable	-32.54	-18.34	1.31
Geography	✓	✓	✓
Population	✓	✓	✓
Agriculture	✓	✓	✓
Income	✓	✓	✓

Notes: The dependent variables are indicated in column titles. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 6. Prevalence of women's associations in the 1970s.

	OLS	Reduced form	2SLS
	(1)	(2)	(3)
Milking machines per capita	34.081		
	(31.873)		
Cows per capita (1930)		6.004**	
		(2.514)	
$\widehat{\text{Milking machines}}$ per capita			150.559*
			(84.953)
R^2	0.17	0.18	0.13
First-stage F			13.24
N	194	194	194
Mean of dependent variable	5.07	5.07	5.07
Geography	✓	✓	✓
Population	✓	✓	✓
Agriculture	✓	✓	✓
Income	✓	✓	✓

Notes: The dependent variable is the share of women's associations out of all associations in 1972. Column (1) reports the OLS estimate for the change in milking machines per capita between 1950 and 1969, column (2) reports the OLS estimate for the number of cows per capita in 1930 (the reduced form of IV), and column (3) reports the 2SLS estimate using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 threshing machines 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 7. Heterogeneous effects by baseline female representation.

	(1)	(2)
Cows per capita (1930)	13.628***	13.773***
	(3.831)	(4.371)
Women's seat share in 1950	-0.384*	
	(0.212)	
Cows per capita (1930) × Women's seat share in 1950	-1.057**	
	(0.421)	
1[Women's seat share in 1950 > 0]		-1.828
		(2.934)
Cows per capita (1930) × 1[Women's seat share in 1950 > 0]		-8.883
		(5.599)
R^2	0.31	0.21
N	327	327
Mean of dependent variable	8.08	8.08
Geography	✓	✓
Population	✓	✓
Agriculture	✓	✓
Income	✓	✓

Notes: The dependent variable is the change in women's seat share in local councils between 1950 and 1972. 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.

Online Appendix

(Not for Publication)

A Additional Descriptive Figures

This appendix contains additional descriptive figures. 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 our instrumental variable—cows per capita in 1930—also for cities, market towns, and partly ceded municipalities. We exclude these localities in our main analysis but do 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.

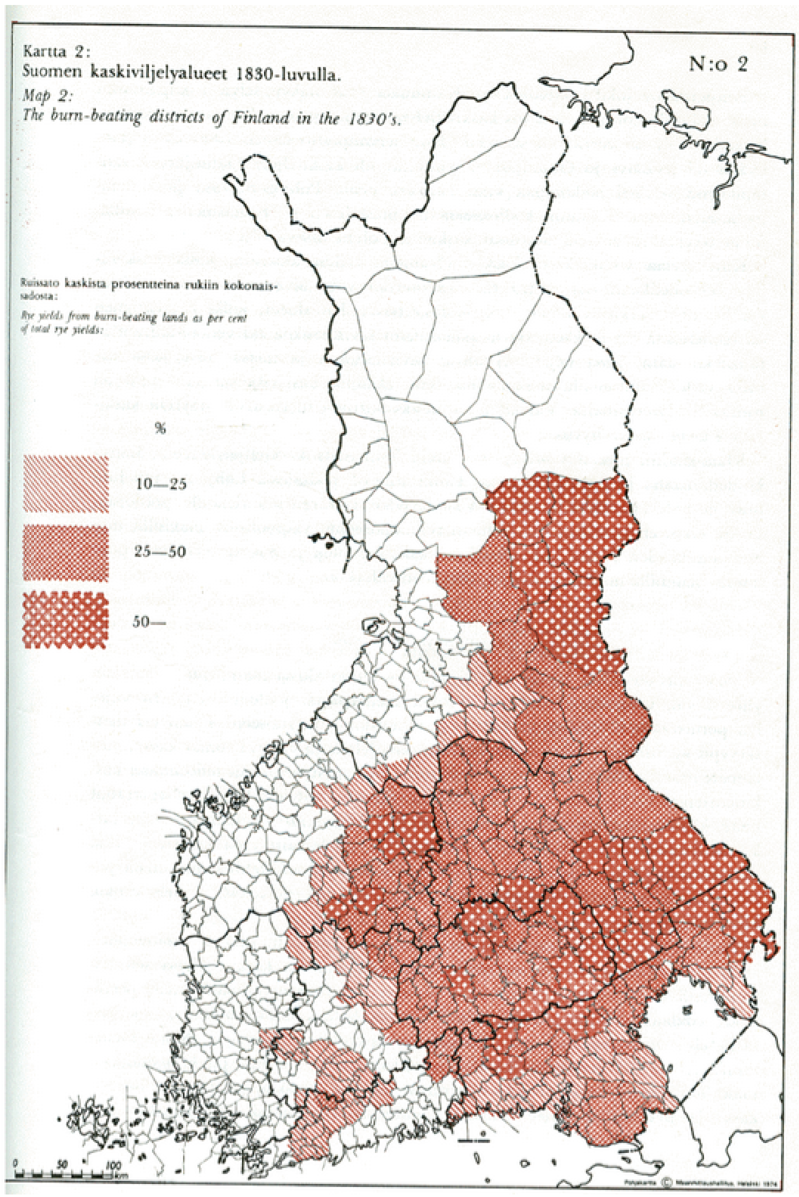
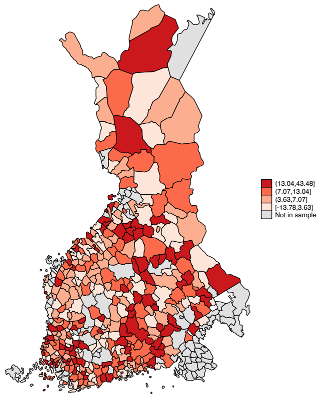
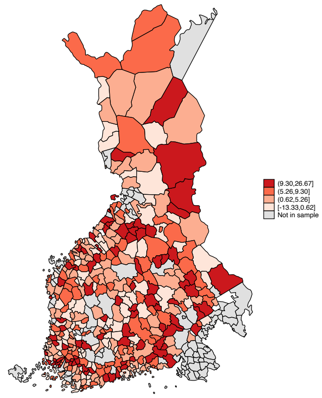


Figure OA1. Slash-and-burn farming in the 1830s.

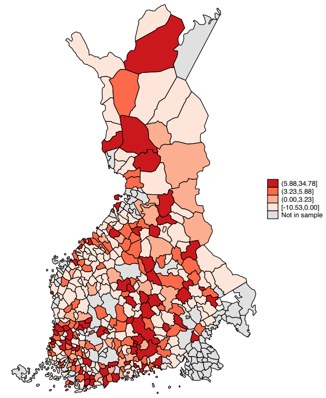
Notes: The figure comes from Soininen (1974). It shows rye yields from slash-and-burn lands as a share of total rye yields. In the 1800s, rye was the most important source of caloric intake in Finland.



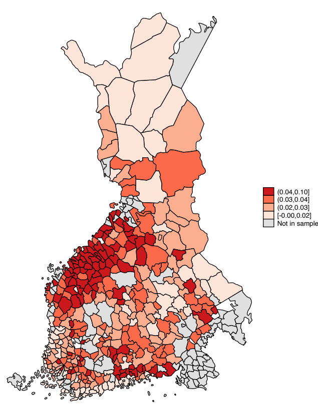
(a) Change in women's representation.



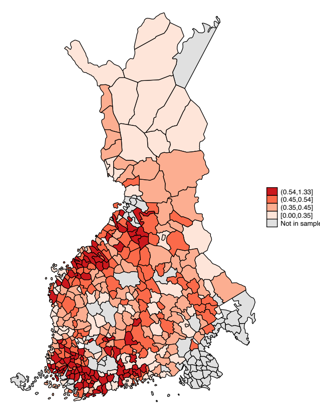
(b) Change in bourgeois women's representation.



(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.

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. In Table OA1, we show that the first-stage relationship is robust across different sets of control variables.

The second identifying assumption is that pre-existing cow intensity in 1930 affects later female political representation only through its effect on milking machine adoption. Formally, this exclusion restriction requires that, conditional on controls X_m, the instrument is uncorrelated with unobserved determinants of female political representation.

Table OA2 further reports estimation results for our other outcome variables for which we have data before milking machine adoption. We do not find any effects on the change in bourgeois parties' seat share, or socialist parties' seat share. However, there is a marginally significant positive effect on the 1929–1950 trend in bourgeois women's seat share, and socialist women's seat share indicates a negative pre-trend. We thus perform robustness checks in which we control for the 1929–1950 trend and, reassuringly, find that this does not alter our results.

In Figure OA3, we plot the first-stage coefficients obtained in our panel setting where we instrument milking machines (per 1950 capita) with cows per capita in 1930 interacted with year dummies. As the figure shows, the instrument has the largest bite on milking machines per capita in the final year of our data. This is to be expected, as much of the milking machine adoption happened only after the year 1950.

Table OA1. First stage.

	(1)	(2)	(3)	(4)	(5)
Cows per capita (1930)	40.155***	41.062***	32.550***	32.591***	31.347***
	(9.306)	(9.875)	(8.710)	(9.391)	(9.638)
R^2	0.13	0.51	0.56	0.59	0.59
N	327	327	327	327	327
Mean of dependent variable	30.19	30.19	30.19	30.19	30.19
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is the change in milking machines per capita between 1950 and 1969. The table reports the first stage of 2SLS using the number of cows per capita in 1930 as an instrument. 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 OA2. 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	0.007	0.035*	-0.017	0.199***	-0.133**
	(0.023)	(0.019)	(0.012)	(0.065)	(0.063)
R^2	0.15	0.09	0.18	0.27	0.25
Panel B: Reduced form					
Cows per capita (1930)	0.308	3.493	-3.166**	0.773	4.333
	(2.612)	(2.255)	(1.316)	(8.116)	(7.681)
R^2	0.15	0.09	0.19	0.25	0.24
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	0.007	0.083*	-0.075**	0.018	0.103
	(0.059)	(0.046)	(0.032)	(0.187)	(0.167)
First-stage F	18.57	18.57	18.57	18.65	18.65
N	324	324	324	320	320
Mean of dependent variable	3.48	2.01	1.41	-2.01	2.97
Geography	✓	✓	✓	✓	✓
Population	✓	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	✓
Income	✓	✓	✓	✓	✓

Notes: The dependent variable is the change in women's seat share in local councils between 1930 and 1950. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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.

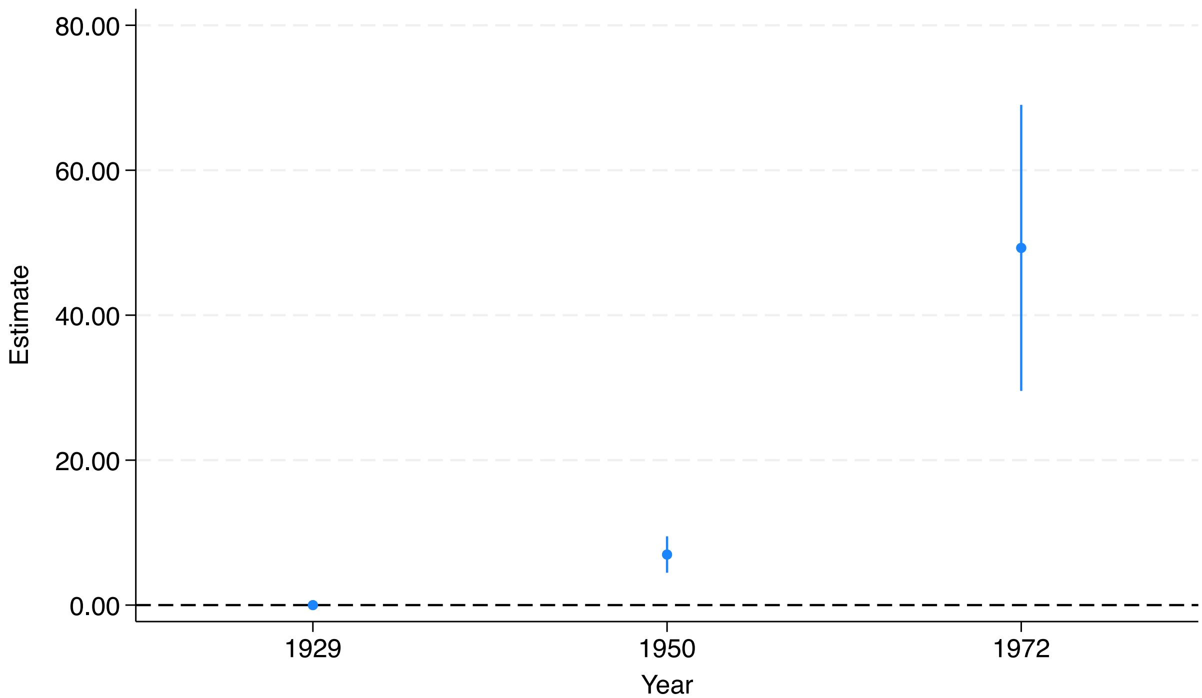


Figure OA3. First-stage estimates using the three-year panel.

Notes: The figure shows first-stage estimates using panel data for three years (1929, 1950, and 1972) and a fixed-effects specification that controls for municipality and year fixed effects, and the full set of covariates interacted with year indicators. We also show 95% confidence intervals constructed using standard errors clustered at the municipality level.

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.

Second, 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.

Table OA3 presents results using this alternative instrument set. The first stage, reported in column (1), confirms that neither cattle intensity nor farm structure alone predicts more milking machine adoption; rather, the interaction between the two is strongly predictive. When running the 2SLS estimation using the pre-treatment change in women's representation as the outcome, we obtain an estimate that is very close to zero in magnitude and statistically significant. These two observations support the validity of our alternative IV approach. The second-stage estimate in column (3) is consistent with our main results, reinforcing our interpretation of the causal effect of milking machine adoption on women's political representation.

Having multiple instruments additionally allows us to perform an overidentification test. The p-value resulting from Hansen's J-test is around 0.17, supporting the validity of our 2SLS estimation.

Third, Table OA4 shows regression results using alternative scalings of our treatment. In our main analyses, we measure population-level exposure to the milking machine with the change in the number of milking machines between 1950 and 1969 divided by the 1950 population. One concern is that the instrument could affect population trends even before 1950. In column (1), we scale the exposure metric and the instrument by the 1930. The results are similar to the main estimates. As further robustness checks, in columns (2) and

[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).

(3), we use the number of farms or the number of population living in agricultural households as the denominator. The scaling does matter for the magnitude of the estimates, but the interpretation remains qualitatively unchanged.

Fourth, to account for such 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 fifth of the reduced-form effect.

Let us now move on to robustness checks for bourgeois and socialist women's seat share and bourgeois and socialist parties' seat share. Tables OA5, OA6, OA7, and OA8 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 for socialist women and a negative—but also statistically insignificant—effect for socialist parties.

In Tables OA9, OA10, OA11, and OA12, 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), controlling for covariates selected using LASSO (column 5), and estimating a fixed effects specification with municipality and time fixed effects, using all three years of data (1929, 1950, and 1972) and clustering the standard errors by municipality (column 6). Column (7) also uses data from all three election years and a panel estimation approach, but we replace the instrument with the shift-share instrument used by Ager et al. (2023). This estimation strategy yields virtually unchanged results.

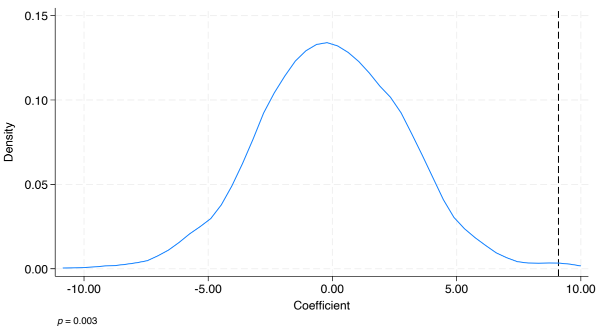
In these robustness checks, we continue to find some evidence of a positive effect on socialist women's political representation and a negative effect on socialist parties' seat share overall. However, as in the analyses we report in the main text, these estimates are not statistically significant. Moreover, 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.

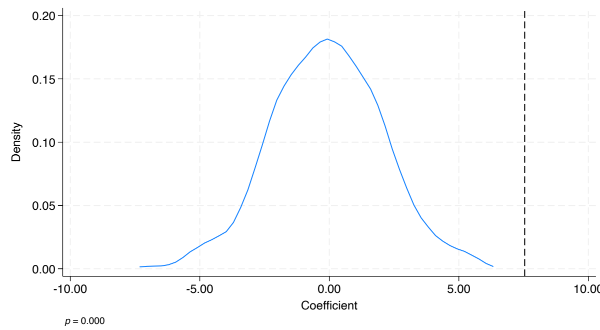
Columns (3)-(6) of Table OA3 report 2SLS estimates obtained using our auxiliary IV strategy introduced above. The estimation results resonate with our main findings. However, while the overidentification test is passed for the change in bourgeois and socialist women's seat share and socialist parties' seat share, we note a potential violation for the change in bourgeois party seat share.

Columns (4)-(15) of Table OA4 show regression results for these auxiliary seat share outcomes using alternative scalings of our treatment. The signs of the estimates persist for all outcomes except for socialist parties' seat share.

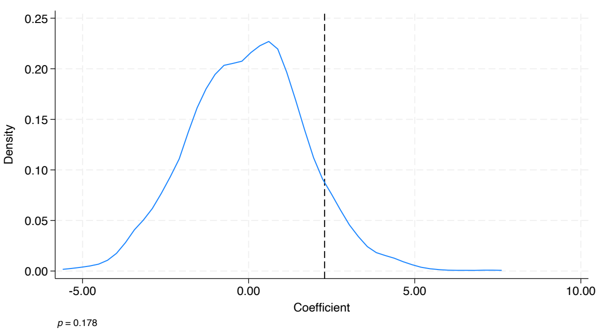
Finally, for the two outcomes that exhibit clearer statistically significant effects, we also report the Conley et al. (2012) bounds. These can be found in Panels B and C of Figure OA5. We find that even with violations of the exclusion restriction that match about 20% of the reduced-form effect, there is still a positive effect that is statistically significant at the 10% level.



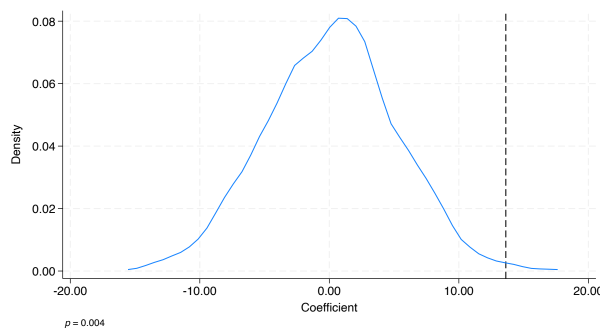
(a) Change in women's seat share.



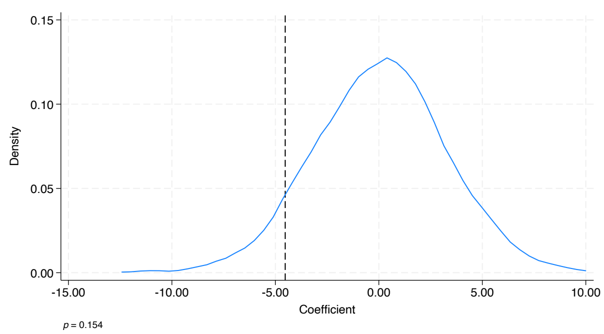
(b) Change in bourgeois women's seat share.



(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.

Table OA3. Regression results using an alternative IV approach.

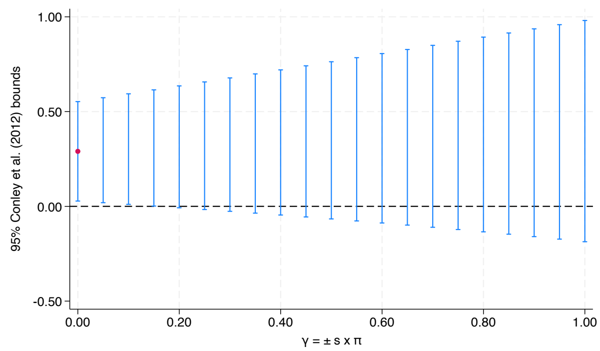
	Milking machine adoption	Δ Women's seat share (1930-1950)	Δ Women's seat share (1950-1972)	Δ Bourgeois women's seat share (1950-1972)	Δ Socialist women's seat share (1950-1972)	Δ Bourgeois parties' seat share (1950-1972)	Δ Socialist parties' seat share (1950-1972)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cows per capita (1930)	6.385						
	(12.776)						
$\mathbb{E}$[Farms with at least ten cows per capita (1930)]	-222.378***						
	(76.346)						
Cows per capita (1930) × $\mathbb{E}$[Farms with at least ten cows per capita (1930)]	395.369***						
	(126.521)						
$\widehat{\text{Milking machine adoption}}$		0.018	0.228**	0.185**	0.060	0.344*	-0.062
		(0.057)	(0.099)	(0.086)	(0.049)	(0.185)	(0.087)
N	327	324	327	327	327	327	327
Mean of dependent variable	30.19	3.48	8.08	5.58	2.34	4.61	-6.91
First-stage F		13.94	14.81	14.81	14.81	14.81	14.81
p-value of Hansen J-statistic		0.72	0.17	0.36	0.55	0.02	0.13
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.

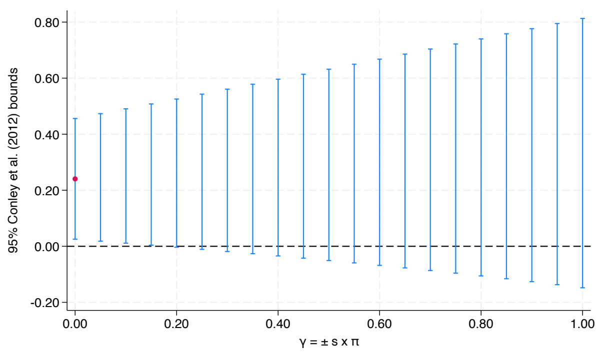
Table OA4. Alternative scaling of milking machine exposure.

	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)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Panel A: FD-OLS															
Milking machine adoption (per 1930 capita)	0.044			0.008			0.036**			0.204***			-0.103***		
	(0.035)			(0.026)			(0.017)			(0.057)			(0.037)		
Milking machine adoption (per 1950 farms)		0.008			0.002			0.006*			0.025***			-0.012**	
		(0.005)			(0.004)			(0.003)			(0.008)			(0.006)	
Milking machine adoption (per 1950 agricultural population)			0.016			0.005			0.011**			0.045***			-0.013
			(0.010)			(0.007)			(0.006)			(0.017)			(0.012)
R^2	0.07	0.07	0.08	0.11	0.11	0.11	0.09	0.09	0.09	0.33	0.32	0.31	0.30	0.29	0.28
Panel B: Reduced form															
Cows per capita (1930)	9.100***			7.542***			2.286			13.627			-4.528		
	(3.089)			(2.451)			(1.784)			(8.309)			(3.519)		
Cows per farm (1930)		1.420***			1.049***			0.399			0.544			0.141	
		(0.383)			(0.327)			(0.253)			(0.959)			(0.569)	
Cows per 1930 agricultural population			2.367***			1.730***			0.636			2.091			0.839
			(0.813)			(0.614)			(0.534)			(2.236)			(1.005)
R^2	0.08	0.09	0.08	0.13	0.14	0.13	0.08	0.09	0.08	0.30	0.30	0.30	0.28	0.27	0.27
Panel C: FD-IV															
Milking machine $\widehat{\text{adoption}}$ (per 1930 capita)	0.225**			0.187**			0.057			0.337*			-0.112		
	(0.098)			(0.079)			(0.043)			(0.197)			(0.091)		
Milking machine $\widehat{\text{adoption}}$ (per 1950 farms)		0.060**			0.045**			0.017			0.023			0.006	
		(0.026)			(0.020)			(0.011)			(0.039)			(0.023)	
Milking machine adoption $\widehat{\text{(per 1950}}$ agricultural population)			0.069**			0.050**			0.019			0.061			0.024
			(0.032)			(0.022)			(0.017)			(0.068)			(0.031)
First-stage F	15.52	9.28	12.52	15.52	9.28	12.52	15.52	9.28	12.52	15.52	9.28	12.52	15.52	9.28	12.52
N	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
Mean of dependent variable	8.08	8.08	8.08	5.58	5.58	5.58	2.34	2.34	2.34	4.61	4.61	4.61	-6.91	-6.91	-6.91
Geography	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Population	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Agriculture	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Income	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

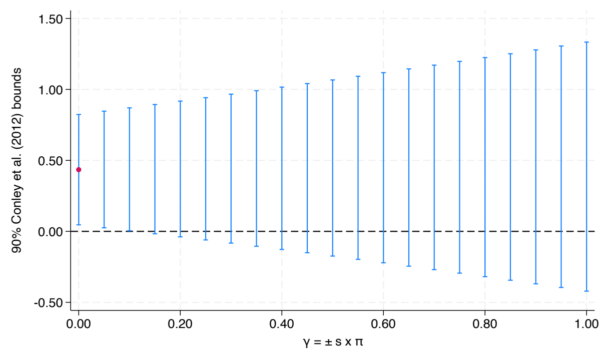
Notes: The dependent variable is the change in women's seat share in columns (1)-(3), the change in bourgeois women's seat share in columns (4)-(6), the change in socialist women's seat share in columns (7)-(9), the change in bourgeois parties' seat share in columns (10)-(12), and the change in socialist parties' seat share in columns (13)-(15). Panel A reports OLS estimates for the change in the number of milking machines between 1950 and 1970. Panel B shows the reduced form of IV, and Panel C reports the IV estimates using the number of cows per capita in 1930 as an instrument for the change in 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.



(a) Change in women's seat share.



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



(c) Change in 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 women's 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 OA5. Robustness to alternative controls—bourgeois women's political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FD-OLS					
Milking machine adoption	0.029	0.056**	0.035	0.034	0.030
	(0.020)	(0.025)	(0.028)	(0.029)	(0.030)
R^2	0.01	0.06	0.09	0.11	0.12
Panel B: Reduced form					
Cows per capita (1930)	8.020***	10.270***	8.917***	7.456***	7.542***
	(2.287)	(2.364)	(2.308)	(2.465)	(2.451)
R^2	0.04	0.11	0.12	0.13	0.13
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	0.200***	0.250***	0.274**	0.229**	0.241**
	(0.077)	(0.081)	(0.108)	(0.103)	(0.110)
First-stage F	18.62	17.29	13.97	12.04	10.58
N	327	327	327	327	327
Mean of dependent variable	5.58	5.58	5.58	5.58	5.58
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is the change in bourgeois women's seat share in local councils between 1950 and 1972. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 OA6. Robustness to alternative controls—socialist women's political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FD-OLS					
Milking machine adoption	-0.014	0.006	0.024	0.033	0.036*
	(0.013)	(0.022)	(0.022)	(0.021)	(0.022)
R^2	0.00	0.05	0.07	0.08	0.09
Panel B: Reduced form					
Cows per capita (1930)	-1.432	-1.514	-0.338	2.046	2.286
	(1.526)	(1.681)	(1.429)	(1.697)	(1.784)
R^2	0.00	0.05	0.06	0.08	0.08
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	-0.036	-0.037	-0.010	0.063	0.073
	(0.038)	(0.039)	(0.043)	(0.050)	(0.055)
First-stage F	18.62	17.29	13.97	12.04	10.58
N	327	327	327	327	327
Mean of dependent variable	2.34	2.34	2.34	2.34	2.34
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is the change in socialist women's seat share in local councils between 1950 and 1972. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 OA7. Robustness to alternative controls—bourgeois parties' political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FD-OLS					
Milking machine adoption	0.192***	0.247***	0.225***	0.259***	0.243***
	(0.061)	(0.066)	(0.063)	(0.072)	(0.068)
R^2	0.05	0.23	0.29	0.31	0.33
Panel B: Reduced form					
Cows per capita (1930)	4.671	15.497*	14.909*	17.146*	13.627
	(8.198)	(8.454)	(8.048)	(9.447)	(8.309)
R^2	0.00	0.20	0.27	0.29	0.30
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	0.116	0.377**	0.458*	0.526**	0.435*
	(0.198)	(0.190)	(0.234)	(0.253)	(0.236)
First-stage F	18.62	17.29	13.97	12.04	10.58
N	327	327	327	327	327
Mean of dependent variable	4.61	4.61	4.61	4.61	4.61
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is the change in bourgeois parties' seat share in local councils between 1950 and 1972. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 OA8. Robustness to alternative controls—socialist parties' political representation.

	(1)	(2)	(3)	(4)	(5)
Panel A: FD-OLS					
Milking machine adoption	-0.072**	-0.174***	-0.141***	-0.149***	-0.141***
	(0.033)	(0.041)	(0.043)	(0.045)	(0.045)
R^2	0.02	0.26	0.28	0.30	0.30
Panel B: Reduced form					
Cows per capita (1930)	1.858	-4.795	-1.127	-5.521	-4.528
	(3.699)	(3.771)	(3.076)	(3.549)	(3.519)
R^2	0.00	0.21	0.25	0.27	0.28
Panel C: FD-IV					
Milking $\widehat{\text{machine}}$ adoption	0.046	-0.117	-0.035	-0.169	-0.144
	(0.095)	(0.084)	(0.093)	(0.113)	(0.116)
First-stage F	18.62	17.29	13.97	12.04	10.58
N	327	327	327	327	327
Mean of dependent variable	-6.91	-6.91	-6.91	-6.91	-6.91
Geography		✓	✓	✓	✓
Population			✓	✓	✓
Agriculture				✓	✓
Income					✓

Notes: The dependent variable is the change in socialist parties' seat share in local councils between 1950 and 1972. Panel A reports OLS estimates for the change in milking machines per capita between 1950 and 1969, Panel B reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel C reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 OA9. Robustness to alternative samples and specifications—change in bourgeois women's representation.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for 1929-1950 trend	LASSO controls	Panel + clustered SEs	Shift-share instrument
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FD-OLS and FE-OLS							
Δ Milking machines per capita	0.039	0.030	0.045	0.058**	0.029		
	(0.027)	(0.029)	(0.032)	(0.025)	(0.020)		
Milking machines per capita						0.057**	
						(0.025)	
R^2	0.12	0.12	0.17	0.26	0.01	0.67	
N	356	327	252	324	327	976	
Mean of dependent variable	5.44	5.58	6.26	5.63	5.58	3.97	
Panel B: Reduced form							
Cows per capita (1930)	8.076***	8.172***	10.172***	7.709***	8.566***		
	(2.367)	(2.620)	(2.866)	(2.555)	(2.665)		
Cows per capita (1930) × 1[Year = 1950]						3.532	
						(2.261)	
Cows per capita (1930) × 1[Year = 1972]						11.093***	
						(2.950)	
Milking machine exposure							0.549***
							(0.152)
R^2	0.14	0.13	0.19	0.24	0.14	0.68	0.68
N	356	338	252	324	324	976	976
Mean of dependent variable	5.44	5.66	6.26	5.63	5.63	3.97	3.97
Panel C: FD-IV and FE-IV							
Milking $\widehat{\text{machine}}$ adoption	0.244**	0.243**	0.362**	0.182**	0.201**		
	(0.103)	(0.113)	(0.175)	(0.071)	(0.080)		
Milking $\widehat{\text{machines per}}$ 1950 capita						0.209***	0.206***
						(0.067)	(0.068)
First-stage F	10.51	10.12	6.07	18.58	17.99	22.31	21.64
N	356	341	252	324	324	976	976
Mean of dependent variable	5.44	5.62	6.26	5.63	5.63	3.97	3.97
Geography	✓	✓	✓	✓		✓	✓
Population	✓	✓	✓	✓		✓	✓
Agriculture	✓	✓	✓	✓		✓	✓
Income	✓	✓	✓	✓		✓	✓

Notes: The dependent variable is the change in bourgeois women's seat share in local councils between 1950 and 1972 in columns (1)-(5) and the seat share in columns (6) and (7). Panel A reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel B reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 in columns (1)-(5); column (6) uses standard errors clustered at the municipality level. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA10. Robustness to alternative samples and specifications—change in socialist women's representation.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for 1929-1950 trend	LASSO controls	Panel + clustered SEs	Shift-share instrument
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FD-OLS and FE-OLS							
Δ Milking machines per capita	0.026	0.036*	0.038	0.030	-0.014		
	(0.022)	(0.021)	(0.025)	(0.022)	(0.013)		
Milking machines per capita						0.022	
						(0.022)	
R^2	0.08	0.09	0.11	0.18	0.00	0.61	
N	356	327	252	324	327	976	
Mean of dependent variable	2.44	2.34	2.38	2.34	2.34	2.07	
Panel B: Reduced form							
Cows per capita (1930)	1.431	1.886	4.174**	2.282	-1.432		
	(1.832)	(1.956)	(2.074)	(1.890)	(1.521)		
Cows per capita (1930) × 1[Year = 1950]						-3.166**	
						(1.315)	
Cows per capita (1930) × 1[Year = 1972]						-0.959	
						(1.987)	
Milking machine exposure							0.028
							(0.109)
R^2	0.08	0.07	0.11	0.15	0.00	0.61	0.61
N	356	338	252	324	327	976	976
Mean of dependent variable	2.44	2.32	2.38	2.34	2.34	2.07	2.07
Panel C: FD-IV and FE-IV							
Milking $\widehat{\text{machine}}$ adoption	0.043	0.067	0.149*	0.054	0.052		
	(0.056)	(0.057)	(0.088)	(0.042)	(0.046)		
Milking $\widehat{\text{machines per}}$ 1950 capita						0.006	0.010
						(0.040)	(0.041)
First-stage F	10.51	10.12	6.07	18.58	17.99	22.31	21.64
N	356	341	252	324	324	976	976
Mean of dependent variable	2.44	2.32	2.38	2.34	2.34	2.07	2.07
Geography	✓	✓	✓	✓		✓	✓
Population	✓	✓	✓	✓		✓	✓
Agriculture	✓	✓	✓	✓		✓	✓
Income	✓	✓	✓	✓		✓	✓

Notes: The dependent variable is the change in socialist women's seat share in local councils between 1950 and 1972 in columns (1)-(5) and the seat share in columns (6) and (7). Panel A reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel B reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 in columns (1)-(5); column (6) uses standard errors clustered at the municipality level. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA11. Robustness to alternative samples and specifications—change in bourgeois parties' seat share.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for 1929-1950 trend	LASSO controls	Panel + clustered SEs	Shift-share instrument
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FD-OLS and FE-OLS							
Δ Milking machines per capita	0.240***	0.243***	0.210***	0.280***	0.266***		
	(0.064)	(0.066)	(0.075)	(0.074)	(0.068)		
Milking machines per capita						0.306***	
						(0.074)	
R^2	0.32	0.33	0.28	0.34	0.33	0.79	
N	356	327	252	320	324	972	
Mean of dependent variable	4.01	4.61	5.79	4.62	4.65	62.90	
Panel B: Reduced form							
Cows per capita (1930)	11.982	15.838*	11.636	15.872*	13.627*		
	(8.149)	(9.380)	(8.417)	(9.437)	(8.024)		
Cows per capita (1930) × 1[Year = 1950]						0.764	
						(8.098)	
Cows per capita (1930) × 1[Year = 1972]						16.606	
						(10.683)	
Milking machine exposure							0.941*
							(0.548)
R^2	0.30	0.30	0.26	0.31	0.30	0.78	0.78
N	356	338	252	324	327	972	972
Mean of dependent variable	4.01	4.86	5.79	4.65	4.61	62.90	62.90
Panel C: FD-IV and FE-IV							
Milking $\widehat{\text{machine}}$ adoption	0.362*	0.447*	0.415	0.375**	0.384**		
	(0.219)	(0.246)	(0.309)	(0.188)	(0.192)		
Milking $\widehat{\text{machines per}}$ 1950 capita						0.350*	0.353*
						(0.189)	(0.186)
First-stage F	10.51	10.12	6.07	18.58	17.99	22.76	21.67
N	356	341	252	324	324	972	972
Mean of dependent variable	4.01	4.83	5.79	4.65	4.65	62.90	62.90
Geography	✓	✓	✓	✓		✓	✓
Population	✓	✓	✓	✓		✓	✓
Agriculture	✓	✓	✓	✓		✓	✓
Income	✓	✓	✓	✓		✓	✓

Notes: The dependent variable is the change in bourgeois parties' seat share in local councils between 1950 and 1972 in columns (1)-(5) and the seat share in columns (6) and (7). Panel A reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel B reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 in columns (1)-(5); column (6) uses standard errors clustered at the municipality level. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.

Table OA12. Robustness to alternative samples and specifications—change in socialist parties' seat share.

	Include cities and market towns	Include partly ceded municipalities	No merged municipalities	Control for 1929-1950 trend	LASSO controls	Panel + clustered SEs	Shift-share instrument
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: FD-OLS and FE-OLS							
Δ Milking machines per capita	-0.130***	-0.141***	-0.159***	-0.170***	-0.160***		
	(0.042)	(0.044)	(0.053)	(0.045)	(0.041)		
Milking machines per capita						-0.171***	
						(0.048)	
R^2	0.35	0.30	0.30	0.33	0.31	0.85	
N	356	327	252	320	324	972	
Mean of dependent variable	-6.01	-6.91	-7.85	-6.97	-6.96	36.16	
Panel B: Reduced form							
Cows per capita (1930)	-4.468	-3.466	-6.464	-3.036	-5.589*		
	(3.605)	(3.717)	(4.232)	(3.552)	(3.289)		
Cows per capita (1930) $\times$ 1[Year = 1950]						4.308	
						(7.670)	
Cows per capita (1930) $\times$ 1[Year = 1972]						1.349	
						(7.692)	
Milking machine exposure							-0.036
							(0.282)
R^2	0.34	0.27	0.27	0.28	0.27	0.85	0.85
N	356	338	252	324	327	972	972
Mean of dependent variable	-6.01	-7.08	-7.85	-6.96	-6.91	36.16	36.16
Panel C: FD-IV and FE-IV							
Milking $\widehat{\text{machine}}$ adoption	-0.135	-0.155	-0.230	-0.072	-0.078		
	(0.109)	(0.122)	(0.166)	(0.083)	(0.086)		
Milking $\widehat{\text{machines per}}$ 1950 capita						-0.007	-0.013
						(0.113)	(0.106)
First-stage F	10.51	10.12	6.07	18.58	17.99	22.76	21.67
N	356	341	252	324	324	972	972
Mean of dependent variable	-6.01	-7.03	-7.85	-6.96	-6.96	36.16	36.16
Geography	✓	✓	✓	✓		✓	✓
Population	✓	✓	✓	✓		✓	✓
Agriculture	✓	✓	✓	✓		✓	✓
Income	✓	✓	✓	✓		✓	✓

Notes: The dependent variable is the change in socialist parties' seat share in local councils between 1950 and 1972 in columns (1)-(5) and the seat share in columns (6) and (7). Panel A reports OLS estimates for the number of cows per capita in 1930 (the reduced form of IV), and Panel B reports the 2SLS estimates using the number of cows per capita in 1930 as an instrument for the change in the number of milking machines per capita between 1950 and 1969. 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 in columns (1)-(5); column (6) uses standard errors clustered at the municipality level. *, ** 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 Heterogeneity by Baseline Female Representation

To understand how milking machine adoption covaries with the permissiveness of local norms, we run a (reduced-form) specification that interacts cows per capita in 1930 with the baseline female representation. In Figure OA6, we plot the predicted values by the instrument value and female representation in 1950, fixing the covariates at means. We see particularly strong increases in milking-intensive locations that had fewer female local councilors in 1950, suggesting that the effects of the milking machine operated through changing local gender-related norms.

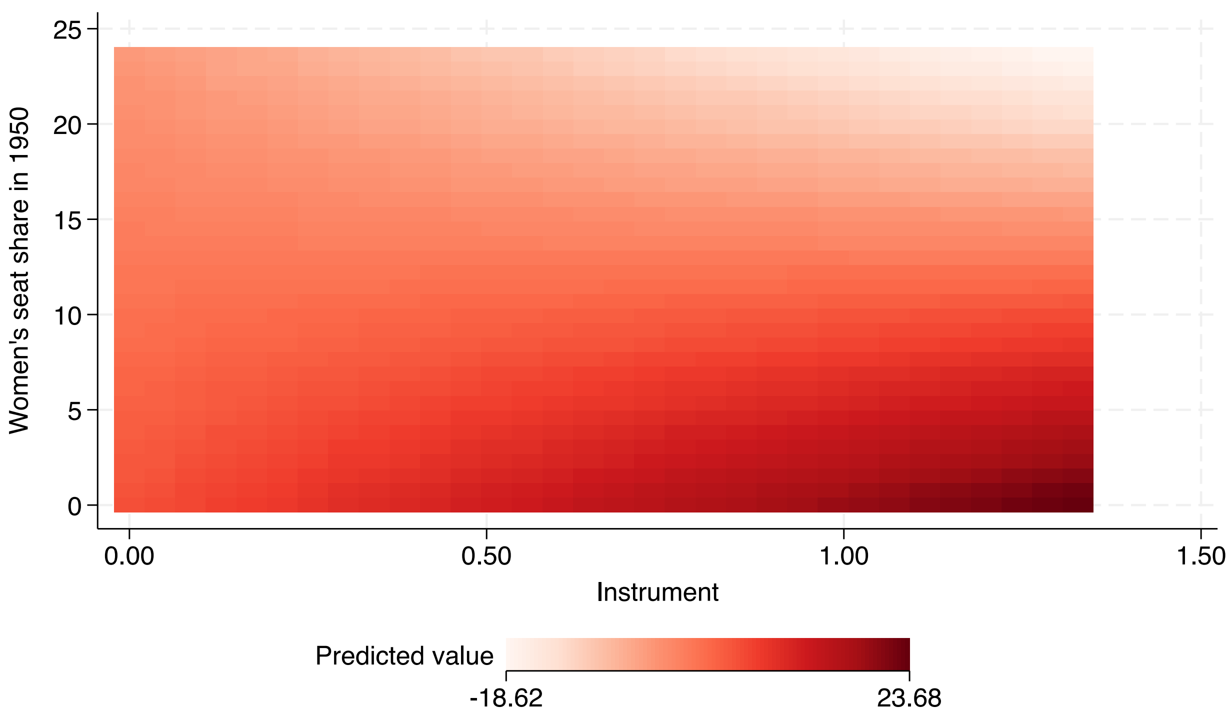


Figure OA6. Visualization of the interaction effect.

Notes: The figure shows the predicted values of the change in women's representation (1950-1972) for different values of the instrument and baseline female representation obtained.

D.2 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 OA7). 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 OA13 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.

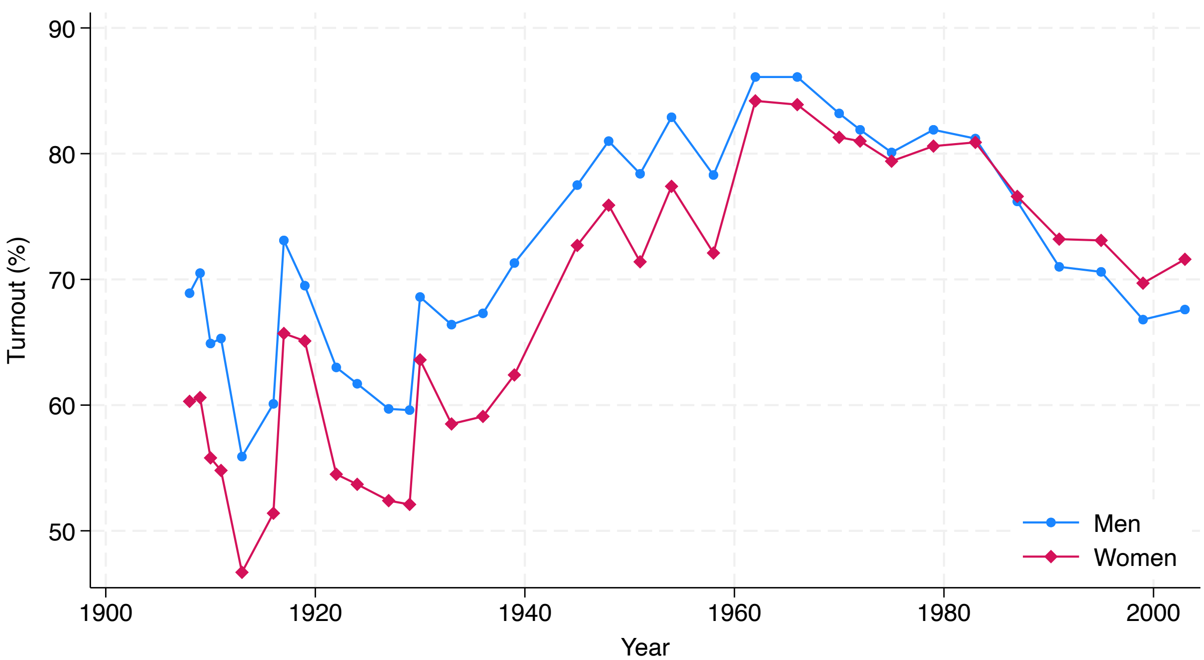


Figure OA7. Trends in voter turnout over time.

Table OA13. The milking machine and voter turnout by gender.

	Δ Women's turnout	Δ Men's turnout
	(1)	(2)
Panel A: FD-OLS		
Milking machine adoption	-0.014	-0.001
	(0.028)	(0.030)
R^2	0.22	0.17
Panel B: Reduced form		
Cows per capita	1.918	3.043
	(2.405)	(3.804)
R^2	0.22	0.17
Panel C: FD-IV		
Milking $\widehat{\text{machine}}$ adoption	0.061	0.097
	(0.072)	(0.111)
First-stage F	10.60	10.58
N	325	326
Mean of dependent variable	11.15	5.85
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 for the change in the number of milking machines between 1950 and 1969. Panel B shows the reduced form of IV, and Panel C reports the IV estimates using the number of cows per capita in 1930 as an instrument for the change in 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.

E Additional Results for the Discussion

This appendix contains additional results for the discussion section.

E.1 Policy Effects

The introduction of milking machines contributed to changes in the political representation of women, but we also find suggestive evidence that there were downstream effects on the allocation of municipal resources. To examine the link between technological and political change and policy outcomes, we use data on local expenditures on education, healthcare, and social and welfare. These spending outcomes have been collected from Statistics Finland's publications on municipalities' expenditures (*Maalaiskuntien finanssit vuonna 1950* and *Kuntien finanssitilasto 1970*), available for the years 1950 and 1970. We report these regression results in Table OA14.[2]

Column (1) in Panel A first suggests a positive correlation between milking machine adoption and the change in education expenditures per capita during 1950-1970. The reduced-form estimate shown in Panel B and 2SLS estimate shown in Panel C also suggest a positive albeit statistically insignificant effect of the milking machine on change in education expenditures.

In column (2), we consider the change in healthcare expenditures per capita as our outcome variable. The estimates are statistically insignificant in all panels, although the 2SLS estimate now suggests an economically more meaningful impact. Increasing milking machine adoption by one standard deviation leads to an increase in the outcome that is equal to 15% of the dependent variable mean.

Last, we report estimation results for the change in social and welfare expenditures per capita in column (3). All specifications now reveal a positive and statistically significant relationship between milking machine adoption and spending changes. The 2SLS estimate also implies a large effect in terms of economic magnitude.

E.2 Additional Results on Persistence

We report detailed regression results on persistence in Table OA15. Here, we use data on local election outcomes from the year 2000 obtained from the Finnish Ministry of Justice. We see that women's vote share (column 1), the share of female candidates (column 2), and women's seat share (column 3) are all positively associated with milking machine adoption

[2] Although not reported here, we note that the estimates remain robust across different specifications and estimation samples.

Table OA14. Policy consequences.

	Δ Education expenditures per capita	Δ Healthcare expenditures per capita	Δ Social and welfare expenditures per capita
	(1)	(2)	(3)
Panel A: FD-OLS			
Milking machine adoption	0.001	-0.003	-0.003
	(0.002)	(0.002)	(0.002)
R^2	0.18	0.24	0.14
Oster's δ for $\beta = 0$	0.51	-1.88	-0.95
Panel B: Reduced form			
Cows per capita	0.318*	-0.002	0.415*
	(0.190)	(0.256)	(0.247)
R^2	0.19	0.24	0.14
Oster's δ for $\beta = 0$	-4.80	0.01	2.62
Panel C: FD-IV			
Milking $\widehat{\text{machine}}$ adoption	0.010	-0.000	0.013
	(0.007)	(0.008)	(0.010)
First-stage F	10.09	8.83	10.09
N	312	311	312
Mean of dependent variable	1.32	2.16	1.54
Geography	✓	✓	✓
Population	✓	✓	✓
Agriculture	✓	✓	✓
Income	✓	✓	✓

Notes: The dependent variable is the change in per capita education, healthcare, and social and welfare expenditures (in 1970 prices) in columns (1), (2), and (3), respectively. The estimation sample includes only rural municipalities. Panels A and B report OLS estimates for the change in the number of milking machines between 1950 and 1970 and the change in women's seat share between 1950 and 1972, respectively. Panel C shows the reduced form of IV, and Panel D reports the IV estimates using the number of cows per capita in 1930 as an instrument for the change in 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.

and the historical change in women's representation, although the estimates show hints of statistical significance only in columns (1) and (3).

To explore whether the long-term changes in political representation associated with milking machine adoption also shaped how citizens perceive local leadership and governance, we turn to survey data from the 1996 *Puolueet ja kunnallisdemokratia* study (Borg 2000). The survey captures responses only from around two hundred individuals across 42 municipalities. Given the limited scope of the sample, we only take the evidence as highly suggestive.

We focus on a set of ten questions that tap into core dimensions of democratic life: citizens' perceived ability to influence municipal politics, their understanding of local decision-making, their trust in politicians, and their views on party responsiveness and accountability. These items allow us to examine whether early changes in political inclusion, particularly the expansion of women's representation, triggered by the milking machine were associated with more inclusive or trusting political cultures in the long run.

We present the regression results in Figure OA8 where the outcomes are measured on a 1–5 scale, and lower response values imply stronger disagreement and higher response values imply stronger agreement with each claim. We control for the same set of municipality-level covariates as in our main analyses and also include controls for respondent characteristics (sex, occupational group, and age). From a substantive point of view, we find suggestive evidence that individuals in municipalities with greater historical exposure to milking machine adoption express more favorable views of party responsiveness and local accountability.

Let us focus on the reduced-form results in Panel C. Respondents from historically more mechanized municipalities express higher agreement with statements reflecting political voice and responsiveness, and lower agreement with statements indicating alienation or disillusionment. Specifically, we find statistically significant positive effects on agreement with the statements that "everybody who wants to can have a say in the affairs of one's home municipality," 'I understand important questions in municipal politics rather well," and that "there is at least one party which tries to promote my interests in municipal politics." Conversely, agreement with the more cynical claims that "I have no say in what the municipal/city council decides" and "parties are only interested in people's votes, not in their opinions" is lower.

The 2SLS estimates in Panel D are in agreement with the reduced-form estimates. However, the OLS estimates for milking machine adoption, reported in Panel A, and the observed change in female representation from 1950 to 1972, reported in Panel B, do not exhibit any clear patterns.

Table OA15. Persistence.

	Women's vote share	Share of female candidates	Women's seat share
	(1)	(2)	(3)
Panel A: Milking machine adoption			
Milking machine adoption (1950-1969)	-0.005	0.017	0.034
	(0.031)	(0.031)	(0.044)
R^2	0.21	0.16	0.23
Panel B: Historical change in women's representation			
Change in women's representation (1950-1969)	0.112**	0.059	0.156**
	(0.048)	(0.043)	(0.071)
R^2	0.22	0.17	0.25
Panel C: Reduced form			
Cows per capita (1930)	7.407	3.367	12.264*
	(4.937)	(4.909)	(6.628)
R^2	0.22	0.16	0.25
Panel D: 2SLS			
Milking machine $\widehat{\text{adoption}}$ (1950-1969)	0.254	0.116	0.421*
	(0.159)	(0.144)	(0.229)
First-stage F	5.21	5.21	5.21
N	279	279	279
Mean of dependent variable	34.51	37.59	32.41
Geography	✓	✓	✓
Population	✓	✓	✓
Agriculture	✓	✓	✓
Income	✓	✓	✓

Notes: The dependent variable is women's vote share in column (1), the share of female candidates in column (2), and women's seat share in column (3). The outcomes are measured in the year 2000 for municipalities that existed in 1972 and 2000. 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.

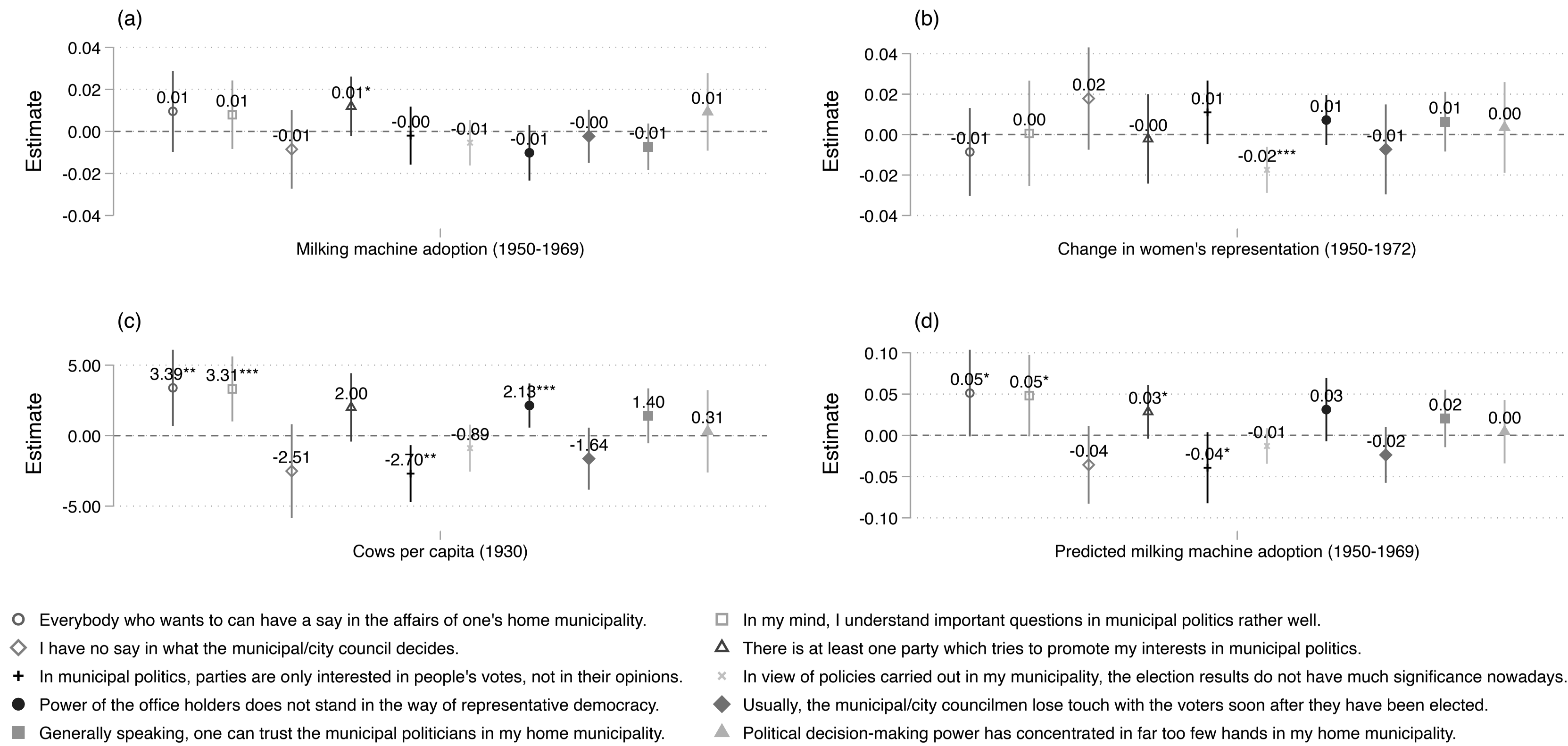


Figure OA8. Effect of the milking machine on modern-day attitudes.

Notes: The figure shows point estimates and their 95% confidence intervals constructed using standard errors adjusted for clustering at the municipality level. All regressions include individual-level controls for age, occupational group, and gender, and the full set of municipality-level controls. *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively.