Rural Electrification, Social Norms, and Female Labor Allocation: Evidence from Rural U.S. and India

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Abstract

I study the impact of rural electrification on the female labor force share and the role of local social norms in mediating this effect. I test theoretical predictions from a model of female labor allocation across home and market production in the presence of social norms. I compare two different historical and institutional settings. First, using data on over 1,900 rural U.S. counties post the Tennessee Valley Authority program (1940), I show that electrification induces a U-shaped change in female labor force share. Second, I leverage detailed information on employment and social norms across over 540,000 Indian villages after a national electrification program (2001) to show that electrification boosts female share of non-agricultural labor by 4-5%, although impacts vary significantly across the caste hierarchy. I also find heterogeneous effects with respect to pre-treatment Purdah (veiling) compliance, gender attitudes and women's historical contribution to production outside the home. (JEL: D13, J16, J22, O12, O18)

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1. Introduction

Rural electrification is a positive productivity shock affecting both home and marketplace production. It has been found to increase consumption, earnings, agricultural productivity, and access to economic opportunity (Burlig and Preonas, 2016; Nagpal and Sovera, 2022; Barnes and Foley, 2004; Dinkelman, 2011). However, there is limited evidence on how rural electrification interacts with social norms to determine female labor outcome trajectories.

This paper investigates how the female share of labor force responds to rural electrification shocks across space and time, and whether local social norms surrounding women's work outside the house influence the direction and magnitude of impact.

I answer these questions in two different contexts and time periods: rural U.S. (1940s) and India (2000s). Linked historical census data in the U.S. context allow me to track short, medium, and long-run effects of rural electrification. However, limited variation in religious and cultural institutions in the rural U.S. sample prevent studying the role of social norms. This is where the rural Indian context is a valuable setting given India's numerous castes and tribes with varying gender norms. The comparative nature of the study enables me to test whether effects vary significantly across different historical and institutional settings.

For the U.S., I estimate the impact of the Tennessee Valley Authority rural infrastructure development program (TVA) on female labor force share trajectories. The analysis spans 1,907 counties in the rural U.S. South. While

the TVA was a bundled rural infrastructure program, its primary component was electricity generation and subsidized electricity provision.

Prior research by Kline and Moretti (2014) finds that the primary effect of TVA was a shift in sectoral composition – a decline in agricultural employment and sustained growth in manufacturing employment and wages – in treated counties. This makes it an ideal setting to test impacts on female labor allocation and, more broadly, the U-shape theory of female labor force participation. The U-shape theory predicts that structural transformation initially reduces female paid work outside the household, until higher wages pull women back into marketplace production (Boserup, 1970; Pampel and Tanaka, 1986; Goldin, 1994; Çağatay and Özler, 1995; Ngai and Petrongolo, 2017).

Using three sets of counterfactual groups, as in Kline and Moretti (2014), I find a 6.5% decline in female share of civilian force within the first decade of the TVA program. However, this effect reverses to a 7% increase after 20 years, and remains positive but is less robust in the very long term. I interpret this result as causal evidence of the U-shape theory of female labor force participation.

I turn to the rural Indian context to understand how rural electrification shocks interact with local social norms surrounding women's workforce participation outside the household. I find no effects of rural electrification on overall village-level female share of labor force but a 1–1.4 percentage point (4–5%) increase in female share of the *non-agricultural* labor force within the first decade of rural electrification. Further, caste plays a significant role. Scholarship on caste and gender in India documents an inverse relationship between restrictions on women's mobility outside the household and a group's rank in the caste hierarchy (Dube, 2003). In this vein, I find that the female

share of labor force *declines* by 7–10 percentage points (28–38%) across sectors in areas dominated by upper castes. On the other end of the caste hierarchy, I find that the female share of firm owners *increases* by 6.3 percentage points (63%) at the expense of a 5 percentage point (25%) decline in cultivation. Importantly, the caste-divergent impacts are observed after accounting for variation in income across social groups. In districts where at least a quarter of the population is Muslim, I find that baseline compliance toward Purdah (veiling) mediates observed effects. Specifically, the interaction effect of baseline Purdah compliance and rural electrification is a 7 percentage point (48%) decline in overall female share of total labor force. I find suggestive evidence of differential effects by baseline attitudes with respect to women's duty toward unpaid home production. Finally, I find that the impact of rural electrification is higher in villages associated with greater historical economic value of women, as instrumented by exogenous soil composition following Carranza (2014).

In terms of mechanisms, I find direct evidence suggesting that changes in marketplace productivity and wages as opposed to home productivity explain the results in the U.S. context. Across both rural U.S. and Indian contexts, employment opportunities in the manufacturing sector drive the observed results. In India specifically, the aggregate increase in female share of non-agricultural workforce is concentrated in tobacco production, manufacturing of coke oven products, gas and petroleum manufacturing and distribution, financial services, and technical testing services.[1]

1. This category includes the performance of physical, chemical and other analytical testing of all types of materials and products, certification of products, including consumer goods, motor vehicles, aircraft, pressurized containers, nuclear plants etc. periodic road-safety testing

This paper contributes to the evidence on electrification and gender outcomes. In the U.S., plausibly exogenous variation in demand for female labor has been shown to drive household technology adoption (Bose et al., 2022). Kline and Moretti (2014) provide results on aggregate impacts of the TVA program on county-level consumption, employment, wages, and sectoral composition of the workforce. I build on their work by delving into gendered impacts of the TVA program in treated counties.

In developing country contexts, Dinkelman (2011) finds a substantial increase in female share of labor force five years after electrification in South Africa. Similarly, in rural Guatemala, Grogan (2018) finds an increase in time spent by women on marketplace production following rural electrification. In the Indian context, this paper builds on prior primarily descriptive evidence (Van de Walle et al., 2013; Samad and Zhang, 2019; Sedai et al., 2021) by providing quasi-experimental estimates of the impact of rural electrification on female labor allocation and incorporating the role of social norms in estimating impacts.

More broadly, this paper contributes to the literature on productivity shocks and female labor force participation across contexts. In the U.S. context, I provide causal evidence of the U-shape trajectory of female labor force participation following economic growth (Boserup, 1970; Durand, 2015; Psacharopoulos and Tzannatos, 1989; Goldin, 1994). Empirical evidence investigating the existence of the U-shape across space and time mostly rely on

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of motor vehicles, testing with use of models or mock-ups (e.g. of aircraft, ships, dams etc.), operation of police laboratories: NIC 2008 Codes.

cross-country regressions (Mammen and Paxson, 2000; Tam, 2011; Tsani et al., 2013) or within country panel data analyses (Olivetti, 2014; Tilly and Scott, 2016).

Further, the paper provides insights on why evidence in support of the U-shape result is mixed in developing countries (Gaddis and Klasen, 2014). India has lower than expected aggregate female labor force participation despite decades of uninterrupted economic growth (Klasen and Pieters, 2015; Mehrotra and Parida, 2017). Specifically, social norms have been identified as a key determinant of how female labor supply responds to productivity shocks (Akerlof and Kranton, 2000; Bursztyn et al., 2018; Jayachandran, 2021). I integrate the role of social norms towards women's workforce participation with a classic model of female labor allocation across home and market production (Gronau, 1977) and then provides empirical evidence in support of the model's predictions. Therefore, this study adds to the growing literature on the interaction between social norms surrounding women's workforce participation outside the household and female labor supply elasticity (Agte and Bernhardt, 2023; Ho et al., 2023).

2. Conceptual Framework

The theoretical framework underlying this paper is a modified version of the model of home production in Gronau (1977). Formally, the household is unitarily deciding how to allocate female labor. The utility function of the

household is given by:

$$U = U(X, L) \tag{1}$$

Where X represents goods and services that can be consumed and L is leisure. Goods X can either be produced in the marketplace (X_M) or through home production (X_H):

$$X = X_M + X_H \tag{2}$$

Home production represents unpaid labor whereas market production represents working for a wage. The production function for home production is given by:

$$X_H = f(H) \tag{3}$$

where H is time spent on unpaid labor and $f()$ has diminishing returns to scale ($f' > 0, f" < 0$). The household faces the following budget constraint:

$$X_M = WN + A, \tag{4}$$

Where W is the market wage rate, A represents alternate income (e.g. wealth), N denotes hours spent in marketplace work. The household is subject

to the following time constraint:

$$T = L + H + N \tag{5}$$

We have the following first order conditions to the maximization problem:

$$\frac{U'(L)}{U'(X)} = f' = W^* = W \tag{6}$$

Where the marginal productivity of work at home equals the marginal rate of substitution across consumption and leisure, which also equals the opportunity cost of time (W*). If $N > 0$, the marginal rate of substitution across consumption and leisure equals the wage rate.

In the current norms agnostic set up, let us consider the impact of an electrification shock. An increase in marketplace productivity would operate through an increase in real wages, i.e. a wealth effect. Given an exogenous increase in W, the model predicts a reduction of hours in home production since home production becomes less profitable. The extent to which hours allotted to marketplace production increases depends on whether the income effect (from a higher wage) dominates the substitution effect. However, the upward sloping supply curve suggests that the substitution effect is likely to dominate the income effect at the lower end of number of hours worked in the marketplace. So, assuming a lower income effect relative to the substitution effect on women's

leisure, rural electrification would reduce hours spent in home production (H) and increase hours spent in marketplace production (N).

On the other hand, suppose rural electrification translated to an increase in home productivity - $f'(H)$. The model predicts an increase in leisure and home production (H), and a decrease in marketplace production (N). Finally, if rural electrification increased both home and marketplace productivity, the aggregate effect is ambiguous. Putting everything together, we have the following predictions regarding the impact of electrification on female labor allocation:

TABLE 1. Rural Electrification: Theoretical Predictions

Channel	Prediction
Market productivity ↑	H ↓; N ↑
Home productivity ↑	H ↑; N ↓

In the absence of social norms, the model predicts that if the market productivity channel dominates and substitution effects are higher than income effects, female labor allocation will move from unpaid home production to paid marketplace production. On the other hand, if the home productivity channel dominates, female labor allocation will move in the opposite direction.

2.1. Incorporating Social Norms

2.1.1. Stigma against women's participation in the workforce outside the household. In order to incorporate the influence of local social norms surrounding women's workforce participation outside the household, I model

the associated costs of breaking social norms as a cost to market entry.[2] We now have the following revised budget constraint:

$$X_M + \delta C = WN + A \tag{7}$$

Where δ is an indicator variable that describes the concerned woman's marketplace employment status. :

$$\delta = \begin{cases} 1 & \text{if} \quad N > 0 \\ 0 & \text{if} \quad N = 0 \end{cases} \tag{8}$$

The implication of including this binary cost[3] is as follows. The marginal household that would have been lured into market production given electrification-induced increase in market productivity will instead remain out of market production and allocate time across leisure and home production.

Corollary 2.1.1: If there is a cost to enter market production in the form of social norms surrounding women's mobility outside the household:

2. For the purpose of this model, I am not incorporating commute costs. However, time costs of marketplace production can be incorporated in the time constraint.

3. In the following subsection, I incorporate the costs as proportional to hours spent working.

1. The share of women moving from home production or leisure to market production hours following an increase in market productivity shocks will be lower than the equilibrium without social norms.
2. The share of women retreating from market production to home production following an increase in home productivity will be higher than the equilibrium without social norms.

Notice that if market production is taking place physically within the household (for e.g. home-based industries), social norms towards women's workforce participation outside the household do not bind and the model's predictions that are summarized in Table 1 hold.

2.1.2. Stigma as a function of women's share of household wage income. Suppose the dominant local social norm is a male-breadwinner model (Bertrand et al., 2015; Gupta, 2020) and stigma accrues as a linear function of women's share of household income (e.g. because it depends on the number of hours spent by the woman in marketplace production), we have the following revised budget constraint:

$$X_M + CN = WN + A \Rightarrow X_M = (W - C)N + A \tag{9}$$

Clearly, the imposition of this norm can be interpreted as a wage penalty for each hour that is spent in market production. As a result, this social norm reduces the equilibrium female market labor supply response, irrespective of physical place of market production (i.e. at home or outside the household).

Corollary 2.1.2: If there is a penalty that accrues on each unit of time spent in market production due to stigma towards breaking the male breadwinner model:

1. A shock (such as rural electrification) that increases marketplace productivity will result in a lower increase in women's market production compared to a stigma-free equilibrium.
2. An intervention that increases home productivity will result in a greater increase in women's home production hours and a more pronounced decrease in their market production hours compared to the stigma-free equilibrium.

In this paper, I am able to test the baseline model predictions (without social norms) in the rural U.S. context, and the social norm-augmented model in the rural Indian context.

3. Context

3.1. Rural U.S.

Under the Tennessee Valley Authority (TVA) program, 163 counties within the Tennessee Valley area received approximately 20 billion USD in terms of federal financing for construction of electricity-generating dams, flood control systems, and road constructions between 1940-1960. Between 1950-1955, the average annual federal subsidy per household amounted to approximately 10% of household income (Kline and Moretti, 2014). After 1960, this share became

negligible since the U.S. Congress declared the TVA operation fiscally self-sufficient.

The most notable transformation brought about by the TVA resulted from the electricity-generating dams.[4] The intervention entailed both large investments in electricity-generation infrastructure and subsidized electricity provision to municipal power authorities and cooperatives within treated counties. The purpose of the program was to enable structural transformation by attracting manufacturing industries to the primarily agrarian region.

Following Kline and Moretti (2014), I use three sets of control groups to uncover the impact of the TVA program on female labor force trajectories in treated counties: (i) 1,744 untreated counties in the rest of the U.S. with similar pre-treatment period characteristics[5], (ii) 779 untreated counties in the U.S. South with similar pre-treatment period characteristics, and (iii) 828 counties that were originally proposed by the Congress as regional authorities that would receive TVA-like "big push" infrastructure investments. However, legislation for the inclusion of these additional counties ultimately failed due to lack of support in Congress. Figure A.1 in the Appendix shows the geographical distribution of the TVA program and non-TVA counties that were originally

4. https://www.archives.gov/milestone-documents/tennessee-valley-authority-act

5. Following Kline and Moretti (2014), pre-treatment period characteristics consist of a quadratic term for the 1920 and 1930 log population and their interactions; the urban share in 1920 and 1930; the log employment in 1920 and 1930; a quadratic term for the agricultural employment share in 1920 and 1930; a quadratic term for the manufacturing employment share in 1920 and 1930; the log wages in manufacturing and trade for 1920 and 1930; dummy variables for missing wage data in manufacturing or trade in 1920 and 1930; farm values, owner-occupied housing values, and rental rates for 1920 and 1930; a quadratic term for the white share in 1920 and 1930; the share of the population aged 5 and older that were illiterate in 1920 and 1930; the share of foreign-born whites in 1920 and 1930; the share of households with a radio in 1930; the 1930 unemployment rate; and the maximum elevation and elevation range to account for mountainous terrain.

slated to receive TVA-like infrastructure development programs. Kline and Moretti (2014) show that control counties are balanced on change in population, employment, manufacturing wages, industry composition and agricultural land values between 1900–1940, conditional on pre-program characteristics. Further, Table 2 shows balance on female work outcomes in the pre-treatment period.

TABLE 2. Balance Test: Pre-treatment Female Workforce Characteristics

	(1)	(2)	(3)
Female % of...	All	South	Proposed Auth.
Manufacturing workers (1910)	-0.022	-0.019	-0.011
	(0.015)	(0.016)	(0.015)
Wholesale establishment workers (1930)	-0.005	-0.002	-0.002
	(0.007)	(0.006)	(0.010)
Unemployed workers (1937)	0.010	-0.005	0.003
	(0.013)	(0.014)	(0.013)
Civilian labor force (1940)	0.003	0.001	0.009
	(0.011)	(0.006)	(0.007)
SE	Clustered	Conley	Conley
Conley Bandwidth	NA	200 miles	200 miles

Notes: The table above shows the treatment effect of TVA on pre-treatment outcome variables for treated counties with respect to three comparison groups. Column (1) shows results with respect to 1,744 untreated counties with similar pre-treatment characteristics identified in Kline and Moretti (2014). Column (2) shows results with respect to 779 untreated counties in the U.S. South with similar pre-treatment characteristics to TVA counties. Column (3) shows results with respect to 828 counties that were originally proposed to receive TVA-like interventions but did not end up receiving treatment due to legislative deadlock. Each observation unit is a county. Standard errors are clustered at the state level in Column (1). Conley standard errors with a 200 mile distance cutoff have been used to account for spatially correlated standard errors in Columns (2) and (3). All specifications include controls for pre-treatment characteristics described in footnote 5.

3.2. Rural India

In 2005, the Indian government launched a national rural electrification program – the Rajeev Gandhi Grameen Vidyutikaran Yojana (RGGVY) – with the aim of extending electricity access to more than 100,000 villages. As of 2001, 138,535 villages (out of 589,780) across the country did not have access to electricity. Appendix Figure A.3 illustrates the spatial distribution of nighttime luminosity across rural India in the pre-program period.

Funds for the RGGVY program were distributed in two phases, where districts were provided funding for implementation on a first-come, first-serve basis. In the first wave, 229 districts received funding to implement the program under the 10th Five-Year Plan. In the second wave, 331 districts received funds to implement the program under the 11th Five-Year Plan. Figure 1 illustrates the two groups of districts.

Exploiting the staggered roll-out design, Burlig and Preonas (2016) and Nagpal and Sovera (2022) found that the RGGVY program led to a tripling of household consumption expenditure[6] and a 1.6 % increase in agricultural production, respectively. I study the impact of this rural electrification program on female labor allocation, given local social norms surrounding women's workforce participation.

According to the 2001 population census records, the baseline female share of labor force across rural India was 23% whereas the female share of firm owners was below 3% nationally. The labor force includes formal and informal workers engaged in employment for at least six months a year. Further, baseline female share of labor force was highest within agricultural labor and household-based industries. The national baseline aggregates mask variation by social groups. Figure 2 shows baseline female labor force participation rates (LFPR) across rural India, by social groups. Specifically, female labor force participation reverses along the caste hierarchy. Hindu Brahmins have the lowest female LFPR, at 6%, compared to 46% and 49% among formerly untouchable Scheduled Castes (Dalit) and Scheduled Tribe (Adivasi) groups. Figure A.4 in

6. In the subset of villages with a population $\geq$ 2000 individuals.

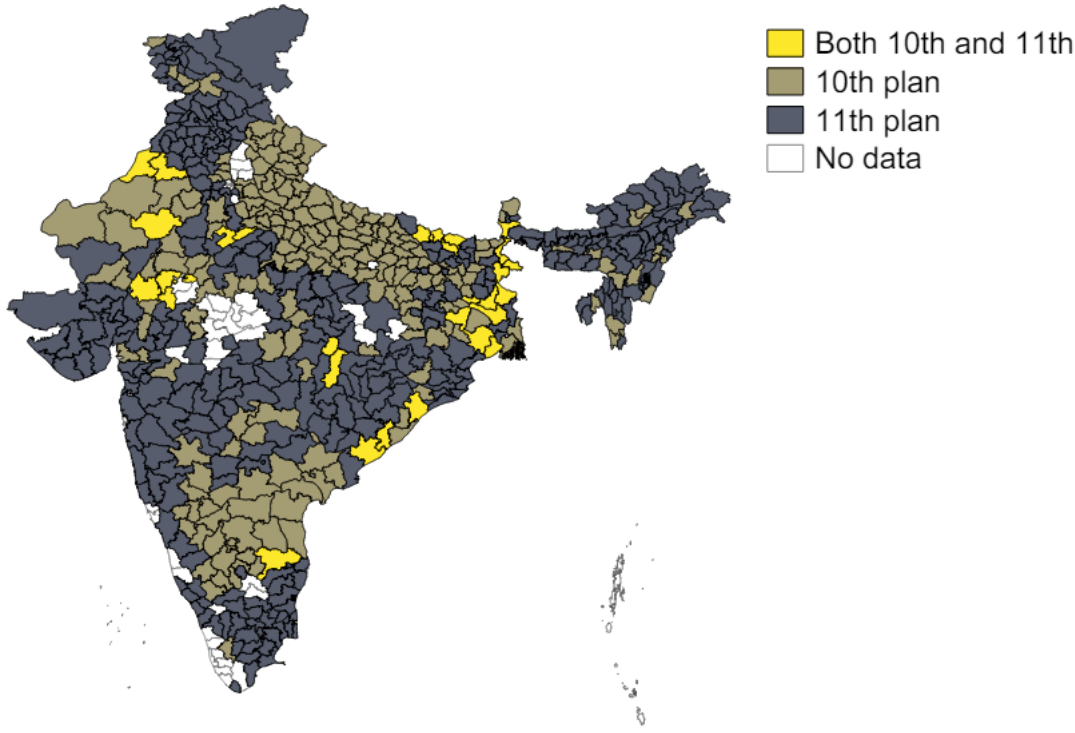


FIGURE 1. Staggered Roll-out of National Rural Electrification. The map above shows two sets of districts. 10th plan districts received funds for rural electrification in 2005. 11th plan districts received funds for rural electrification in 2015. Union territories and the state of Goa were not a part of the program and are, therefore, not included in the analysis. The districts in white were not eligible for the electrification program. Note that 30 districts received funds for the program under the 10th and 11th plan, they have been treated as "Early adopters" in the analysis, following Burlig and Preonas (2016).

the Appendix shows that these caste-wise differences in baseline female labor force participation persist even after holding quintiles of consumption per capita constant.

The inverse baseline relationship between caste rank and female LFPR illustrated in Figure 2 aligns with the belief among Hindus that upper caste women are more vulnerable to "permanent pollution" compared to women of marginalized castes and tribes. In other words, concerns with preserving the "purity" of women are heightened at the upper end of the caste hierarchy (Dube, 2003). Given this, restrictions surrounding women's workforce participation outside the household would be more stringent among Hindu dominant castes in order to prevent upper caste women from interacting with individuals, particularly men, from dominated castes and tribes. This variation in norms surrounding women's workforce participation across the caste hierarchy is critical to the analyses presented in subsequent sections of this paper.

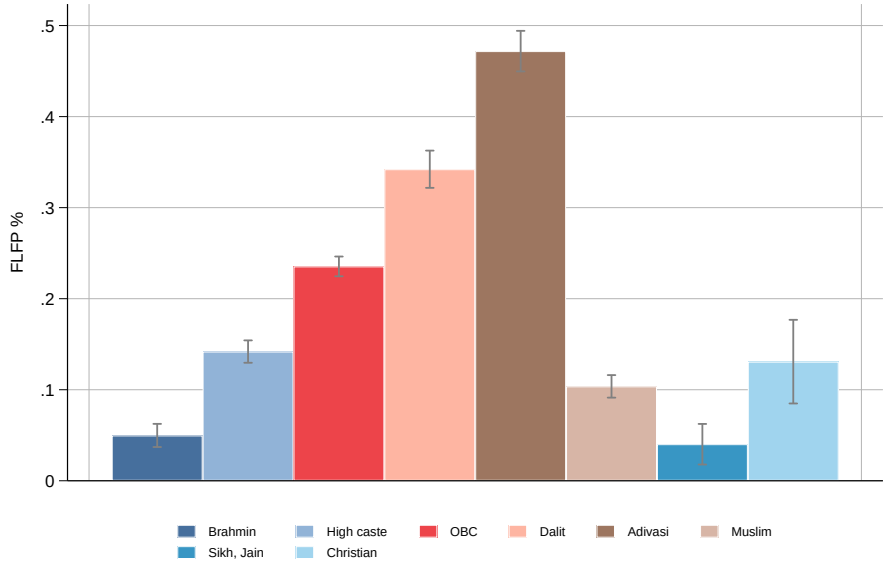


FIGURE 2. Female Labor Force Participation, by Social Groups (2005). The figure shows female labor force participation by social groups. The underlying dataset is a national household survey representative at the district level (IHDS, 2005). The denominator for the FLFP measure is 15-49 year old women within each group at the time of survey. The measure incorporates informal and formal occupations reported by respondents. The group "High Caste" represents all non-Brahmin Hindu upper castes; "OBC" represents Hindu backward castes (Shudras); "Dalit" represents Scheduled Caste groups and "Adivasi" represents Scheduled Tribe groups.

4. Data

4.1. Rural U.S. South

I use the dataset compiled by Kline and Moretti (2014) for their study on the long-run effects of the Tennessee Valley Authority (TVA) rural infrastructure development program. Microdata from the Population Census, Manufacturing Census, and Agricultural Census were combined to create a county-level panel dataset spanning 1,907 counties between 1900–2000 for the original study. Out of these 1,907 counties, 163 are assigned as areas treated by the TVA program.

The remaining 1,744 counties belong to one of three control groups (described in detail in Section 3.1).

4.2. Rural India

A village-level panel dataset was constructed by combining data on district-level rural electrification treatment wave status with village-level outcomes on female shares of employment and firm ownership. The primary components of the analysis dataset include three consecutive Indian Population Censuses (1991, 2001, and 2011), in combination with three successive Indian Economic Censuses (1998, 2005, and 2013).

The Population Census Data is a comprehensive census of households in India, with publicly available data at the village and town level. The Population Census Abstract (PCA) comprises the number of households, population of men and women by social groups, and number of workers across various occupation categories. The Economic Census of India is a complete survey of non–farm economic entities. This census spans all formal, informal, government, and private firms, excluding entities engaged in crop production. The sampling frame for the Economic Census is the house listing of the most recent Population Census at the time of survey. These datasets were extracted from and merged using geographic identifier concordances provided on the Socio-Economic High Resolution Rural Urban Geographic (SHRUG) data platform (Asher et al., 2021). I combined the analysis dataset with district-level caste composition and social norm measures from the India Human Development Survey (2005), which is a nationwide household survey, representative at the

district level. Finally, I integrated the analysis dataset with the digitized FAO-UNESCO Soil Map of the World (FAO/UNESCO, 2003). Using sub district-level measures of soil texture in this merged dataset, I am able to instrument for historical deep tillage requirements, as in Carranza (2014). Appendix Figure A.2 shows the spatial distribution of clay content in soil units across India.

5. Empirical Strategy

5.1. Rural U.S.

Following Kline and Moretti (2014), the U.S.-specific analysis employs the following empirical specification:

$$Y_i = \beta_0 + \beta_1 TVA_i + \gamma X_i + \varepsilon_i \tag{10}$$

Where Y_i represents the percentage change in the female labor force share across three time periods (1940–1950, 1950–1960, and 1960–1970), at the county i level; TVA_i is an indicator for whether county i lies within the TVA treatment region; γ_i represents a vector of county-specific controls including population, demographic, employment, wage, and workforce composition controls from the pre-program period (1920 and 1930), maximum elevation and elevation range, as well as county area. Results are presented using the three groups of counterfactual counties: (i) untreated counties with similar pre-treatment characteristics (see Section 3.1), (ii) untreated counties in the U.S. South with similar pre-treatment characteristics, and (iii) counties that were slated to

receive a TVA-like program but did not due to legislative deadlock. Standard errors are clustered at the state level in analyses with respect to untreated counties across the U.S.. Due to limited number of states in the analyses with respect to control counties in the U.S. South and proposed alternative project authority counties, Conley standard errors (Conley, 2010) with a distance cutoff at 200 miles are used instead, following Kline and Moretti (2014).

5.2. Rural India

The India-specific analyses employs the following difference-in-difference specification:

$$Y_{it} = \beta_0 + \beta_1 Treatment_i * Post_t + \gamma_i + \psi_t + X_{it} + \eta_{it} \tag{11}$$

Where Y_{it} represents outcome variable of interest in village i in period t. Each village is observed at two time periods before program implementation (1991 and 2001) and seven years since program implementation (2011-12). $Treatment_i$ is an indicator variable for whether the village belongs to a district which received funds for rural electrification in 2005 (under the 10th Five-year Plan). Control districts received funds for rural electrification in 2015 (under the 11th Five-year Plan). Since the endline observations precede the year in which control group districts received funds for electrification, concerns with variation in treatment timing in staggered difference-in-difference studies (Goodman-Bacon, 2021) do not apply to this paper.

$Post_t$ is an indicator variable for whether the outcome variable for village i was observed after program implementation. γ_i and ψ_t are district and time-period fixed effects respectively. X_{it} is a vector that includes state-specific linear time trends, within state consumption quartile specific linear time trends and national consumption quartile specific time trends. All regressions are weighted by baseline village population. Standard errors are clustered at the district level across all analyses since policy variation is at the district level.

The identification assumption is that early (10th-plan) and late (11th-plan) electrification adopter districts have parallel counterfactual trajectories after controlling for the time trends and fixed effects described above. Column (1) of Table 4 shows results from the formal identification assumption test and is described in greater detail in Section 6.1.2.

6. Results

6.1. Main Results

In this section, I first describe primary results from the rural U.S. and Indian contexts and conclude by exploring mechanisms explaining these reduced form results.

6.1.1. Rural U.S.

Figure 3 shows the non-parametric trajectory of female share of civilian labor force across treated and control counties (i.e. non-TVA counties with comparable pre-treatment characteristics across the U.S.), across six decades since implementation.

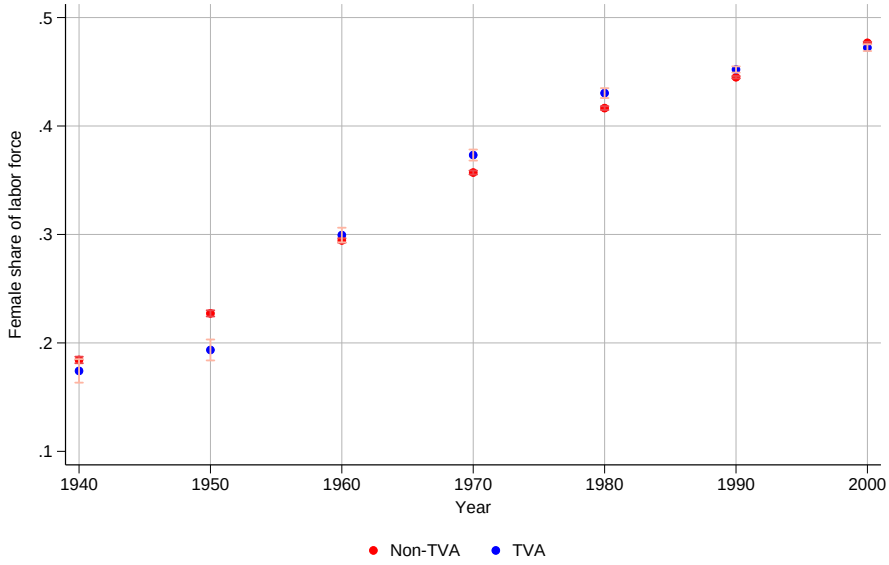


FIGURE 3. Female share of Labor force (1940–2000), by TVA status. The figure shows average female share of civilian labor force across TVA and non-TVA counties for each decade between 1940–2000. Most of the TVA investment and construction took place between 1940-1950.

Table 3 formalizes the relationship between the county-level female share of labor force trajectory and the TVA program, following the empirical specification described by Equation (10). Based on my preferred specification (Table 3, Column (6)), I find that the percentage change in female share of labor force was 1.5 percentage points (6.5%) lower in TVA treated counties compared to counterfactual counties in the near-term (1940–1950)[7]. In the medium-term the direction of impact reverses. Specifically, the percentage change in female share of labor force was 2.1 percentage points (7%) higher in TVA treated counties compared to counterfactual counties between 1950-1960. However,

7. Mean female share of labor force in non-TVA counties was 23%, 29%, and 48% in 1950, 1960, and 1970 respectively.

the positive impact diminishes substantially and is statistically insignificant across specifications that include controls (even-numbered columns) after 1960. Importantly, federal financing of the TVA program ended after 1960.

TABLE 3. Impact of TVA on Change in Female share of Labor Force

	(1) All	(2) All	(3) South	(4) South	(5) Proposed Auth.	(6) Proposed Auth.
1940-1950	-0.024***	-0.015***	-0.008	-0.012*	-0.021**	-0.015**
	(0.007)	(0.006)	(0.007)	(0.007)	(0.009)	(0.007)
1950-1960	0.039***	0.022***	0.031***	0.021***	0.032***	0.021***
	(0.006)	(0.006)	(0.003)	(0.004)	(0.004)	(0.004)
1960-1970 (dec.)	0.011***	0.005	0.010***	0.004	0.010***	0.005
	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)
Controls	No	Yes	No	Yes	No	Yes
SE	Clustered	Clustered	Conley	Conley	Conley	Conley
Conley Bandwidth	NA	NA	200 miles	200 miles	200 miles	200 miles

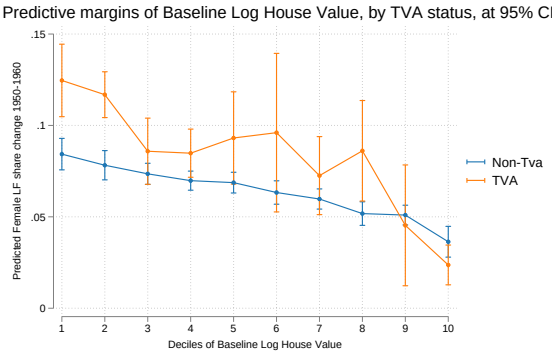
Notes: The table above shows impact of TVA treatment on change in county-level female share of civilian labor force across three time periods. Columns (1)-(2) show results with respect to 1,744 untreated counties with similar pre-treatment characteristics identified in Kline and Moretti (2014). Columns (3)-(4) show results with respect to 779 untreated counties in the U.S. South with similar pre-treatment characteristics to TVA counties. Columns (5)-(6) show results with respect to 828 counties that were originally proposed to receive TVA-like interventions but did not end up receiving treatment due to legislative deadlock. Each observation unit reflects a county. Standard errors are clustered at the state level in Column (1). Conley standard errors with a 200 mile distance cutoff have been used to account for spatially correlated standard errors in Columns (2) and (3). Specifications across columns (2), (4), and (6) include controls for pre-treatment characteristics described in footnote 5. Mean female share of labor force in non-TVA counties was 23%, 29%, and 48% in 1950, 1960, and 1970 respectively.

The results in Table 3 confirm the U-shape theory of female labor force participation. The theory predicts that the introduction of a new technology initially results in women retreating from paid marketplace production due to income effects, decline in female labor demand in agriculture and own-substitution effects. Eventually, as manufacturing employment continues to expand and wages continue to rise, women are lured back into marketplace production.

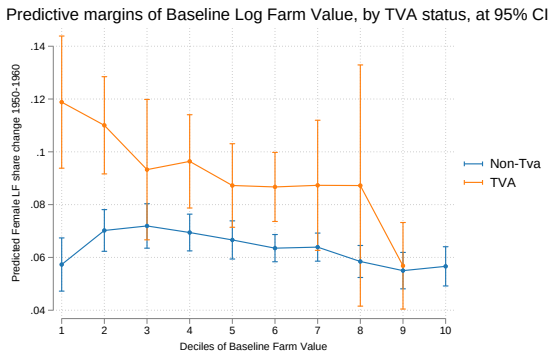
However, the aggregate results mask heterogeneity by pre-program wealth and income. Figure 4 shows that the positive impact of TVA on change in female share of labor force between 1950–1960 is concentrated in poorer counties,

as measured by deciles of pre-program log employment, median house values, and farm values. This result could be driven by two channels. First, poorer households had a greater opportunity cost of leisure compared to wealthier households. Second, there could have been a "male-breadwinner" social norm resulting in stigma accruing to a husband if his wife's marketplace participation signals inability to "provide" for the family. Poorer households could not afford to subscribe to these norms despite resulting stigma.

Panel A



Panel B



Panel C

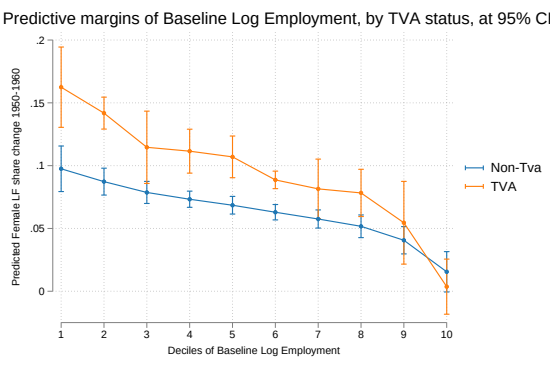


FIGURE 4. Impact of TVA, Conditional on Baseline Wealth. The figure above shows the differential impact of the TVA program on change in female share of civilian labor force (1950-60), by baseline wealth of counties. In Panel A, baseline wealth is measured by the log of median house values of counties in the decade preceding TVA implementation (1930). In Panels B and C, baseline wealth is measured by the log of median farm values of counties (1930) and the log of employment (1930) respectively. The Y axis represents predicted values of the outcome variable conditional on county-specific demographic controls, maximum elevation, elevation range and area measures.

In order to explicitly test the interaction between social norms surrounding women's workforce participation and the impact of rural electrification on the female share of labor force, I turn to the Indian context.

6.1.2. Rural India.

Table 4 shows the average impacts of rural electrification on female share of labor force, at the village level. Column (1) of Table 4 shows results from a formal test of the parallel counterfactual trajectories assumption across treated and control districts, after controlling for linear time trends and fixed effects. The results suggest that the parallel trends assumption is satisfied across village-level female shares of agricultural laborers, cultivators, non-agricultural workforce, firm owners and household industry workers, as well of share of firms that employ women. However, female share of overall workforce was declining in treated districts in the pre-treatment period compared to control districts in the decade preceding electrification. Given this, the coefficients estimating the impact of electrification on overall female share of labor force will be a biased estimate of the true impact.

Column (2) of Table 4 suggests that rural electrification is not associated with discernible positive or negative impacts on aggregate female share of labor force. However, this result should be interpreted with caution given differential pre-trends for this outcome. On the other hand, rural electrification is associated with a 1–1.4 percentage point (4–5 %) positive and statistically significant impact on female share of non-agricultural labor force. I also find

that rural electrification is associated with a 1.3 percentage point (4%) increase in share of firms that hire women.[8]

TABLE 4. Impact of Rural Electrification on Female Share of Labor Force in India

	(1) Pre-treatment		(2) Post-treatment		(3) N	(4) Control mean
Female % of ...						
Main workers	0.007*	(0.004)	0.004	(0.003)	1618715	0.26
Ag labor	0.007	(0.005)	0.001	(0.003)	1383020	0.32
Cultivators	0.011	(0.007)	0.002	(0.003)	1575180	0.21
Non-ag (Pop census)	-0.007	(0.005)	0.009***	(0.004)	1473487	0.24
Household firms	-0.002	(0.008)	0.009	(0.006)	916514	0.28
Non-ag (Ec. census)	0.001	(0.005)	0.014***	(0.005)	1395088	0.29
Firm owners	-0.001	(0.003)	0.004	(0.004)	1395088	0.10
Firms employing women	0.006	(0.008)	0.013*	(0.007)	1395088	0.34

Notes: Column (1) in the table above is a formal test of parallel pre-trends. The coefficients show the interaction effect of being in a treated district and difference in village-level female labor force shares in the pre-treatment period (1991) with respect to baseline (2001). Column (2) shows the actual impact of the program on share of female labor force in the post-treatment period (2011). All specifications include district and year fixed effects and linear time trends at the state, within state household expenditure decile and national household expenditure quartile levels. Standard errors are clustered at the district level. Regressions have been weighted by baseline village population.

As motivated by the conceptual framework, I expect that local social norms surrounding women's labor allocation in marketplace production mediates the female labor supply response to rural electrification. Given the substantial variation in baseline female labor force participation by caste groups (see Figure 2) and the insight that concerns of female purity are concentrated at the upper end of the caste hierarchy (Dube, 2003), Table 5 shows differential impacts of

8. While all regressions have been weighted by baseline village population, Appendix Table A.1 shows that results remain unchanged when the analysis sample is restricted to villages with baseline population greater than 2000 individuals. This robustness check is motivated by Burlig and Preonas (2016)' finding that rural electrification led to a substantial increase in consumption expenditure specifically in villages with more than 2,000 individuals. On the other hand, Nagpal and Sovera (2022) find that the underlying electrification program increased agricultural productivity irrespective of baseline population.

rural electrification across areas dominated by castes at the highest and lowest ends of the caste hierarchy.

Specifically, I find that in areas dominated by "upper" castes (Brahmins and Hindu Forward Castes), rural electrification is associated with a 6.8 percentage point (28%) decline in female share of non-agricultural workers[9], 10.4 percentage point (38%) decline in female share of household industry based workers, and a 6.3 percentage point (63%) decline in female share of firm owners.

On the other hand, in areas dominated by "backward" castes (Scheduled Caste (*Dalit*) and Scheduled Tribes (*Adivasi*)), rural electrification is associated with a structural transformation type response by female workers. Specifically, I find a 5 percentage point (25%) decline in female share of cultivators and a 6.3 percentage point (63%) increase in female share of firm owners. The point estimates on female share of agricultural labor are negative, and those on female share of non-agricultural employment share are positive but not statistically significant.

As a further exploration of how social norms mediate the female labor supply response to rural electrification, I restrict the sample to districts where at least 25%[10] of the population is Muslim, and then investigate differential effects by baseline compliance with Purdah (veiling) norms.

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9. Note that the results on female share of non-agricultural employees based on the Economic Census (as opposed to the Population Census) suggest a 5 percentage point (17%) decline as well. However, this point estimate is not statistically significant.

10. The 25% threshold has been chosen based on experimental evidence of the population share at which a group's own social norms become salient (Centola et al., 2018). Note that at baseline, 8% of the national rural population was Muslim (IHDS, 2005).

TABLE 5. Impact of Rural Electrification on Female Share of Labor Force, Interacted with District Caste Composition

	(1) Treatment x Marginalized caste %		(2) Treatment x Upper caste %		(3) N	(4) Control mean
Female % of ...						
Main workers	-0.025	(0.021)	-0.005	(0.022)	510243	0.26
Ag labor	-0.019	(0.028)	-0.012	(0.027)	444884	0.33
Cultivators	-0.050**	(0.023)	0.013	(0.026)	493957	0.20
Non-ag (Pop census)	0.021	(0.026)	-0.068**	(0.027)	485511	0.24
Household	0.014	(0.032)	-0.104***	(0.038)	328786	0.27
Non-ag (Ec. Census)	0.034	(0.041)	-0.051	(0.044)	469896	0.30
Firm owners	0.063**	(0.031)	-0.063**	(0.031)	469896	0.10
Firms employing women	0.023	(0.055)	-0.089	(0.058)	469896	0.35

Note: The table above shows the average impact of rural electrification interacted with district-level marginalized (scheduled castes and tribes) caste share (Column (1)) and upper caste population share (Column (2)) on female share of a) total workforce, b) agricultural workers, c) cultivators, d) non-agricultural workforce, e) household industry-based workforce, and f) female share of firm owners. The coefficients represent δ from the following specification: $Y_{it} = \beta_0 + \beta_1 Treatment_i * Post_t + \tau Casteshare_i * Post_t + \delta Casteshare_i * Treatment_i * Post_t + \gamma_i + \psi_t + X_{it} + \eta_{it}$; where X_{it} represents linear time trends at the state, within state household expenditure decile and national household expenditure quartile levels. All specifications include district and year fixed effects.Standard errors have been clustered at the district level. Regressions have been weighted by baseline village population

Table 6 shows the results. Column (1) shows that parallel pre-trends are satisfied in this sub-sample. Column (3) illustrates that in more conservative districts, as measured by baseline Purdah compliance, rural electrification is associated with a 6.8 percentage point (48%) decline in female share of total labor force. This decline is mostly driven by decreasing female share of agricultural laborers (5 pp, 29%) and cultivators (8 pp, compared to a control mean of 0.08).

However, I also observe a 8.2 percentage point increase in female share of firm owners suggesting a shift in marketplace production away from labor on the fields to self-employment. One justification of this result could be that in Purdah-dominant districts, as soon as household based self-employment opportunities increase, women shift from paid economic production that

require interacting with members outside the household to home-based firms where employment is largely provided by family members. This explanation is less about stigma accruing from women participating in paid economic production *(Corollary 2.1.2)* and more about restricting women's interaction with members outside the household *(Corollary 2.1.1)*. However, these results should be interpreted with caution since the interacted impacts of Purdah and electrification on female share of non-agricultural workforce are imprecise and inconsistent across data sources.

TABLE 6. Impact of Rural Electrification on Female Share of Labor Force, Interacted with Baseline Purdah Compliance

	(1) Pre-treatment		(2) Post-treatment		(4) Post-treatment x Purdah share		(5) N	(6) Control mean
Female % of ...								
Main workers	-0.026	(0.018)	0.059**	(0.028)	-0.068***	(0.024)	67591	0.14
Ag labor	-0.005	(0.017)	0.026	(0.022)	-0.053**	(0.024)	62094	0.17
Cultivators	-0.018	(0.011)	0.074***	(0.018)	-0.078***	(0.015)	66270	0.08
Non-ag (Pop census)	-0.016	(0.032)	-0.051	(0.036)	0.075***	(0.022)	63464	0.18
Household	-0.060	(0.043)	0.004	(0.053)	-0.011	(0.048)	43424	0.23
Non-ag (Ec. census)	0.021	(0.023)	0.076*	(0.041)	-0.063*	(0.036)	60119	0.21
Firm owners	-0.007	(0.006)	-0.064**	(0.026)	0.082***	(0.028)	60119	0.06
Firms employ women	0.033	(0.044)	0.097*	(0.049)	-0.039	(0.038)	60119	0.23

Notes: The coefficients above are from the following specification: $Y_{it} = \beta_0 + \beta_1 Treatment_i * Post_t + \tau Purdahshare_i * Post_t + \delta Purdahshare_i * Treatment_i * Post_t + \gamma_i + \psi_t + X_{it} + \eta_{it}$; where X_{it} represents linear time trends at the state, within state household expenditure decile and national household expenditure quartile levels. The sample is restricted to districts where at least 25% of the population is Muslim. Column (1) is a formal test of parallel trends assumption in this subsample. Column (2) shows the impact on electrification in districts without any pre-treatment Purdah prevalence. Column (3) shows the treatment effect interacted with baseline share of women who report compliance with Purdah/veiling norms. All specifications include district and year fixed effects. Standard errors are clustered at the district level. Regressions have been weighted by baseline village population.

Since social norms are perpetuated through external social sanctions as well as internalization (Elster, 1989), I explore the differential impact of rural electrification by baseline measures of the degree to which women subscribe to gender roles surrounding home production. Specifically, Table 7, Column (1) shows differential results by an index variable capturing the number of the

following reasons for which women justified domestic violence: a) leaving home without permission, b) neglecting the home, or c) cooking poorly. Column (2) shows results using an indicator variable for whether women justified beating for any of the reasons mentioned above. Overall, the results suggest that baseline attitudes that align strongly with gendered household roles are associated with a negative impact of electrification on female labor force shares. However, point estimates are only statistically significant for decline in female share of cultivators (1 pp, 5%) and share of firms that employ any women (1.8 pp, 5%).

TABLE 7. Impact of Rural Electrification on Female Share of Labor Force, Interacted with Baseline Attitudes

	(1)		(2)		(3)	(4)
	Treatment x Beating justified (index)		Treatment x Beating justified (dummy)		N	Control mean
Female % of ...						
Main workers	-0.004	(0.005)	-0.007	(0.013)	512415	0.26
Ag labor	-0.004	(0.006)	-0.007	(0.017)	446976	0.33
Cultivators	-0.008*	(0.005)	-0.014	(0.013)	496071	0.20
Non-ag (Pop census)	-0.001	(0.005)	0.002	(0.015)	487666	0.24
Household	-0.009	(0.008)	-0.024	(0.023)	330570	0.28
Non-ag (Ec. Census)	-0.012	(0.008)	-0.028	(0.025)	471954	0.30
Firm owners	0.001	(0.004)	0.002	(0.015)	471954	0.10
Firms employing women	-0.018*	(0.010)	-0.044	(0.031)	471954	0.35

Notes: The coefficients represent δ from the following specification: $Y_{it} = \beta_0 + \beta_1 Treatment_i * Post_t + \tau Attitudes_i * Post_t + \delta Attitudes_i * Treatment_i * Post_t + \gamma_i + \psi Period_t + X_{it} + \mu_{it}$; where X_{it} represents linear time trends at the state, within state household expenditure decile and national household expenditure quartile levels. Column (1) shows differential results by an index variable capturing the number of the following reasons for which women reported that a husband beating his wife is justified:leaving home without permission, neglecting the home, or cooking poorly was justified. Column (2) shows results using an indicator variable for whether women justified beating for any of the reasons mentioned above. All specifications include district and year fixed effects. Standard errors have been clustered at the district level. Regressions have been weighted by baseline village population.

Finally, given the empirical evidence on the negative relationship between dependence on the plough, deep tillage requirements, and historical demand for female labor (Alesina et al., 2013; Carranza, 2014), Table 8 shows results

from the following empirical specification:

$$Y_{it} = \beta_0 + \beta_1 Treatment_i * Post_t + \beta_2 Clay_{sd} * Treatment_i * Post_t + \gamma_i + \psi Period_t + X_{it} + \mu_{it} \quad (12)$$

Where β_2 is the coefficient that captures the interaction effect of rural electrification at the village level ($Treatment_i * Post_t$) with the share of clayey soil in the sub-district associated with the village ($Clay_{sd}$). Given the exogenous nature of soil texture, clay content can be treated as an instrument for lower deep tillage requirements and therefore greater historical economic value of women (Carranza, 2014). I find that the positive impact of rural electrification on female labor force shares was concentrated in villages located in soil units with greater clay content. The interaction coefficient is positive and statistically significant on overall female share of labor force (1.2 pp, 5%), household industries workforce (2.8 pp, control mean of 0.28), and firm owners (1.3 pp, control mean of 0.10).

6.2. Mechanisms

There are two distinct channels through which rural electrification could affect female labor allocation: a) change in home productivity and b) change in marketplace productivity and wages. The theoretical framework described in Section 2 predicts that if the market productivity channel dominates and substitution effects are stronger than income effects, we expect an increase in

TABLE 8. Impact of Rural Electrification Interacted with Soil Texture

	(1) Treatment		(2) Treatment x Clay content		(3) N	(4) Control mean
Female % of ...						
Main workers	0.003	(0.003)	0.012**	(0.005)	1065864	0.26
Ag labor	-0.000	(0.004)	0.006	(0.005)	917081	0.33
Cultivators	-0.000	(0.003)	0.007	(0.006)	1029869	0.21
Non-ag (Pop census)	0.010**	(0.004)	0.006	(0.005)	1007845	0.24
Household	-0.004	(0.006)	0.028***	(0.008)	671383	0.28
Non-ag (Ec. census)	0.011**	(0.005)	0.012	(0.011)	963519	0.29
Firm owners	0.001	(0.004)	0.013*	(0.008)	963519	0.10
Firms employing women	0.012	(0.008)	0.015	(0.011)	963519	0.34
Firms employing women	-0.018*	(0.010)	-0.044	(0.031)	471954	0.35

Notes: The table shows the impact of the electrification program interacted with subdistrict-level clay content in soil texture on female share of a) total workforce, b) agricultural workers, c) cultivators, d) household industry-based workforce, and e) female share of firm owners. The coefficients represent β_2 from the following specification: $Y_{it} = \beta_0 + \beta_1 Treatment_i * Post_t + \beta_2 Clay_{sd} * Treatment_i * Post_t + \gamma_i + \psi Period_t + \varphi_{it} + \mu_{it}$; where φ_{it} represents linear time trends at the state, within state household expenditure decile and national household expenditure quartile levels. All specifications include district and year fixed effects.Standard errors have been clustered at the district level. Regressions have been weighted by baseline village population.

female share of labor force. On the other hand, if home productivity expansion dominates, female shares of labor force should decline.

Figure 5, Panel A shows how the difference in predicted change in female labor force share (1940–50) across TVA and non-TVA counties varies with change in household adoption of refrigerators (home productivity). Panels B, C, and D show how the predicted change for the same period varies against change in log wages and structural transformation (marketplace productivity). The figure presents suggestive evidence that the observed changes in female labor supply response is driven by changes in nature of marketplace production, as opposed to home productivity. Importantly, Figure 5 suggests that the decline in female share of labor force within the first decade of implementation was



FIGURE 5. TVA-Induced Change in Female Labor Force share (1940-50): Mechanisms. The figure above shows predicted change in female share of labor force (1940-1950) based on specification 10, across TVA (orange) and non-TVA (green) counties against change in share of households with mechanized refrigerators in the same time period (Panel A), change in share of labor force employed in the manufacturing sector (Panel B) and change in log wages (Panel C).

concentrated in treated counties that did not witness substantial structural transformation.

Further, structural estimates by Kline and Moretti (2014) suggest an 8.7% increase in local manufacturing productivity over the 1940–1960 time period. Figure 6 provides suggestive evidence that the medium-term positive impact of TVA on female share of labor force is concentrated in counties that witnessed a larger increase in manufacturing share of employment between 1940–1960. On the other hand, the observed increase in female share of labor force is lower in counties that experienced a larger increase in median household

income following the TVA program.[11] This result weakly suggests the role of a countervailing income effect generated by increase in household earnings.

Similarly, in the Indian context, I find that the positive impact of electrification on female share of non-agricultural labor is concentrated in manufacturing occupations. Figure 7 shows average impacts of rural electrification at a granular occupation category level. Coefficients have only been displayed for occupations where impacts were statistically significant. The positive aggregate impact on female share of overall non-agricultural labor force is largely explained by changes in share of women working in tobacco production (9.7 percentage points, 25%), manufacture of coke oven products (20 percentage points, 80%), petroleum extraction (10 percentage points), financial services (8.5 percentage points, 24%), and technical testing (19 percentage points, 50%). For context, at baseline, the three sectors with the highest female share of labor force were: tobacco manufacture (31%), education (34%), and the care industry (42%). Apart from tobacco production and education, all other industries in Figure 7 that received an electrification-driven boost in female share of labor force had baseline female shares well below 10%. These sectors – e.g. coke oven production, equipment manufacture – have large power requirements. The disaggregated results suggest that similar to the rural U.S. context, electrification facilitated the expansion of manufacturing sector labor demand in rural India. This translated to the observed growth in female share of labor force in manufacturing jobs. However, before declaring electrification

11. Due to data limitations, I am only able to show how results vary against change in county-level median household income between 1950-1960, as opposed to the entire 1940-1960 time period.

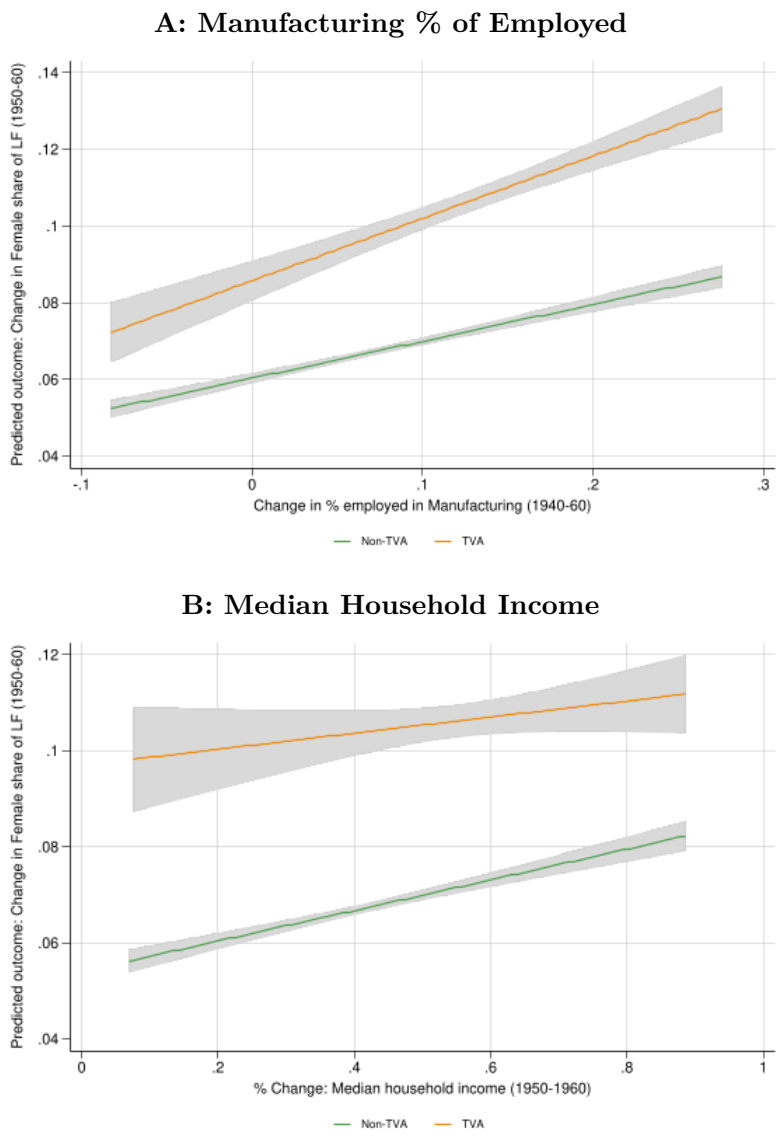


FIGURE 6. TVA-Induced Change in Female Labor Force share (1950-60): Mechanisms. The figure above shows predicted change in female share of labor force (1950-1950) based on specification 10, across TVA and non-TVA counties against change in share of labor force employed in the manufacturing sector since baseline (Panel A), and change in median household income between 1950-1960 (Panel B).

as a win for women's economic empowerment in rural India, future research

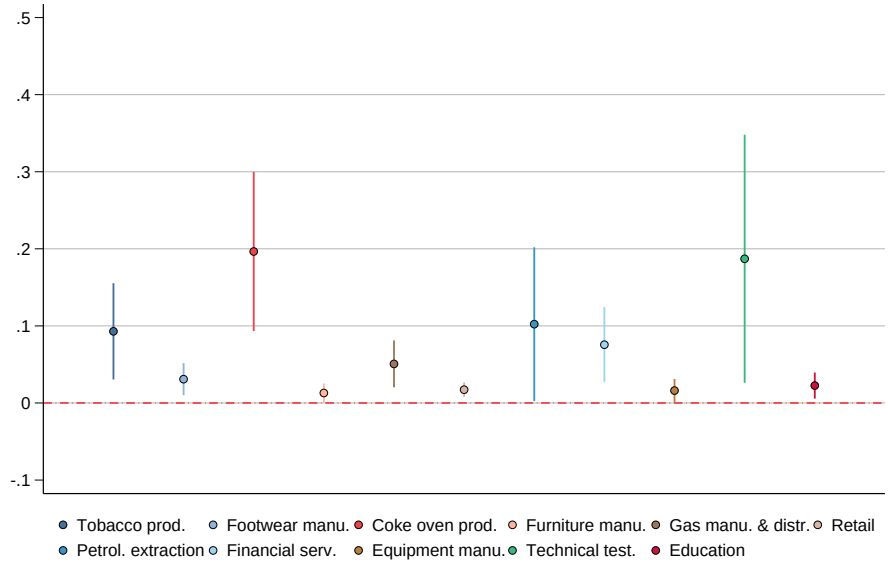


FIGURE 7. Impacts of Rural Electrification, By Occupation Type. The figure above shows average impacts of rural electrification at a granular occupation type level. Coefficients have only been displayed for occupations where impacts were statistically significant. The occupations displayed are: Tobacco production, footwear manufacture, coke oven products manufacture, furniture manufacture, gas manufacture and distribution, non-specialized retail, petroleum extraction support, financial services, equipment manufacture, technical testing and analysis, and education.

should investigate working conditions, wage structures, and bargaining power of women compared to male workers in these industries.

7. Conclusion

In this paper, I provide evidence on the impact of rural electrification on female labor allocation across two contexts: Indian villages in the 21st century and rural American counties in the 20th century. Overall, I find a 6.5% decline in female share of labor force in treated counties in the U.S. within the first decade of implementation. This pattern reverses and there is a 7% increase in female share of labor force in the second decade following program

implementation. However, the magnitude of impact diminishes in the long-run. These empirical results provide support for the U-shape theory of female labor force participation following structural transformation. In the U.S., I also find that the positive part of the U-shape is steeper for counties that were poorer in the pre-treatment period.

Data limitations prevent a comprehensive study of the role of social norms in driving heterogeneous results in the U.S. Therefore, I turn to the Indian context to understand the interactive impact of rural electrification and social norms on the female share of labor force. In rural India, I find positive impacts in aggregate female share of non-agricultural workforce and share of firms that hire any women. Affirming interdisciplinary scholarship on the inverse relationship between female purity concerns and caste rank, I find impacts that are opposite in direction at two ends of the caste hierarchy. Rural electrification leads to a decline in female shares of labor force across sectors in upper-caste dominant areas whereas results vary substantially in marginalized-caste dominant areas. I also provide suggestive evidence on differential impacts by baseline compliance of Purdah (veiling) norms in districts where at least a quarter of the population is Muslim. Effects also vary by baseline self-reported attitudes toward the justification of domestic violence if a woman fails to perform household duties. Finally, effects are positive and larger across outcomes in villages that have higher clay content in their soil texture. This result suggests that rural electrification led to a greater share of women in the workforce in areas where women were historically involved in agricultural production.

In terms of mechanisms, I find that across both the rural U.S. and Indian context, employment opportunities in manufacturing sectors explain the shifts in female labor force trajectories. This is a particularly useful insight in the Indian context where much of the evidence and policy dialogue is on change in overall female labor force participation, as opposed to an understanding of the specific jobs women occupy, conditional on participating in the labor force. Future research should focus on understanding gender inequality in terms of wage gaps, bargaining power and working conditions among laborers within the Indian manufacturing sector.

8. Appendix

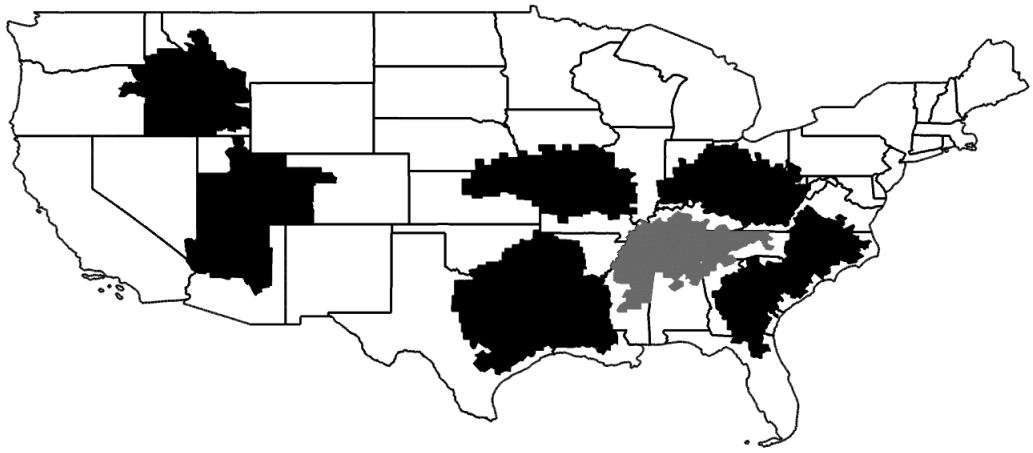


FIGURE A.1. Geographical Distribution of TVA (treated and untreated) counties. The area shaded in gray represents the TVA region. Areas shaded in black represent counties that were slated to receive TVA-like rural infrastructure development programs but ultimately did not due to legislative disagreement. Source: Kline and Moretti (2014), Online Appendix.

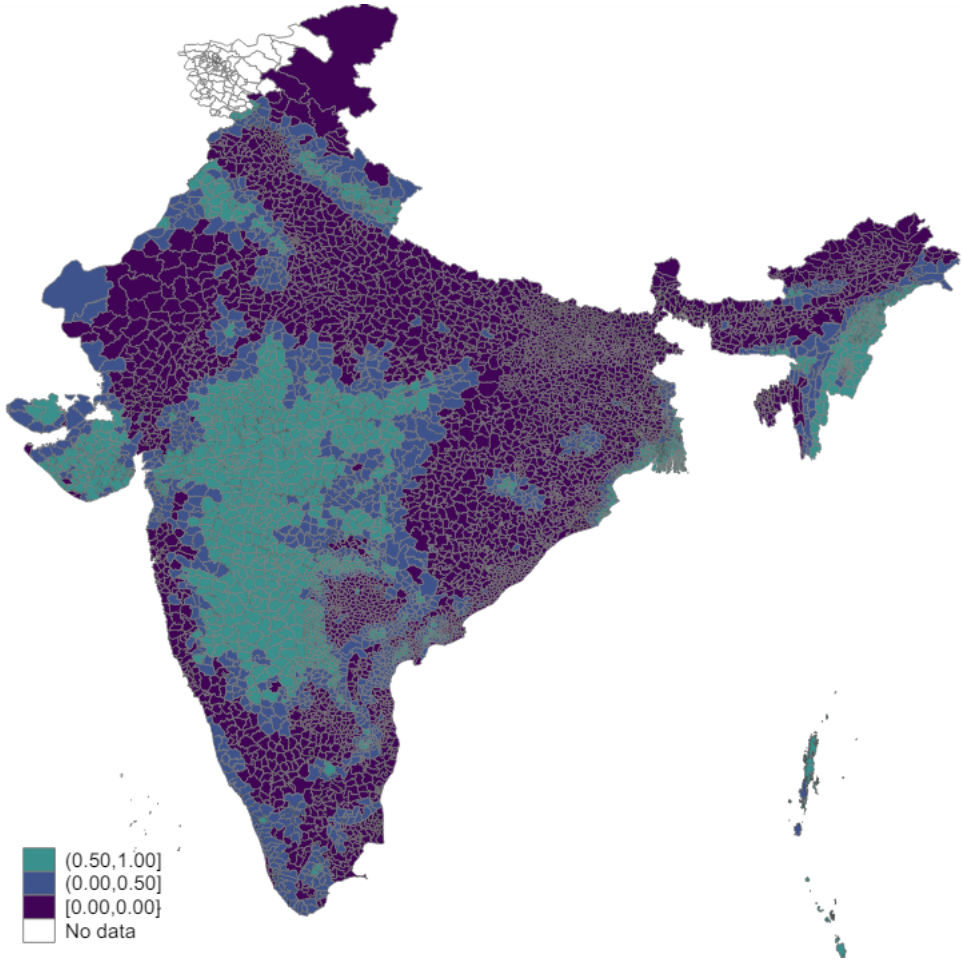


FIGURE A.2. Spatial Distribution of Clay Content in Soil. The figure above shows average clay content across soil units at the sub-district level. Source: FAO/UNESCO Soil Map of the World, 2003 (FAO/UNESCO, 2003).

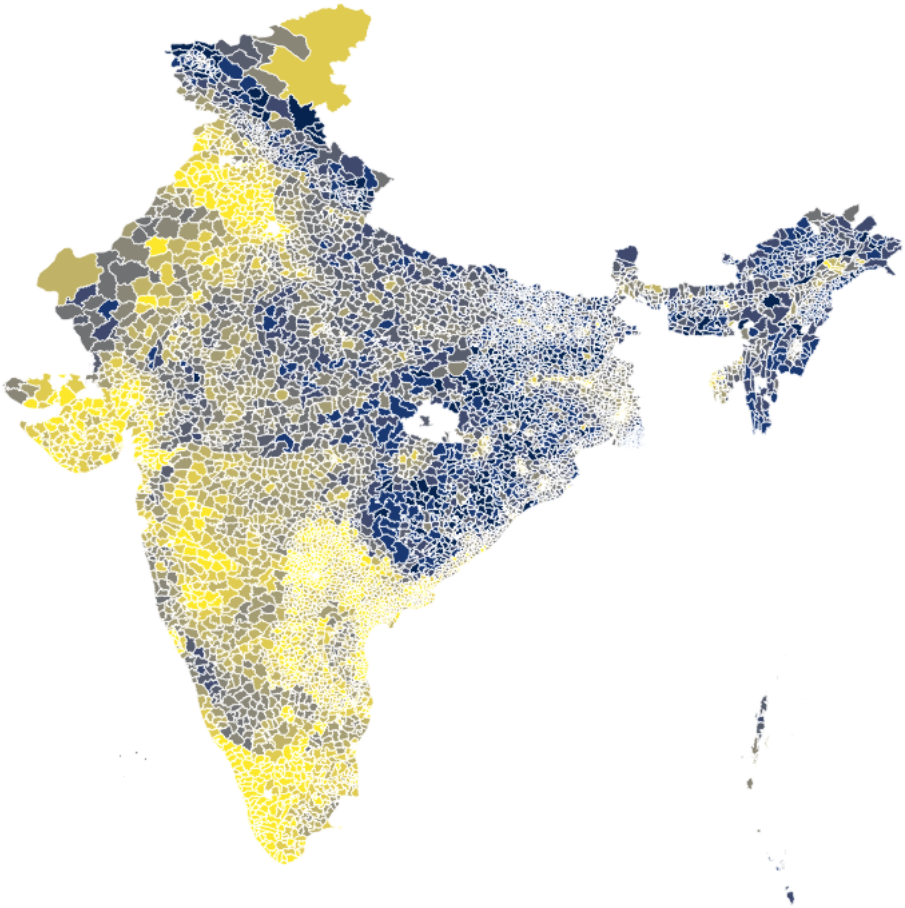


FIGURE A.3. Nightlights at Baseline (2001) across Rural India. The figure above shows average night-time luminosity (calibrated) across villages for each sub-district across India. Source: SHRUG (Asher et al., 2021)

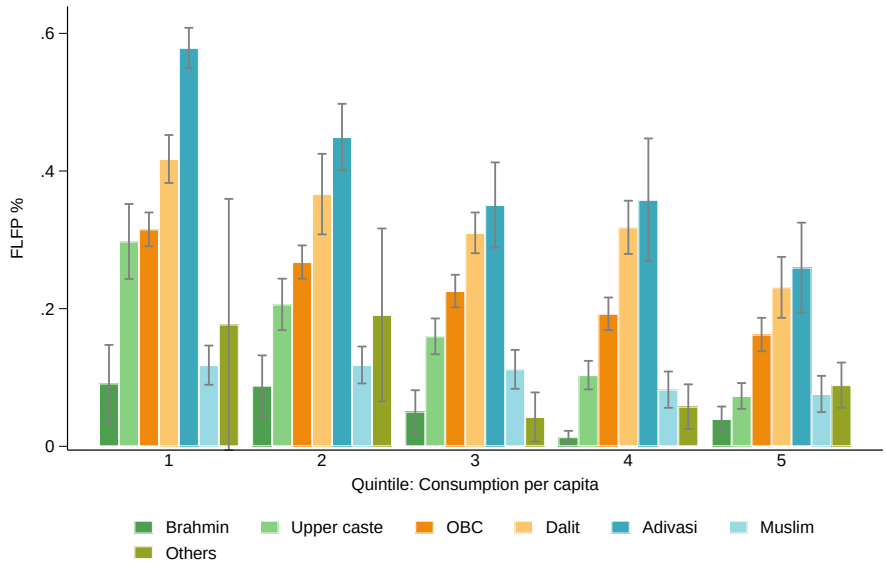


FIGURE A.4. Baseline FLFP, disaggregated by Social Groups and Consumption Per Capita. The figure above shows baseline female labor force participation by social groups, and quintiles of consumption per capita. The underlying dataset is a national household survey representative at the district level (IHDS, 2005). The denominator for the FLFP measure is 15-49 year old women within each group at the time of survey. The measure incorporates informal and formal occupations reported by respondents. The group "High Caste" represents all non-Brahmin Hindu upper castes; "OBC" represents Hindu backward castes (Shudras); "Dalit" represents Scheduled Caste groups and "Adivasi" represents Scheduled Tribe groups.

TABLE A.1. Impact of Rural Electrification on Female Share of Labor Force in India, Villages with Population > 2000

	(1)		(2)		(3)	(4)
	Pre-treatment		Post-treatment		N	Control mean
Female % of ...						
Main workers	0.005	(0.004)	0.005*	(0.003)	277179	0.25
Ag labor	0.007	(0.005)	0.002	(0.004)	275332	0.32
Cultivators	0.002	(0.005)	0.001	(0.004)	276966	0.19
Non-ag (Pop census)	-0.003	(0.006)	0.010**	(0.004)	276842	0.20
Household	0.010	(0.008)	0.005	(0.006)	253627	0.30
Non-ag (Ec. Census)	0.001	(0.006)	0.013**	(0.006)	263152	0.25
Firm owners	-0.001	(0.003)	0.005	(0.004)	263152	0.11
Firms employing women	0.005	(0.009)	0.017**	(0.008)	263152	0.28

Notes: Column (1) in the table above is a formal test of parallel pre-trends. The coefficients show the interaction effect of being in a treated district and difference in village-level female labor force shares in the pre-treatment period (1991) with respect to baseline (2001). Column (2) shows the actual impact of the program on share of female labor force in the post-treatment period (2011). All specifications include district and year fixed effects and linear time trends at the state, within state household expenditure decile and national household expenditure quartile levels. Standard errors are clustered at the district level. Regressions have been weighted by baseline village population.

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