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Women's representation and the governance of the commons

Sandra Aguilar-Gomez[1] | **Francesca Eustacchi**[2] | **Laura Aguirre-Duran** [3]

[1]Tecnologico de Monterrey, Mexico City, Mexico.
saguilargomez@tec.mx

[2]University College Dublin, School of Economics, Dublin, Ireland.

[3]Universidad de los Andes.

Roughly half of the world's land is held collectively by indigenous and local communities, often governed through common-property institutions. Despite national efforts to expand political inclusion, women remain largely excluded from these local bodies. This paper examines how gender inclusion affects the management of common property resources. We exploit a 2016 reform to Mexico's Agrarian Law, which mandated gender quotas in agrarian committees, and estimate the causal effects of women's participation on environmental, economic, and organizational outcomes using a staggered event-study design. Drawing on data from over a decade of agrarian community records (2012–2023), we find that greater participation by women reduces annual deforestation rates by about 6 percent without diminishing local economic activity. Inclusion also reshapes communities' interactions with the state: applications to empowerment-oriented programs rise, while applications to production subsidies decline. Although aggregate application volumes remain constant, approval rates fall in communities with more women in office, suggesting persistent institutional barriers. These findings reveal how formal inclusion of women can reshape the governance of shared resources, but highlight systemic barriers faced by women in community leadership positions.

JEL codes: D71, J16, O13, Q23

KEYWORDS
Gender quotas, Political representation, Collective governance, Deforestation, Staggered difference-in-differences, Mexico.

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La representación de las mujeres y la gobernanza de los bienes comunes

Sandra Aguilar-Gomez[1] | **Francesca Eustacchi**[2] | **Laura Aguirre-Duran** [3]

[1]Tecnologico de Monterrey, Mexico City, Mexico.
saguilargomez@tec.mx

[2]University College Dublin, School of Economics, Dublin, Ireland.

[3]Universidad de los Andes.

Aproximadamente la mitad de la tierra del mundo es de propiedad colectiva de pueblos indígenas y comunidades locales, con frecuencia administrada mediante instituciones comunitarias de gestión de recursos. A pesar de los esfuerzos nacionales por ampliar la inclusión política, las mujeres siguen estando en gran medida excluidas de estos espacios de decisión. Este documento analiza cómo la inclusión de género en estas instituciones afecta la gestión de los recursos de propiedad común. Para ello, utilizamos la reforma de 2016 a la Ley Agraria de México, que estableció cuotas de género en los comités agrarios, y estimamos los efectos causales de la participación femenina sobre resultados ambientales, económicos e institucionales mediante un diseño de estudio de eventos escalonado. Con datos de más de una década de registros de comunidades agrarias (2012–2023), encontramos que una mayor participación de las mujeres reduce las tasas anuales de deforestación en alrededor de 6 por ciento sin afectar negativamente la actividad económica local. La inclusión también modifica la forma en que las comunidades interactúan con el gobierno: aumentan las solicitudes a programas orientados al fortalecimiento de capacidades y disminuyen las solicitudes a subsidios productivos. Aunque el volumen total de solicitudes se mantiene estable, las tasas de aprobación caen en comunidades con mayor presencia femenina en cargos de autoridad, lo que sugiere la persistencia de barreras institucionales. En conjunto, los resultados muestran que las reformas de inclusión pueden transformar la gobernanza de los recursos compartidos, pero también revelan restricciones sistémicas que enfrentan las mujeres en posiciones de liderazgo comunitario.
Códigos JEL: D71, J16, O13, Q23

KEYWORDS

Cuotas de género, Representación política, Gobernanza colectiva, Deforestación, Diferencias en diferencias escalonadas, México.

1 | INTRODUCTION

Women's political voice has expanded worldwide, yet the pace of change remains uneven, especially outside urban centers. Today, women hold just 25% of parliamentary seats and 36% of local government positions worldwide (UN Women, 2022). Electoral reforms have attempted to address this gap: 132 countries have adopted gender quota reforms, with Latin America leading the way through legislated candidate quotas. A deeper gender representation divide tends to predominate in rural areas. Globally, only one in five agricultural landowners or rights-holders is female (UN Women, 2024), and nearly half of rural residents (47%) still believe men make better political leaders, while only a third (34%) of urban residents do (UN Women, 2022). Persistent underrepresentation thus constrains women's ability to champion policies that directly affect their livelihoods and well-being, from land rights to local public goods (Chattopadhyay and Duflo, 2004; Rehavi, 2007; Funk et al., 2015).

Approximately half of the world's land, particularly rural and forested areas, is governed through communal or collective land tenure systems (World Resources Institute, 2017).[1] Institutional efforts to improve women's representation within these collective governance structures are prevalent worldwide, but we still know little about how effective such reforms are. The urgency of exploring gender dynamics in environmental management is underscored by ongoing global deforestation. Each year, approximately 10.2 million hectares of forest—an area comparable in size to Panama–is lost (FAO, 2024). Forests are essential for biodiversity conservation, hosting approximately 80% of terrestrial species and playing a vital role in mitigating climate change by sequestering carbon emissions; deforestation alone accounts for nearly 15% of global greenhouse gas emissions (WWF, 2024; IPCC, 2019). Furthermore, forest loss severely affects local livelihoods, with around 1.6 billion people globally depending on forests for agriculture, forestry, and medicinal resources (World Bank, 2021).

Understanding the impact of enhanced participation of women in collective land management is particularly relevant given the extensive evidence highlighting gender differences in leadership and management, with some positive outcomes associated with the presence of women in power. For instance, women in governance roles prioritize community-oriented investments, reduce corruption, and foster enhanced collaboration.[2] Similarly, at the household level, women managing financial resources consistently achieve greater efficiency and place a stronger emphasis on the welfare of households and communities, an insight leveraged extensively in conditional cash transfer programs and microfinance initiatives (Duflo, 2012; Lechene, 2010; Hoffmann, 2008; Davis et al., 2002; Doepke and Tertilt, 2019; Rubalcava

[1] In terms of formal land ownership rigths, (World Resources Institute, 2017) reports that this number is reduced to one-fifth of global land, with the rest held under customary tenure. Most of this communal land lies in China, Canada, Brazil, Australia, and Mexico.

[2] Evidence includes, e.g., Chattopadhyay and Duflo (2004); Clots-Figueras (2011); Duflo and Topalova (2004); Hicks et al. (2016); Clayton and Zetterberg (2018); Wängnerud (2009); Brollo and Troiano (2016); Alatas et al. (2009); Epstein et al. (2005); Brito Rebolledo et al. (2024).

et al., 2009; Pitt et al., 2003; Swaminathan et al., 2010; Ssewamala et al., 2010). Research highlights that gendered traits and structural constraints—such as compliance, risk aversion, prosocial behavior, and vulnerability to environmental degradation—generate distinct environmental attitudes and practices (Brañas-Garza et al., 2018; Croson and Gneezy, 2009; Aguilar Gómez et al., 2024; Aguilar-Gómez and Salazar-Díaz, 2025). Empirical findings from South Asia further reinforce this notion, demonstrating that women's active participation in land management correlates with more sustainable forest-use practices (Agarwal, 2009, 2010; Leone, 2019). Given the extensive evidence of women's positive impacts in governance, a critical policy question emerges: Can enhancing women's representation also effectively address environmental challenges?

This paper connects the literature on gender equality and environmental governance by examining whether institutional reforms that expand women's political representation can also enhance collective resource management. Specifically, it asks: Did Mexico's legislated gender quotas succeed in increasing women's participation within communal land institutions, and did this greater inclusion contribute to more sustainable forest outcomes? We focus on Mexico, where local decision-making bodies, formally known as agrarian communities, represent the most widespread form of collective land tenure; 60% of the country's forest area (Comisión Nacional Forestal, 2020) is managed by agrarian communities who depend on forest use for their livelihoods. We employ data on the universe of agrarian communities with forest cover between 2012 and 2022 to analyze the causal impact of women's participation in the decision-making bodies of Mexican agrarian communities on deforestation rates and land management.

To answer our research questions, we leverage the introduction of the 2016 Agrarian Law, which mandated that no more than 60% of candidates for agrarian community governance committees be of the same gender. Agrarian communities hold regular elections every three years but on staggered calendars. The nonuniform timing of their first post-2016 elections gave rise to a natural experiment that we take advantage of with a staggered-adoption difference-in-differences (DID) design (Callaway and H.C., 2021; Sunderland et al., 2014; Freyaldenhoven et al., 2021). Because not all the communities that became subject to the quota immediately saw an increase in women's representation, all the results except those on women's participation itself should be interpreted as intention-to-treat (ITT) effects—that is, the average impact of exposure to the quota reform regardless of actual changes in representation. To assess the causal effect of the election of women on outcomes such as deforestation, we further construct local average treatment effect (LATE) estimates by dividing the reduced-form effect of the reform on each outcome by its first-stage effect on women's representation, following a Wald estimator approach.

Our analysis reveals that the quota reform significantly increased representation of women by 5.9 percentage points (pp) in the first postreform election, with this figure growing to 7.6 pp by the third year—an increase of nearly one-third relative to the pre-reform average of 24%. However, the reform did not reshape power evenly within community

governance structures. Agrarian community boards have six different posts with varying responsibilities and attributions. The most significant gains occurred in administrative and supporting roles—positions centered on record-keeping, oversight, and auxiliary tasks—where women's participation rose by 13–21 pp over three years. In contrast, in the most influential posts, which control community resources and executive decisions, there was little to no change. The quota thus opened the door to women's inclusion, albeit primarily at the lower tiers of authority, revealing a stepped glass ceiling within agrarian governance.

Were these mixed representation gains enough to foster social and environmental change? Our results suggest they were. We find that exposure to the quota reform led to a 6% reduction in annual deforestation rates, a clear environmental dividend from the greater inclusion in local governance. The effect was strongest in the year following the first postreform election and was driven by small agrarian communities—settings where collective rules are easier to enforce and local oversight is most effective. In contrast, no significant changes are observed for medium or large communities, where coordination is more difficult and land use pressures are higher. The reductions were also concentrated in areas without formal environmental protection, indicating that women's leadership makes a difference precisely where local discretion matters most. Scaling the estimates by the reform's first-stage effect on women's representation, the LATE implies that a 1 pp increase in the number of women elected reduced deforestation rates by about 1.2 pp from their level before treatment.

We also explore the mechanisms behind these results. First, we find that the reduction in deforestation did not come at the expense of economic activity: Nighttime lights, a proxy for local production, remained unchanged after the reform. Second, drawing on detailed administrative data, we examine whether women's leadership altered how agrarian communities interact with government support programs—a key channel of resources and capacity building. We find no change in the total number of applications submitted but a marked decline in the number of awards granted, suggesting that structural barriers—be they limitations in leadership experience or discrimination—also play a role. When grouping program applications and allocations by domain, distinct patterns emerge across categories. In programs related to women's empowerment, applications increased, but awards did not. In programs that promote productive activities such as management plans, technical assistance, and entrepreneurship, both applications and awards declined, while for conservation- and technology-oriented programs, which fund forest maintenance and infrastructure, we detect no effect. These results indicate that while women's entry into collective governance shifted decision-making priorities, entrenched institutional barriers continued to limit their ability to translate formal representation into material influence. Furthermore, the contrast between rising interest in empowerment programs and declining participation in production-oriented programs underscores how gendered roles persist within ANs: women may seek greater involvement in domains tied to inclusion, but men's

control over land, income, and production decisions continues to shape which applications are ultimately successful.

Our paper contributes to three strands of literature. First, we add to research on women's underrepresentation in decision-making bodies. By leveraging a binding candidate quota, we show that formal rules can substantially increase women's election rates in collective land governance but that these gains are concentrated in lower-ranking positions. This pattern aligns with evidence that while quotas are effective in opening access, they do not necessarily dismantle gender hierarchies within institutions (Bagues and Campa, 2021; Fujiwara et al., 2024). Our results highlight how formal inclusion can coexist with persistent structural barriers to substantive power.

Second, we contribute to the relatively unexplored economic literature on women's roles in communal land management. Prior studies from South Asia find that higher participation of women in forest user groups improves forest outcomes and promotes more sustainable resource use.[3] We extend this evidence to a new context—Mexico's collective lands—using causal identification and high-resolution data. We also show that the environmental gains under women's leadership do not come at the expense of local economic activity, pointing to a potential pathway for sustainable development rather than a trade-off between conservation and production.

Finally, we advance the literature on gender and local governance by analyzing how women's participation shapes interactions with the state. Using comprehensive administrative data on applications to and allocations from public support programs, we show that women's entry into collective governance changes how communities engage with government resources but that persistent structural and bureaucratic barriers limit their ability to translate representation into material influence. This provides a rare, institutional perspective on how gender inclusion interacts with state capacity and program delivery in rural settings.

2 | INSTITUTIONAL BACKGROUND

2.1 | Collective land tenure and governance

Collective land tenure is the dominant ownership form in rural Mexico. More than 32,000 agrarian communities occupy approximately 46% of the national territory (RAN, 2024). Agrarian communities are custodians of Mexico's forests. At a canopy-cover threshold of 30% or more, over 60% of the national forests (roughly 70.6 million hectares) lie within the boundaries of agrarian communities (Comisión Nacional Forestal, 2020). More than half of agrarian communities actively manage forests as a source of livelihoods; forests directly support about 11.87 million people (9.3% of Mexico's population), providing timber, nontim-

[3] See, for example, Agarwal (2009, 2010); Leone (2019), who document these effects for India and Nepal, showing that forests fare better when more women are involved and that active participation in decision-making is essential for translating representation into conservation gains.

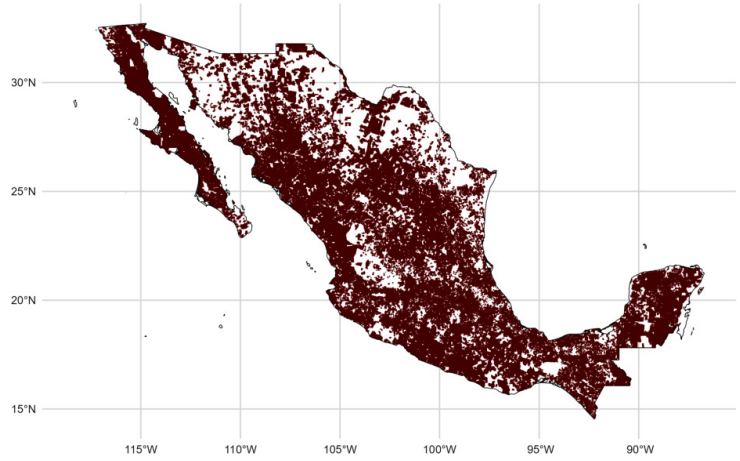
ber products, and ecosystem services. Committees can decide which stands are opened for logging, where crops or pasture can expand, and whether environmentally sensitive zones should be protected. They also negotiate timber contracts, enroll in conservation programs, and engage with nongovernmental organizations. Figure 1 illustrates this territorial and environmental relevance. Panel (a) shows the national distribution of agrarian communities, highlighting the extent of collectively owned land parcels (*ejidos* and *comunidades*) across Mexico. Panel (b) shows only those agrarian communities with more than 10% forest cover, our analysis sample, revealing their concentration in the central and southern regions where communal forest management is most prevalent, but also their presence in the northern highlands.

These entities emerged from Mexico's postrevolution land-redistribution program. The key institutional distinction between these two forms of collective governance—*ejidos* and *comunidades*—is that ejido parcels may, with assembly approval, be converted to private property, whereas land inside a *comunidad* is inalienable. In practice, de facto privatization occurs in both. In all other respects, however, their governance structures and legal obligations are the same under the Agrarian Law, and the same rules regulate their elections and decision-making procedures. Throughout the paper, we therefore refer to both as agrarian communities[4] and do not analyze them separately, as the reform applied to both and their institutional behavior is otherwise equivalent for the purposes of this study.

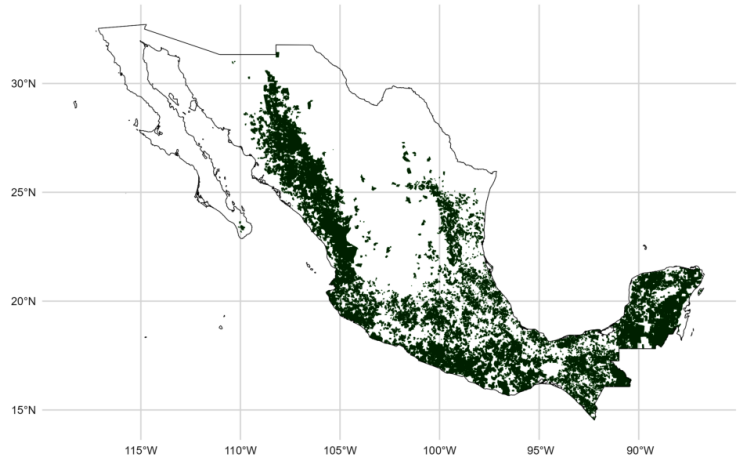
Authority within each unit is distributed across three bodies: the General Assembly and two committees elected by it. The General Assembly, in which all registered members with land rights (*ejidatarios* or *comuneros*) may participate and vote, decides on land use, allocates resources, and adopts internal regulations. This typically implies one assembly member per family since land rights are inherited without subdivision. The first committee, the Commissariat, comprises a president, a first secretary, and a treasurer; it manages communal assets, coordinates productive activities, and represents the community in legal transactions and in dealings with all levels of government, including applications for and receipt of government programs. The second committee, the Oversight Committee, also has three members and audits accounts, oversees compliance with assembly mandates, and may convene extraordinary sessions when irregularities arise.

Within the Commissariat, the president functions as the head of the local executive, chairs meetings, executes assembly decisions, and represents the agrarian unit before public and private actors; the treasurer exercises budgetary and financial control, manages bank accounts, and prepares periodic reports; and the first secretary maintains minute books, membership rolls, and land and cadastre records. The Oversight Committee performs ex post oversight: Its president leads monitoring and investigations and may trigger corrective actions or call the assembly when irregularities are detected. The first and second secretaries primarily provide auxiliary support, maintain audit files, and draft supervisory reports

[4]The literal translation of the legal term in Mexican law would be "agrarian communities," but because this term is uncommon in English-language scholarship, we use agrarian communities or agrarian units throughout.



(a) Agrarian nuclei land



(b) Agrarian nuclei with $>$ 10% forest area

FIGURE 1 Collective land in agrarian communities and forested sample

Notes: Panel (a) maps the spatial distribution across Mexico of agrarian communities under collective tenure. Panel (b) shows the subset of communities with more than 10% of their territory covered by forest, the analytical sample used in this paper. Data from the Agrarian Registry (RAN) and INEGI land cover maps.

(Morett-Sánchez and Cosío-Ruiz, 2017).

Since December 2016, the Agrarian Law has required that no more than 60% of candidates for any committee be of the same gender. The statute does not dictate the gender composition of the winners. Importantly for our identification strategy, election calendars are not synchronized across communities.

Women remain underrepresented in both the economic and political life of rural Mexico. Labor force participation among rural women is 42%, compared with 51% among urban

women and 77% among rural men (ENOE 2024 Q4). Production units refer to the set of lands, infrastructure, machinery and equipment, animals and other goods used to carry out productive agricultural or forestry activities. Units headed by women average 8.8 hectares, compared to 14.7 hectares for units headed by men (Instituto Nacional de Estadística y Geografía (INEGI), 2024), and women have markedly lower access to agricultural machinery (Secretaría de Agricultura y Desarrollo Rural, 2023). Only 26% of the holders of formal rights to ejidos or *comunidades* are women (Comisión Nacional Forestal, 2020). Political gaps are large in local and national rural governance: According to National Agrarian Registry (RAN) records from 2023, fewer than 23% of committee seats are held by women, and women preside over fewer than 7% of agrarian communities' Commissariats.

2.2 | The 2016 agrarian elections reform

Mexico's 2016 reform establishing gender quotas in agrarian communities' candidate lists occurred in the context of a broader, decades-long push toward gender parity in party-based public office. Prior to 2002, the law merely recommended the inclusion of women in party lists. Accordingly, women's representation in the Chamber of Deputies hovered around 15%. Mandatory quotas introduced in 2002 set a 30% floor and were followed by a rise in the actual share of women in the chamber to about 23%; raising the quota to 40% in 2007 brought women's representation in the national legislature to approximately 28% (Torres, 2010). Enforcement tightened in 2011 after a ruling by the Superior Chamber of the Electoral Tribunal,[5] after which women's representation reached 37%—surpassing the 30% threshold often cited as the minimum for effective influence in collegiate bodies (Martínez, 2013). The parity requirement was then constitutionalized in 2014,[6] with political parties mandated to present candidate lists composed of 50% women and 50% men at the federal and local levels.

Agrarian communities—Mexico's collective-land governance institutions—have historically operated on the margins of party politics and therefore, prior to 2016, were not subject to any gender quotas. Consequently, women's participation in them lagged markedly: Throughout the 1990s and 2000s, women's presence as candidates and officeholders in agrarian communities remained about 10% in comunidades and 15% in ejidos. The Agrarian Law was amended in 2016 to address this gap by imposing a candidate rule for agrarian committees: No gender may exceed 60% of nominees for any office. While the statute did not mandate outcomes, qualitative evidence suggests that the increase in women's representation among candidates set in motion a positive feedback loop, generating further opportunities for their engagement in governance and land management initiatives (García-Morán and Yates, 2022a).

[5] Ruling SUP-JDC-12624/2011 of the Superior Chamber of the Electoral Tribunal of the Federal Judiciary.
[6] Article 41, Section I of the *CPEUM* (Constitución Política de los Estados Unidos Mexicanos), together with Articles 33.3–33.5 of the *LGPP* (Ley General de Partidos Políticos) and Article 232.3 of the *LEGIPE* (Ley General de Instituciones y Procedimientos Electorales).

During the period of our analyses, several other reforms to the Agrarian Law were passed, as summarized in Appendix Table A.1. However, only four of them stand out for being related to gender. In 2017, a decree added women's agroindustrial units (UAIMs) to the Agrarian Law, allowing (not requiring) ejidos and comunidades to allocate productive land for women's collective initiatives; uptake is discretionary and not tied to the first post-2016 election. Hence, this change does not threaten our identification strategy. More recently, reforms enacted in 2023 to Articles 4, 32, and 37 continued this trajectory. Article 4 now requires that rural development policies incorporate a gender perspective, and Article 32 states that the composition of ejido governance bodies should observe the principle of gender parity. However, this latter article does not impose a binding requirement to reserve seats or ensure balanced outcomes. By contrast, Article 37 introduces a concrete obligation: Candidate lists for agrarian committees and auxiliary bodies must include men and women in equal proportion. This reform strengthened the earlier 2016 provision—which established a 60/40 gender cap—by requiring strict 50/50 gender parity in nominations. Because this 2023 mandate represents a different treatment, we omit observations of our outcomes from 2023 onward from the analysis.

Article 37 of the Agrarian Law established that no more than 60% of candidates for agrarian governance bodies may be of the same gender. However, only final election results are digitized, which means that there is no public record of candidate lists that would allow systematic verification of compliance at the community level. In practice, the Procuraduría Agraria (PA)—the federal agency responsible for overseeing and certifying agrarian assemblies—is tasked with monitoring adherence to this quota. Official communications and reports indicate that PA officers review assembly records, advise on candidate registration, and occasionally supervise elections to ensure gender balance, usually upon request. Hence, incentives to comply with the law are influenced by the perceived probability of audit by the PA. The agency has also launched programs such as Mujeres por el Acceso a la Tierra to provide legal assistance and promote women's participation in agrarian governance (Secretaría de Desarrollo Agrario, Territorial y Urbano (SEDATU), 2021).

Qualitative analyses highlight that enforcement remains uneven. Several authors note that female nominees are often listed as substitutes and that social norms or fear of community backlash discourage women from running for executive positions. For instance, Torres-Mazuera (2023) concludes that "gender parity in agrarian representation remains a law on paper, with little application in the daily life of ejidos and communities." These barriers are reinforced by the fact that women remain a minority among land-right holders, which limits their eligibility and confidence to assume leadership roles. Similarly, García-Morán and Yates (2022b) report that there are few women with recognized agrarian rights; many are only beginning to participate in community assemblies, in the face of resistance and cultural stigma. Against these cultural and economic obstacles, one might a priori expect our quantitative analyses to reveal null effects of the quota reform. However, administrative data establish that the share of women in agrarian governing bodies substantially

increased as a consequence of the reform.

One potential mechanism for the identified increases is the incentive of government support programs. There is a clause specifying that ejidos or agrarian communities must prove who legally represents them when applying for Comisión Nacional Forestal (CONAFOR) programs. They must submit the official minutes of the assembly showing that their representative bodies (*comisariado ejidal/comunal* and Oversight Committee) were formally elected. Alternatively, they can provide a valid credential from the RAN certifying the current members of the representative committee.[7] Our results not only highlight the importance of binding mechanisms operating at various government levels for enforcing political change but also the value of causal analysis for comparing and contrasting with qualitative insights.

3 | DATA AND DESCRIPTIVE STATISTICS

3.1 | Data sources

Using the unique RAN identifier for each ejido or comunidad, we link agrarian communities' committee election results and administrative program registries (federal support applications and receipts). The registry provides agrarian communities' names, locations, and geospatial boundaries as of April 2024. We identify 32,256 agrarian communities, of which 1,899 are noncertified (5.9%) and therefore eliminated from the estimating sample.[8]

We rely on agrarian communities' committee election records from the PA for 2012–2022. For identification, we exclude outcomes from 2023 onward because the parity mandate constitutes a distinct intervention. These records are highly granular but prone to human error: Assemblies record results on paper and mail them to the PA, and PA staff manually digitize them into the national registry. After merging these records with our main sample, we find election data for 82% of certified agrarian communities.[9]

The electoral dataset reports elected officials' gender and the date of each election, which marks the start of the new governing body's term. It does not include candidate lists or vote margins. Elections occur every 3.1 years on average, consistent with the three-year legal cycle.[10] For agrarian communities that stop reporting elections, we carry

[7] Several documents contain this clause: Reglas de Operación 2023 del Programa Desarrollo Forestal Sustentable para el Bienestar, CONAFOR; Reglas de Operación del Programa Apoyos para el Desarrollo Forestal Sustentable 2018, 2019, 2020, 2021, 2022, CONAFOR; Reglas de Operación del Programa Nacional Forestal 2013, 2014, 2015, 2016, 2017, CONAFOR.

[8] Certified agrarian communities have completed the land certification process (specifying their formal boundaries and documented rights); noncertified communities have not, so they cannot be mapped. We also discard 17 communities with boundary files but no entry in the registry.

[9] We also observe election records for 3,589 agrarian communities not listed in the registry. According to our consultations with the PA and RAN, these are likely processing errors, though some may reflect dissolved communities.

[10] We also examine whether the reform affected election frequency—for example, whether assemblies delayed elections to avoid including women or, conversely, became more compliant and held elections more regularly. We find no evidence of either pattern.

forward the last known officials for up to three years; after that, we drop subsequent years because nonreporting may reflect dissolution or reporting delays. We also exclude agrarian communities that report only one election during the period, as these do not appear to follow regular electoral procedures and a single observation does not permit trend analysis. Such one-off entries account for 21% of the election dataset. After we remove them, the sample includes 19,786 agrarian communities.

We incorporate data from CONAFOR on the federal support provided to agrarian communities for a wide range of purposes between 2011 and 2023. This support was primarily delivered through two major programs. From 2007 to 2013, the PROÁRBOL program provided economic incentives and technical assistance to rural communities to encourage reforestation and conservation, while also aiming to boost economic productivity and fight poverty. Subsequently, the National Forestry Program (PRONAFOR) effectively extended and broadened these objectives from 2014 to 2022. Building on its predecessor's foundation, PRONAFOR's scope included additional goals such as wildfire prevention, pest control, and the development of value chains. For this analysis, we group these supports into four distinct categories by thematic focus: empowerment and inclusion, technology and infrastructure, conservation and maintenance, and production.[11] For these programs, our data include the number of applications and allocations for each agrarian community.[12] Nearly half of the records received from CONAFOR do not report the unique agrarian community identification code, but rather the official name. The official names themselves are not consistently reported, as abbreviations and variations are frequently used across documents.[13] To mitigate this problem, we use text analysis and visual inspection to recover as many of these records as possible. While we successfully retain 34% of the observations missing an agrarian community identification code, this still results in a total data loss. Overall, we are able to utilize only 67% of the full dataset CONAFOR/PROARBOL dataset for our analysis.

We rely on high-resolution satellite data from Hansen Global Forest Change (Hansen et al., 2013) to assess forest changes over the years. Hansen's dataset is one of the most widely used resources for monitoring deforestation. Forest loss is defined as the complete removal of tree canopy cover within a given area. A grid cell is categorized as having experienced forest loss when its tree cover, which must be at least 30% canopy density at the start, is cleared during a specific year. Each pixel corresponds to a 30×30 meter area on the ground, which makes this dataset highly granular and capable of detecting small-scale changes in forest cover. The dataset is provided at an annual resolution, starting from the year 2000. This allows tracking of forest loss year by year, such that it captures deforestation trends over time. Figure 2 shows yearly tree cover loss in Mexico between 2001 and 2022:

[11] For an extensive explanation of each category, please refer to Appendix Table A.2.

[12] In what follows, we use the term *applications* to refer to requests submitted by agrarian communities to government programs (*aplicaciones* in RAN terminology) and *allocations* to refer to the supports or resources granted by the programs (*asignaciones* in RAN terminology).i.e, successful applications.

[13] For example, *San José dos* is inconsistently recorded as *San José no. 2*, while *San Rafael* is also abbreviated to *sn Rafael*.

During this period, Mexico lost 4890 kha (thousand hectares) of tree cover, equivalent to a nationwide 9.2% decrease in tree cover since 2000. The top four states accounted for 58% of all tree cover loss between 2001 and 2023.

We rely on nighttime lights data obtained from the dataset Global NPP-VIIRS-like Nighttime Light (2000—2022), expressed in nanowatts per square centimeter per steradian ($nWcm^{-2}sr^{-1}$), developed by (Chen et al., 2020) and available on Google Earth Engine. This product provides ready-to-use annual composites, constructed from the median of the 12 monthly imageseps of each year, which corrects distortions caused by stray light contamination at mid and high latitudes. In addition, the authors applied a dark background mask (values $< 1nWcm^{-2}sr^{-1}$) to remove unstable pixels and defined a maximum saturation threshold calibrated with reference cities (New York, London, Shanghai, and Beijing) to correct anomalous values. Therefore, no additional correction processes are applied in this study. On the basis of these already-corrected data, in Google Earth Engine, we calculate for each agrarian community the annual average intensity between 2012 and 2022, at a resolution of 500 m and in projection EPSG:4326.

Last, we use the official cartography of protected natural areas administered by the National Commission of Natural Protected Areas (CONANP). These protected areas are classified into six management categories: natural resource protection areas, biosphere reserves, flora and fauna protection areas, national parks, natural monuments, and sanctuaries. We intersect the protected-area boundaries with the agrarian community polygons to calculate the surface area in hectares (ha) corresponding to each protected-area category and the percentage this represents of the community's total area. In cases with no overlap, the value is recorded as 0 ha. For the purposes of our analysis, we create a dummy equal to 1 if any type of protected area falls within an agrarian community, and 0 if it does not.

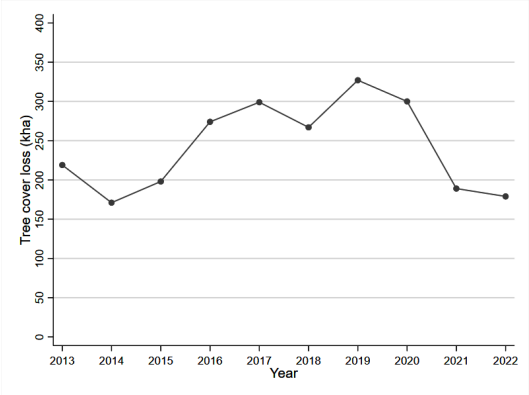


FIGURE 2 Yearly aggregate tree cover loss in Mexico (kha), 2013–2022

Notes: The figure depicts yearly aggregate tree cover loss in Mexico using all high-resolution satellite data from Hansen Global Forest Change for 2001–2022 (Hansen et al., 2013). Tree cover loss is defined as complete removal of tree canopy cover within a given area. Values are expressed in thousand hectares of tree cover.

We restrict our analysis sample to certified agrarian communities for which at least 10%

of the total area is classified as forest, at a minimum canopy density of 30%. These criteria result in a final sample of 10,892 agrarian communities.

3.2 | Descriptive statistics

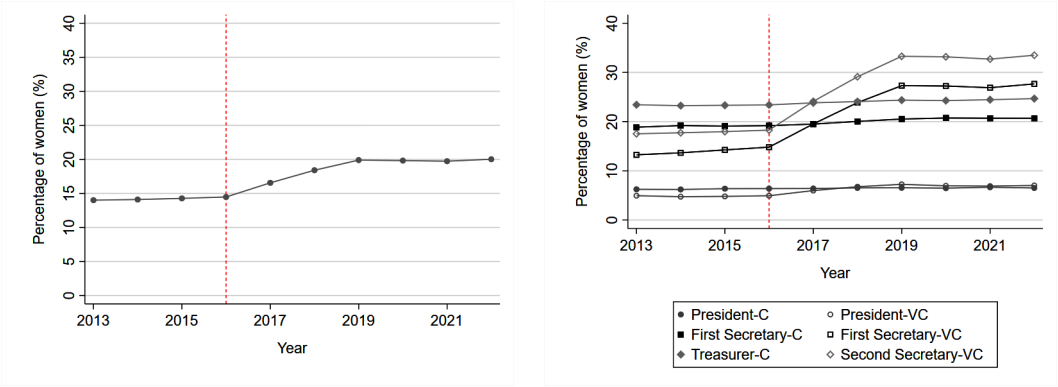
Table A.3 summarizes the final estimating sample: agrarian communities with more than 10% forest cover, concentrated in southern and southeastern Mexico, given the predominantly arid conditions in the north. The areas vary widely in size from about 5 hectares to 466,000 hectares, so scale is a first-order feature of governance. Most of our analyses focus on smaller units, defined as those below the 25th percentile by area ($\leqslant$ 636 ha), for two reasons. First, these units exhibit less de facto privatization.[14] Second, collective decision-making is more tractable at this scale, whereas the largest units approach the territorial size of small countries. From the descriptive statistics, we find that the agrarian communities in our sample are covered by an average of 40% forest area, with a slightly higher percentage observed for larger communities. The average annual deforestation rate is approximately 10%, though we see a clear difference by size: Small communities face a higher rate of 13%—nearly double the rate of larger communities (7%). In terms of economic activity, approximated by nighttime lights data, small and large agrarian communities show similar average values, while significantly large dispersion is observed for the group of medium-sized agrarian communities.

In Figure 3, the percentage of women in representative bodies is depicted by year. Following the implementation of the law in December 2016, a notable rise in the percentage of women elected is observed, particularly between 2016 and 2019. Nonetheless, the proportion of women remains considerably below the 40% threshold targeted by the reform.

Through 2015, women's representation changed little across roles and showed no systematic divergence (Figure 3). Right before the reform, women held about 7% of Commissariat presidencies in agrarian communities (AN); the share among Commissariat first secretaries was higher—around 21%. Before 2015, the role with the highest share of women was treasurers, approximately a quarter of whom were women. In the Oversight Committee, women's representation in the top position (president) was similarly low, with fewer than 6% of presidencies held by women in 2016. In contrast, the number of women holding secretary posts was higher, with second secretaries accounting for roughly 20% of the positions in 2016.

A clear trend break after 2016 is observable in Figure 3 for most positions. The share of Commissariat presidencies held by women remained roughly flat at approximately 7%. That of Commissariat first secretaries rose modestly, by approximately 2.6 pp from a 21% baseline, while the share of female treasurers continued to lie in the 20–30% range. In the Oversight Committee, presidencies held by women increased from under 6% in 2016 to

[14] Many agrarian communities have been informally parceled and traded, although legal title remains collective and parcels cannot be sold de jure.



(a) Total (b) By position

FIGURE 3 Women's representation in agrarian communities (%), 2013–2022.

Notes: Our calculations based on Registro Agrario Nacional (RAN) data (2013–2022). Panel (a) shows the percentage of women in all representative bodies of agrarian communities in Mexico. Panel (b) shows the distribution by position over time. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.

above 8% by 2022. The largest shifts occurred in secretary positions: The share of women among Oversight Committee first secretaries jumped between 2016 and 2019, and that among second secretaries increased from 20% in 2016 to 35% by 2019.

4 | METHODOLOGY

We proceed in three steps. First, we study whether the 2016 candidate rule increased women's representation in agrarian communities' governing bodies. Second, we investigate the relationship between exposure to the rule and deforestation, as well as other outcomes. In both cases, the treatment is defined as the first post-2016 election held under the quota, and the event-study coefficients are interpreted as dynamic intent-to-treat (ITT) effects relative to a pre-reform baseline.

4.1 | Event study

The treatment variable is defined as a binary indicator equal to 1 at the first election held by an agrarian community after the reform. This is modeled as an absorbing state—once an agrarian community receives treatment, it remains treated in all subsequent periods. We leverage the 2016 Agrarian Law, which, given the variation on the timing of ejidos' and comunidades' elections, created a staggered treatment. This variation provides an ideal setting for implementing an event-study approach. We index the event time by $k = t - E_i$, where E_i is the calendar year of community i's first postreform election. We set $k = 0$ to the year of that election, use $k = -1$ (the year just before) as the omitted baseline, and bin the tails at $k \leqslant -4$ and $k \geqslant +4$.

We implement the visualization and detrending approach proposed by Freyaldenhoven et al. (2021), which partials out linear pretrends via a generalized method of moments (GMM) estimator instead of relying on ad hoc trend controls. Appendix Table A.4 documents a persistent linear pretrend in women's representation that remains under all alternative trend specifications, fixed-effects sets, and controls. These pretrends introduce attenuation in most of our results, as the identified trends generally go in the opposite direction of the policy effect and therefore do not drive our results. However, we employ the detrended GMM estimator of Freyaldenhoven et al. (2021) wherever we identify statistically significant pretrends. This algorithm implements the method proposed by Dobkin et al. (2018) to remove potential confounding trends correlated with event time. The idea is that if the outcome variable follows a smooth trend around the treatment period, independent of the treatment itself, this trend could bias our estimates. To address this, the command function first estimates the trend using only the pretreatment periods. We then extrapolate this estimated trend into the post-treatment period and subtract it from the observed data. This procedure yields a detrended outcome, where smooth, underlying variation not caused by the treatment is removed. This approach allows us to better isolate the true effect of the treatment by comparing the observed outcomes to what we would have expected had the pretreatment trend continued over time.

Specifically, we estimate the following equation:

$$Y_{it} = \alpha + \sum_{k=-4}^{4} \beta_k \cdot T_{i,t+k} + \lambda_t + \mu_i + \epsilon_{it}, \tag{1}$$

where Y_{it} is the outcome for agrarian community i in year t. In the first part of the analysis, Y_{it} is the percentage (or indicator) of elected women; in the second part, it is the deforestation rate and, in extensions, economic activity (nighttime lights) and receipt of government support. The deforestation rate is calculated as the percentage of forest loss in a given year over the percentage of forested area in that unit in 2012. $T_{i,t+k}$ denotes event-time indicators as defined above, μ_i and λ_t are agrarian community and year fixed effects, and the β_k coefficients trace dynamic ITT effects relative to the outcomes at $k = -1$.

4.1.1 | Assumptions and limitations

Inference under staggered adoption requires several assumptions. The first is parallel trends: namely, that absent the reform, cohorts adopting at different times would have followed similar paths in Y_{it}. Appendix Section A.2.1 shows no different trends between early adopters (i.e., those having their first postreform election in 2019) and late adopters (those having it in 2017). These results are intuitive since agrarian communities have fixed triennial election calendars that they cannot easily manipulate and the exact timing of their election cycles is most likely driven by historical institutional factors unrelated to our variables

of interest. As discussed, we address residual pretrends using the detrended event-study framework of Freyaldenhoven et al. (2021).

The second assumption is no anticipation, meaning that agrarian communities did not strategically adjust their management decisions in expectation of the reform before their first post-reform election. Centering identification on deviations from $k = -1$ helps guard against short-run anticipatory responses. The third assumption is exogeneity of election timing: Conditional on fixed effects and covariates, the timing of the first postreform election must be unrelated to unobservables driving Y_{it}. As discussed, the institutional three-year cycles combined with the fact that the electoral calendars across agrarian communities are nonsynchronous support this claim (Goodman-Bacon, 2021).

The fourth assumption is of no relevant concurrent policies. To reduce the scope for confounding, at least one of the following must be satisfied for any contemporaneous reform: (a) It did not align with the staggered timing of first postreform elections, (b) it is unrelated to women's participation in communal governance, or (c) it is not mandatory/binding for agrarian communities. As detailed in the context section, this is the case for all concurrent policy changes except for the 2023 Agarian Reform, so we exclude observations from that year.[15] Finally, the DID methodology requires the stable unit treatment value assumption (SUTVA), which in practice means there were no spillovers. We do not expect cross-community spillovers on women's participation because elections and governance rules are internal to each community. We provide evidence supporting this assumption in Appendix Table A.6.

Because our data include only electoral outcomes, we cannot observe potential changes in the composition or quality of the candidate pool. Therefore, our estimates reflect changes among elected officials rather than shifts in the size or composition of the pools. If communities responded strategically to the quota (for instance, by reserving nominations for men for their most experienced members), our estimates would represent a lower bound on the reform's effects, capturing its realized impact under prevailing gender norms and nomination practices.

4.2 | Estimating LATEs via a Wald estimator

In our analysis described so far, we use Callaway and H.C. (2021) and Freyaldenhoven et al. (2021) to estimate the impact of the reform on both the percentage of elected women and deforestation. For deforestation, these estimates capture the ITT effect since not all agrarian communities experienced an increase in women's representation after the reform. To provide an estimate of the magnitude of the effect among compliers, we construct LATEs using a Wald estimator for each period k (Angrist et al., 1996).

Calculating the LATE requires additional assumptions. First, monotonicity requires that no agrarian community would have seen an increase in women's participation in the

[15] For a comprehensive summary of all the key reforms that took place, please refer to Appendix Table A.1.

absence of the reform but seen a decrease in it under treatment. Second, the instrument must be relevant, which means that the reform must have significantly affected women's representation, a fact that we establish in the first part of our analysis. Third, the reform must satisfy the exclusion restriction, which implies that it had no direct effect on deforestation other than through women's participation.

Under these assumptions, the Wald estimator of the treatment effect at relative time k is

$$\hat{\tau}_k = \frac{E[D_{it} \mid t - E_i = k,\ k \neq -1] - E[D_{it} \mid k = -1]}{E[Z_{it} \mid t - E_i = k,\ k \neq -1] - E[Z_{it} \mid k = -1]} \quad \forall k \neq -1, \tag{2}$$

where D_{it} denotes the deforestation outcome for agrarian unit i at time t, Z_{it} the share of women in the governing body of unit i, E_i the date of the first postreform election, and $k = t - E_i$ the relative time with respect to that election. The numerator of equation (2) represents the reduced-form effect of the reform on deforestation, while the denominator is the corresponding first-stage effect on women's representation. Their ratio, $\hat{\tau}_k$, recovers the LATE, that is, the causal effect of women's representation on deforestation at horizon k.

Because $\hat{\tau}_k$ is a ratio of two estimated effects, standard errors cannot be obtained directly. We therefore rely on a nonparametric bootstrap: From a sample of size s, we draw N resamples with replacement and, for each draw, reestimate both the reduced form and first stage following equation (1). We set $N = 500$ and $s = 1{,}000$. The empirical distribution of the bootstrapped estimates of $\hat{\tau}_k$ is then used to construct confidence intervals, with the 95% interval given by the 2.5^{th} and 97.5^{th} percentiles.

5 | RESULTS

We examine how the quotas introduced by the reform on candidate lists for agrarian communities' representative bodies shaped the composition of elected seats and, consequently, the decisions made within these assemblies. This section presents the results of our empirical analyses and is organized as follows: We begin by examining in Section 5.1 the shifts in women's representation within agrarian communities in response to the quota reform. Section 5.2 shows the ITT effects on deforestation rates. Next, Section 5.3 examines potential mechanisms that may be at play, with Section 5.3.1 presenting estimates of post-treatment changes in economic activity proxied with satellite-based night light measurements and Section 5.3.2 documenting agrarian communities' participation in government programs that support collective land management.

5.1 | Quota reform and women's representation

Figure 4 depicts the reform's impact on the proportion of elected women on agrarian communities' boards, which we obtain by implementing equation (1). Panel (a) displays

the event-study plot with an overlaid extrapolation line. It is visible from Panel (a) that the percentage of women in agrarian communities' governance had followed a decreasing trend in the years leading to the reform and that detrending is thus a necessary step. This finding also alleviates the concerns that the staggering of the reform's application was part of an overall positive trend in the election of women in agrarian communities in Mexico. If this were the case, we would expect the pretrend to have the opposite sign.

Panel (b) presents the detrended plot, where we subtract the extrapolated trend from the event-study estimates, following Freyaldenhoven et al. (2021). Using this methodology, we find that women's representation in the average agrarian community in our sample increased by 5.9 pp after its first election following the reform (k= 0). This increase reached 7.6 pp in the third year after the first postreform election. Importantly, none of the point estimates are statistically significant for the periods before the treatment, supporting the plausibility of the parallel trends assumption.

While the aggregate share of women on agrarian community boards increased after the reform, this was not true for all positions. Quotas on candidate lists do not automatically translate into more women in office: Assemblies can nominate strategically to circumvent the new requirements, and voters may punish female candidates. The characteristics and responsibilities of each position—and whether the role aligns with social conceptions of women's work—also matter. Figure 5 sheds light on these dynamics by examining how the reform's impact on women's likelihood of holding office varies by position type and rank.

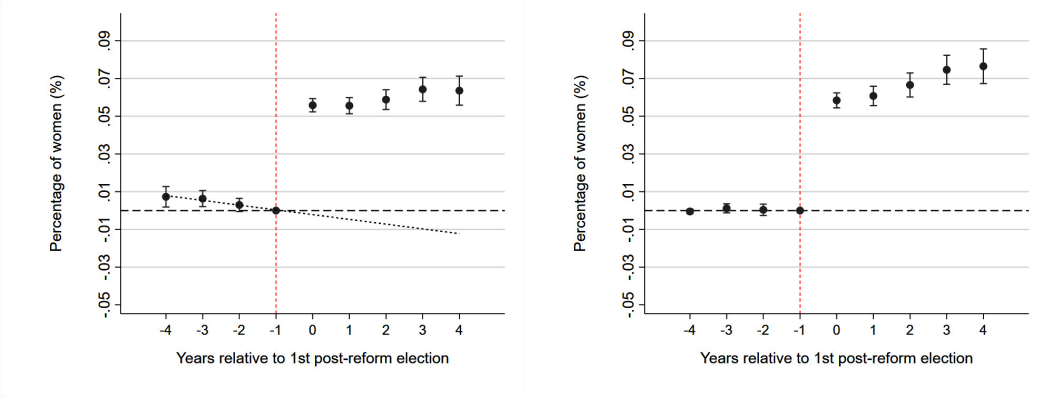
For the highest post, president of the Commissariat, there is no evidence of significant change before or after the reform. Other high-ranked positions show modest gains. For instance, the probability that the first secretary of the Commissariat is a woman increased by 1.1 pp at the first postreform election and by 2.6 pp by the third year after that election. For the treasurer, the probability rose by 1.1 pp in the first year, but the effect was temporary and returned to prereform levels by year three.

For the Oversight Committee, a very different picture emerges. For the president position, the probability of a woman being elected increased by 2.3 pp in the first postreform election; this effect continued to grow, reaching a 4 pp increase by the third year. This effect, while modest in absolute terms, represents a substantial increase when compared with the prereform average of 5% and contrasts with the null effect we observe for the Commissariat. For the first secretary position, we see an increase of 13.6 pp in the first year after the reform. This increase continued, with the probability rising by 18 pp after three years. For the second secretary, the probability of a woman being elected rose by 17 pp in the first postreform election. This effect is the largest observed in our analysis, further climbing to 21 pp after three years.

The differences between the Commissariat and Oversight Committee, as well as the attributions of each position, are key to interpreting these results. The Commissariat is in charge of the executive and administrative functions of the community, including managing communal resources and deciding how to implement assembly decisions. The Oversight

Committee has a monitoring role, with its president having executive authority to monitor and take action in cases of irregularities. Consequently, the position with the most power in agrarian communities is president of the Commissariat, the head of the local executive branch. The treasurer has financial control over the resources and sits in the second position in the hierarchy. In a similar position is the president of the Oversight Committee, although this official arguably has less power as it does not involve management of the community's financial resources. Following the Oversight Committee president is the first secretary, responsible for documenting and maintaining the records of the agrarian community's activities, beneficiaries, and properties. In contrast, the first and second secretaries of the Oversight Committee—the positions with the highest increases in women's participation—primarily serve record-keeping and auxiliary roles (Morett-Sánchez and Cosío-Ruiz, 2017). Therefore, our results on the effect of the quota on women's representation suggest an interesting finding: The participation increase appears inversely related to the hierarchical position within the community, indicating a sort of stepped glass ceiling, where the most powerful positions remain reserved for men and the largest gains for women correspond to administrative or auxiliary roles.

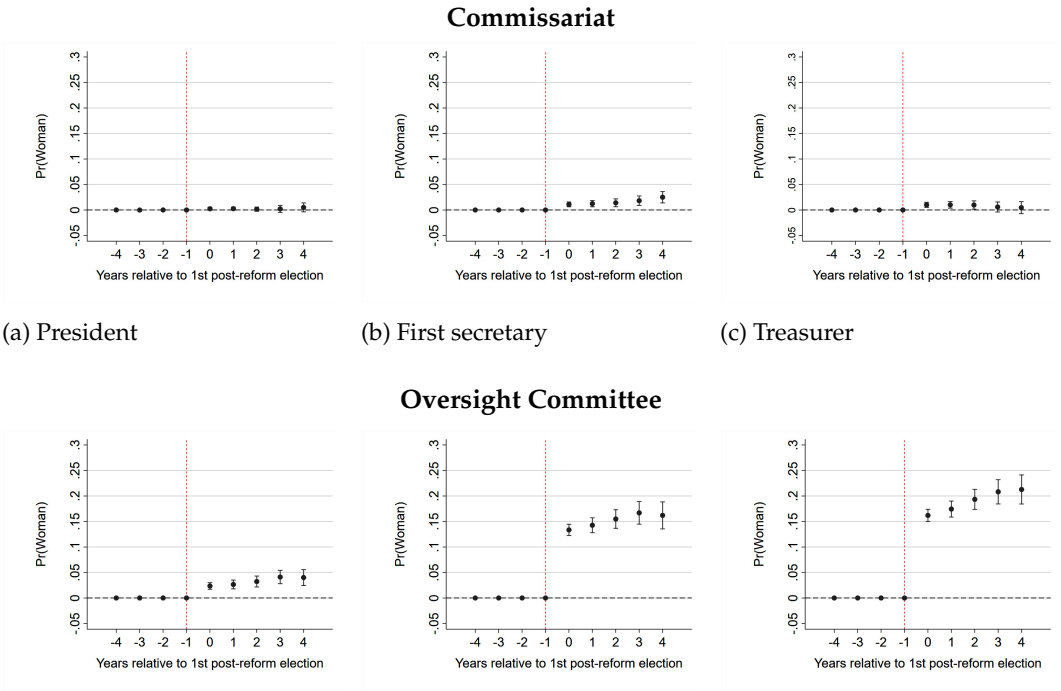
Through its auditing and reporting responsibilities, the Oversight Committee is designed as an institutional check on the misuse of common resources. Given the theoretical links between gender and the environment, in increase in women's participation in these positions could be expected to improve monitoring of land use and forest management and ultimately help mitigate deforestation. In the next section, we explore this relationship.



(a) With extrapolation line (b) Subtracting extrapolated trend (GMM)

FIGURE 4 Share (%) of women in representation bodies

Notes: Our calculations based on RAN data (2013–2022). The figure illustrates the impact of the quota reform on women's participation, as defined in equation (1). Panel (a) plots the percentage of women in all representative bodies of agrarian communities in Mexico, together with the underlying trends over time. Panel (b) presents the same specification, net of time trends. The x-axis indicates years relative to the first postreform election ($k = 0$). Error bars show 95% confidence intervals. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.



(a) President (b) First secretary (c) Treasurer

(d) President (e) First secretary (f) Second secretary

FIGURE 5 Women's representation by position around the first postreform election (GMM detrended)

Notes: Our calculations based on RAN data (2013–2022). The figure illustrates the impact of the quota reform on women's participation on specific positions, as defined in equation (1). Each panel reports the probability that the indicated position is held by a woman. All estimates are the GMM versions obtained by subtracting the extrapolated pretrend from the outcome (i.e., detrended on the basis of the extrapolated prereform dynamics). The horizontal axis shows years relative to the first postreform election ($k = 0$). Error bars show 95% confidence intervals. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.

5.2 | Effect of women's representation on deforestation

Women's leadership and management often differ from men's: Evidence links the presence of women in power to greater investment in common goods, lower corruption, and more collaborative governance (Chattopadhyay and Duflo, 2004; Brollo and Troiano, 2016; Wängnerud, 2009). A smaller literature, mostly on South Asia, suggests women also promote more sustainable forest use (Agarwal, 2010; Leone, 2019; Berniell et al., 2025). Together, these findings motivate the hypothesis that, under this reform, greater participation of women in agrarian governing bodies could improve local forest health. This conjecture is consistent with work showing that women are more exposed to environmental degradation and more reliant on the commons—and therefore often express stronger environmental concerns (Croson and Gneezy, 2009; Aguilar Gómez et al., 2024; Aguilar-Gómez and Salazar-Díaz, 2025).

We therefore ask whether women can shift land use outcomes even though their largest representation gains occurred in the lowest positions within the agrarian communities

TABLE 1 Deforestation rate – average post-treatment effect

	Full sample	Small	Medium	Large
	(1)	(2)	(3)	(4)
Treatment (static)	-0.048*	-0.153***	0.087**	-0.034
	(0.026)	(0.057)	(0.039)	(0.032)
Pretreatment mean	0.868	1.037	0.859	0.696
Observations	93,523	31,179	31,172	31,172

Notes: Our estimates using high-resolution satellite data from Hansen Global Forest Change, 2001–2022 (Hansen et al., 2013). The dependent variable is the deforestation rate. "Small," "Medium," and "Large" indicate subsamples of area terciles. Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

(typically auxiliary/record-keeping roles) and within the Oversight Committee, which emphasizes monitoring rather than direct resource-management decisions. We estimate ITT effects of the reform on deforestation and then convert these into LATE estimates of the marginal effect of a 1 pp increase in women's representation on deforestation rates. We first focus on all agrarian units, regardless of size and conservation status. Table 1 shows the static DID estimate (Callaway and H.C., 2021). On average, the reform reduced annual deforestation rates by .05 pp relative to prereform levels, a decline equivalent to approximately 5.5% of the pretreatment mean.

We then split agrarian communities by size. The theoretical motivation for this analysis stems from the theory of collective action. Landholding sizes in our sample show substantial heterogeneity, ranging from 5 to almost 500,000 hectares. In small agrarian communities, the number of members is manageable for collective decision-making, and social proximity facilitates agreement on rules and mutual monitoring, reducing the "scaling-up problem" that weakens governance in larger groups (Ostrom et al., 1999). By contrast, in very large units, distance among members and the dispersion of parcels make coordination costly, and informal privatization for individual uses—while illegal—is widely documented (Varley and Salazar, 2021). Under such de facto privatization, communal governance loses significance. This is consistent with Alix-Garcia et al. (2005), who argue that reducing deforestation through community management requires groups to be sufficiently small and cohesive to monitor and sanction members. Medium-sized communities may fall between these regimes, often located in more accessible transition zones with mixed agricultural and forest use, where collective enforcement is weaker and land use pressures are higher (Schmook and Radel, 2008). The pattern of our results reflects this logic: The effects are concentrated among small communities, where collective rules can still be effectively enforced.

The dynamic estimates confirm this finding and show that the largest effects occurred one year after entering into treatment: The postreform decline in deforestation rates is statistically significant for only one year after the implementation of the new committees. Specifically, we find a 0.073 pp decrease one year after the first postreform period (Figure 6). This effect is quite large in magnitude, representing a 8.45% decrease from the prereform

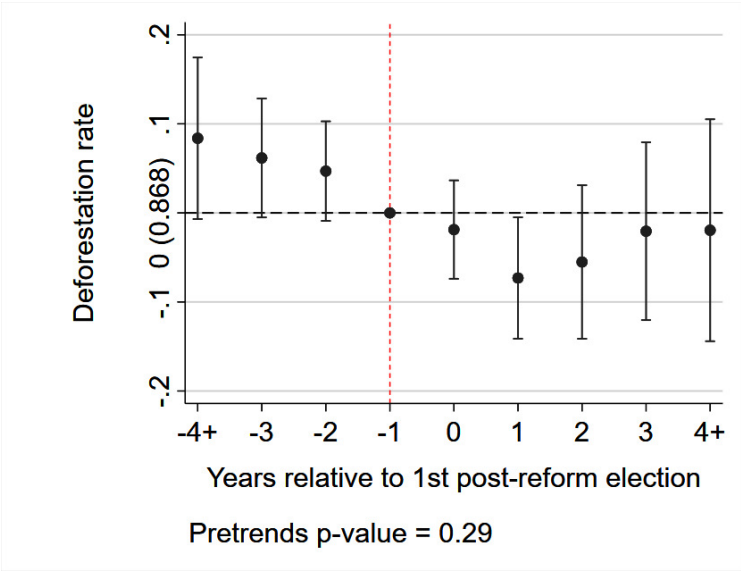


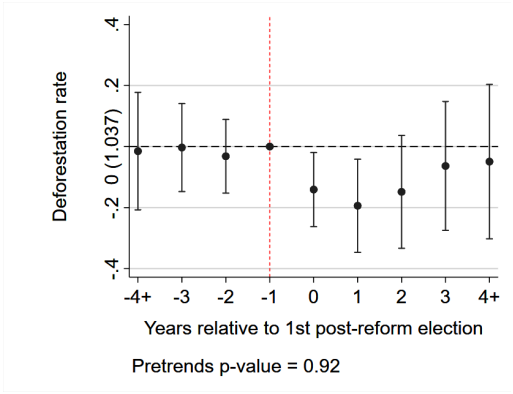
FIGURE 6 Deforestation rate

Notes: Our estimates using high-resolution satellite data from Hansen Global Forest Change for 2001–2022 (Hansen et al., 2013). The deforestation rate is based on forest loss, defined as the complete removal of tree canopy cover within a pixel area during a given year. The deforestation measure is normalized relative to tree cover in 2012. The graph shows the ITT of women's representation on deforestation as defined in equation (1). The horizontal axis shows years relative to the first postreform election ($k = 0$). Error bars show 95% confidence intervals. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.

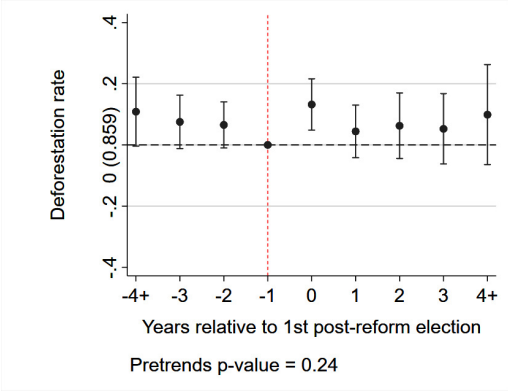
sample mean of 0.87 pp. However, dynamic estimates suggest that it does not persist over the years, although attenuation bias could likely be a factor as statistical power substantially decreases after treatment.

When we examine the dynamic estimates by landholding size (Figure 7), the heterogeneity arises again. We find that the aggregate effect is driven by small agrarian units, which experienced a reduction in deforestation of up to 0.19 pp one year after the first postreform election. This effect is quite large in comparison to the prereform sample mean of 1.04 pp, amounting to an 18.7% decrease. In contrast, medium units displayed an increase in their deforestation rate of about 0.13 pp in the year of the first postreform election and no changes thereafter. For large units, we observe no statistically significant changes in deforestation rates as a consequence of the reform.

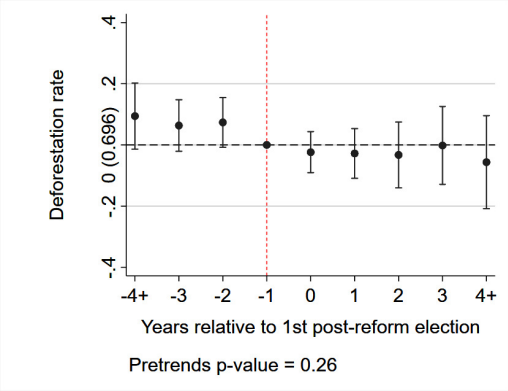
Not all agrarian communities saw an increase in women's participation after the reform. As discussed, the event-study with deforestation as the outcome identifies ITT effects. Appendix figures report Wald/LATE estimates scaled to the effect of a 1 pp increase in women's representation among agrarian communities in which participation rose because of the reform (compliers). We find a significant negative effect among this group: -1.17 pp in the deforestation rate at the time of the election ($k = 0$). These magnitudes indicate a large marginal response of deforestation to women's participation. While the bulk of the effect is transitory, delaying deforestation still yields net carbon gains because shifting



(a) Small



(b) Medium



(c) Large

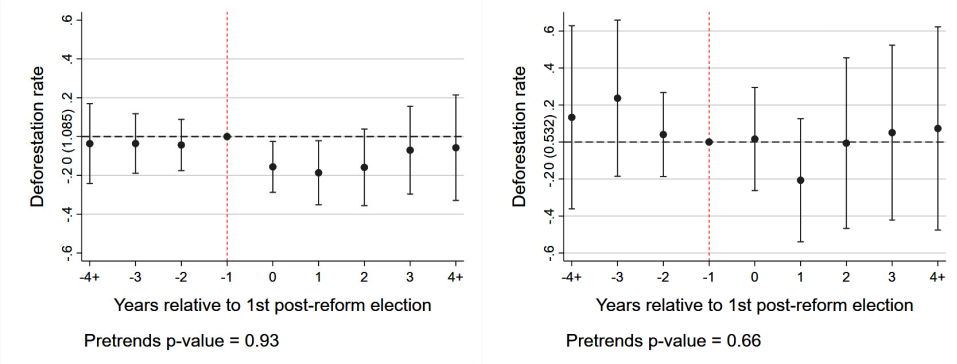
FIGURE 7 Deforestation rate by agrarian community size

Notes: Our estimates using high-resolution satellite data from Hansen Global Forest Change, 2001–2022 (Hansen et al., 2013). Each panel reports the deforestation rate around the first postreform elections for agrarian communities grouped by size tercile. Agrarian communities are categorized as follows: *small* (first tercile), *medium* (second tercile), and *large* (third tercile). The deforestation rate is based on forest loss, defined as the complete removal of tree canopy cover within a pixel area during a given year, and is normalized relative to tree cover in 2012. The graph shows the ITT of women's representation on deforestation as defined in equation (1). The horizontal axis shows years relative to the first postreform election ($k = 0$). Error bars show 95% confidence intervals. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.

emissions into the future reduces the present value of climate damages (Jayachandran et al., 2017). When we split the sample by size, we find no significant effect for medium or large landholdings. For small agrarian communities, we observe a significant negative effect of -3.75 pp at the time of the election ($k = 0$), before the value returns to near zero for the medium run, indicating a high responsiveness of this outcome to women's participation. These size-based results confirm our initial hypothesis that women may find it easier to participate and make their voices heard in smaller settings, which is where the effect of women's representation on deforestation is concentrated.

We also examine the ITT effect on deforestation by the share of the agrarian community area protected under the national protected areas program. What results we should antici-

pate from these analyses is a priori ambiguous: On the one hand, in areas with some degree of protection, we might expect higher impacts given the evidence that women are more compliant with regulations and so as leaders might prioritize enforcement of federal protection guidelines. On the other hand, in protected areas, the impact of decisions made by the local governing body may be limited, as these areas are subject to higher federal-level oversight and enforcement. Given this, we split our analysis between agrarian communities with some form of protection and those without any protection. As shown in Figure 8, the effects in the aggregate sample seem to come from areas with no environmental protection. These display a decrease in deforestation of 0.156 pp in the first election postreform and up to 0.187 pp one year after—both relatively large estimates with respect to average deforestation in this sample. In contrast, areas with some protection do not show a clear pattern. This evidence is most consistent with our hypothesis of limitations on local discretion: Women's leadership reduces deforestation where local governance retains scope to act (outside protected areas) but shows no comparable effect under heightened federal oversight.



(a) Agrarian communities with no protection (b) Agrarian communities with some protection

Notes: Our estimates using high-resolution satellite data from Hansen Global Forest Change from 2001 to 2022 (Hansen et al., 2013) and the official cartography of protected natural areas administered by CONANP. Panel (A) reports the deforestation rate around the first postreform elections for agrarian communities without any form of protection by the federal state; panel (B) reports the same estimate for agrarian communities with any form of protection by the federal state. The deforestation rate is based on forest loss, defined as the complete removal of tree canopy cover within a pixel area during a given year. The deforestation measure is normalized relative to tree cover in 2012. The graph shows the ITT of women's representation on deforestation as defined in equation (1). The horizontal axis shows years relative to the first postreform election (k = 0). Error bars show 95% confidence intervals. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.

FIGURE 8 Deforestation rate by share (%) of protected area

5.3 | Mechanisms

Several mechanisms could explain the improvement in environmental outcomes in agrarian communities. First, the reader might wonder whether the reduced deforestation comes at the expense of economic activity. Women in governance may face higher obstacles to

exercising decision-making authority, and any associated stalling of projects—unless they are conservation related—would generally translate into better environmental outcomes but also lower production. Alternatively, women leaders might successfully steer production toward activities less dependent on forest resources. We test this question using night lights as a proxy for economic activity in Section 5.3.1.

We next examine whether women's leadership affects the management strategies of agrarian communities, particularly in their participation in public programs, an important source of resources and capacity building for agrarian communities. To answer this question, we utilize administrative data on all categories of government support for which agrarian communities can apply. In Section 5.3.2, We examine whether applications for and receipt of support from government programs changed in the postreform period.

5.3.1 | Changes in economic activity

Nighttime light data are a reliable proxy for economic activity, particularly in the context of rural Mexico. While satellite-measured light emissions may not accurately capture economic growth in highly developed, urbanized areas because of a "top-capping" effect, whereby sensors become saturated, this limitation is less pronounced for rural settings (Mellander et al., 2015). For these regions, a strong correlation exists between expansions of economic activities and increases in electricity consumption and infrastructure, which are directly measurable by nighttime light data.[16]

Our analysis reveals no significant changes in economic activity, as approximated by nighttime light, within small agrarian communities, as shown in Figure 9. This suggests that the increase in women's participation and subsequent decrease in deforestation rates did not come at the expense of local economic activity. A closer look through the LATE estimates (Appendix Figure A.2.3) confirms this finding.

5.3.2 | Application for and receipt of support from government programs

As a measure of local decision-making and management, we next examine whether the increase in women's representation within agrarian community boards affected the communities' participation in government support programs. We consider programs in four categories: *(i) empowerment and inclusion*—initiatives that support women's participation in rural governance; *(ii) technology and infrastructure*—investments in equipment and infrastructure (e.g., roads, surveillance) to modernize operations; *(iii) conservation and maintenance*—forest

[16]Several studies support the validity of this approach. For instance, Pérez-Sindín et al. (2021) highlight that nighttime lights are a good proxy for economic activity in rural areas, especially in middle- and low-income countries, for which traditional economic data can be unreliable or scarce. This is because initial investments in infrastructure and development, such as electrification of villages or building of small-scale factories, create new light sources that are easily detected by satellites. Moreover, a study focusing specifically on Mexican municipalities finds that satellite nighttime lights are a valid measure of economic growth, confirming their utility for the specific geographic context of this research (Millán López and González Olivares, 2024).

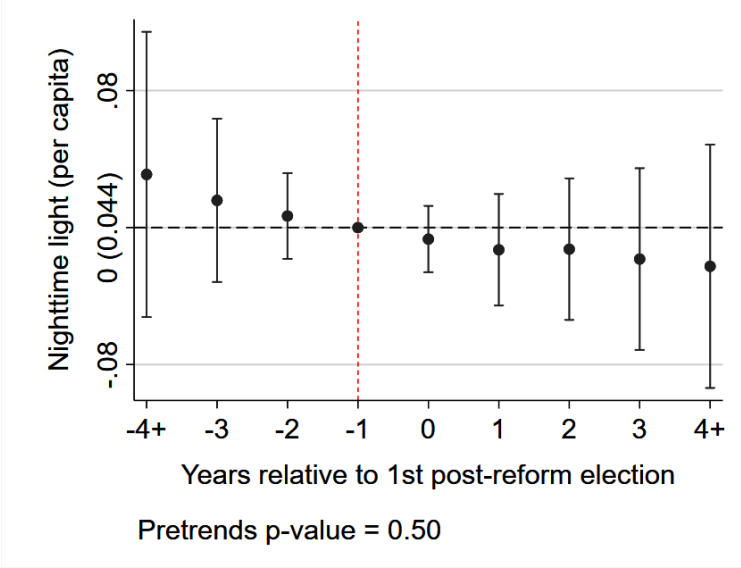


FIGURE 9 Nighttime light

Notes: Our estimates using Global NPP-VIIRS-like Nighttime Light data (2013–2022). The outcome variable represents the standardized annual average intensity per capita. The graph shows the ITT of women's representation on nighttime light as defined in equation (1). The horizontal axis shows years relative to the first postreform election (k = 0). Error bars show 95% confidence intervals. The sample is restricted to agrarian communities with at least 10% forest cover in 2013 and to the first size tercile of agrarian communities.

certifications and audits, restoration of soil and water, large-scale reforestation, fire, pest, and disease protection, and community monitoring; and *(iv) production*—management plans and required technical documents, support for commercial plantations, and entrepreneurship to strengthen the forestry value chain.[17]

Table 2 shows the postreform change in total applications and applications by category, and Table 3 examines awards. We study applications and awards separately because these variables reflect potential demand- and supply-side changes as more women take part in governance bodies. The empirical relevance of this distinction is evident even at the aggregate level: The total number of applications remained unchanged after the reform, but the number of grants awarded to treated agrarian communities declined substantially—the reductions of between 0.01 and 0.05 correspond to 14% and 71% of the pretreatment mean. Individual and systemic barriers may shape both the quality of applications and, even when quality is comparable, their likelihood of approval. This suggests that better formal representation alone may be insufficient to level the playing field if broader institutional or procedural biases persist.

We observe the same divergence between applications and awards in the *empowerment and inclusion* category (column (5) in Table 2 and column (4) in Table 3): there is an increase

[17] As discussed in Section 3, the data quality of agrarian unit identifiers is lower than that of other sources used in this project; consequently, we can match only approximately half of the agrarian communities in our main sample, which limits statistical power. Appendix Table A.2 details the categories included in each broad category described here.

in applications to this category that starts in year 0 and strengthens over the years. In the LATE estimates (Appendix Figure A.5), an increasing trend in applications appeared after the reform and was statistically significant by year 3, for which the LATE reaches an increase of almost one application, large relative to the sample mean of 0.02. The impact on applications suggests a potential virtuous cycle: A greater presence of women in governing bodies incentivizes higher participation in women-oriented programs, which may, in turn, encourage more women to engage in the political process. This finding also aligns with the concept of substantive representation in the political science literature. [18] A discouraging result, however, is that the higher number of applications once again did not translate into a higher number of disbursements (Figures A.5 and A.6), suggesting supply-side constraints or discrimination in program awards.

For the *conservation and maintenance* category, the ITT estimates for neither applications (Table 2, column(2)) nor awards (Table 3, column (2)) reach statistical significance. Consistent with this, the corresponding LATE estimates reported in the appendix show no discernible effect: Across the postreform window, the confidence intervals cover zero and exhibit no systematic trend. This contrasts with the reduction in deforestation, suggesting that those reductions did not depend on additional program resources. Given the limited duration of the deforestation reductions, these patterns also raise the possibility that, if women were able to secure greater public support for conservation, the effects could be more durable.

The third category we explore is *production*. Here, the results reveal a clear and consistent pattern: After the first postreform election, agrarian communities appear to have applied for (Table 2, column(3)) and received (Table 3, column (3)) less support from programs fomenting production activities. The LATE estimates confirm this result: For applications, the effect is negative and statistically significant at the 5% level at $k = 3$ and at the 10% level at $k = 0$ and $k = 2$. For allocations, the negative and statistically significant effect at the 5% level persists for all postreform periods. This result suggests a potential trade-off: In the agrarian communities where women's participation increased, their emphasis on other priorities, such as *empowerment and inclusion*, may have led to a decrease in the pursuit of support from traditional production-oriented programs.

Last, we analyze the *technology and infrastructure* category. For some prereform periods, we see positive and statistically significant coefficients, with a pretrends p-value of 0.091; therefore, the results from the detrended specification are presented in Tables 2 and 3, column (6). This specification yields no statistically significant ITT or LATE estimates, as presented in Figures A.5 and A.6.

The reform may also have altered the composition of candidates along dimensions other than gender. In this regard, several mechanisms could operate simultaneously. Women in Mexico tend to have higher average educational attainment than men in the same communities (though this pattern is weaker for rural areas; (Ghilardi et al., 2023; OECD,

[18] Substantive representation refers to representatives acting on behalf of women's interests by placing their concerns on the agenda and translating them into policy (Chattopadhyay and Duflo, 2004; Wängnerud, 2009; Clayton et al., 2017).

2024), but they face heavier unpaid work burdens and fewer opportunities to accumulate political experience or networks (Aguilar-Gomez et al., 2026). Given these structural barriers, the women who do enter electoral competition are likely to be positively selected, combining above-average education, stronger community support, or family connections that enable them to overcome time and mobility constraints. If, in parallel, ejidos strategically adjust nominations such that men retain control over high-status positions, the reform could induce differential selection within both genders, reshaping the overall profile of local leadership. While these attributes are unobservable in our data, such mechanisms may help explain the persistence of gender gaps in powerful roles despite broader inclusion of women.

TABLE 2 Forest support program applications by category

	All	**Conservation**	**Production**	**Empowerment**		**Tech. & Infra.**	
	(1)	(2)	(3)	(4) Raw	(5) Detr.	(6) Raw	(7) Detr.
$k = -4$	-0.033	-0.034	0.004	-0.000	-0.000	0.011**	-0.002
	(0.035)	(0.030)	(0.007)	(0.000)	(0.000)	(0.004)	(0.004)
$k = -3$	-0.032	-0.031	0.004	0.000	0.000	0.008**	-0.001*
	(0.026)	(0.024)	(0.006)	(0.000)	(0.000)	(0.004)	(0.005)
$k = -2$	0.015	0.015	0.002	0.000	0.000	0.009***	0.005*
	(0.023)	(0.021)	(0.005)	(0.000)	(0.000)	(0.003)	(0.003)
$k = 0$	-0.022	-0.011	-0.006	0.000	0.000**	-0.002	0.003
	(0.022)	(0.020)	(0.004)	(0.000)	(0.000)	(0.002)	(0.003)
$k = +1$	-0.039	-0.020	-0.010*	0.001	0.001*	-0.006**	0.003
	(0.026)	(0.022)	(0.006)	(0.000)	(0.000)	(0.003)	(0.005)
$k = +2$	-0.021	-0.007	-0.005	0.001	0.001*	-0.007**	0.006
	(0.032)	(0.027)	(0.007)	(0.001)	(0.001)	(0.003)	(0.006)
$k = +3$	-0.055	-0.009	-0.016*	0.001	0.001	-0.014***	0.002
	(0.039)	(0.034)	(0.009)	(0.001)	(0.001)	(0.004)	(0.008)
$k = +4$	-0.047	0.001	-0.023**	0.004**	0.004**	-0.021***	-0.000
	(0.048)	(0.042)	(0.011)	(0.002)	(0.002)	(0.005)	(0.010)
N	30,601	30,601	30,601	30,601	30,601	30,601	30,601
$\bar{Y}_{pre}$	0.221	0.162	0.028	0.001	0.001	0.009	0.009
R^2	0.385	0.315	0.212	0.149	0.149	0.281	0.281
Pretrend p val.	0.234	0.131	0.920	0.057	0.214	0.025	0.135

Notes: Estimates are based on RAN data (2013–2022). The table reports event-study estimates of the quota reform's effect on applications for government support programs by category. $\bar{Y}$ denotes the prereform sample average of the dependent variable. Each column corresponds to a separate estimation of equation (2). For "Tech. & Infra.", estimates are shown in raw form and after detrending using the extrapolated prereform trend (GMM). Standard errors clustered at the agrarian community level are reported in parentheses. The indicator k measures years relative to the first postreform election ($k = 0$). The sample includes agrarian communities with at least 10% forest cover in 2013. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 3 Forest support program allocations by category

	All	Conservation	Production	Empowerment	Tech. & Infra.	
	(1)	(2)	(3)	(4)	(5) Raw	(6) Detr.
$k = -4$	0.020	-0.014	0.009	-0.000	0.009**	0.000
	(0.016)	(0.020)	(0.006)	(0.000)	(0.004)	(0.004)
$k = -3$	0.004	-0.016	0.004	-0.000	0.005	-0.001
	(0.009)	(0.016)	(0.005)	(0.000)	(0.003)	(0.001)
$k = -2$	0.009	0.015	0.001	-0.000	0.006**	0.003
	(0.007)	(0.014)	(0.005)	(0.000)	(0.003)	(0.002)
$k = 0$	-0.010*	0.001	-0.008**	0.000	-0.001	0.001
	(0.006)	(0.011)	(0.003)	(0.000)	(0.002)	(0.003)
$k = +1$	-0.020**	-0.011	-0.008*	0.000	-0.005**	0.001
	(0.009)	(0.013)	(0.004)	(0.000)	(0.002)	(0.004)
$k = +2$	-0.023*	-0.015	-0.012**	0.000	-0.009***	-0.000
	(0.012)	(0.017)	(0.005)	(0.000)	(0.003)	(0.005)
$k = +3$	-0.051***	-0.034	-0.025***	0.001	-0.014***	-0.003
	(0.016)	(0.020)	(0.006)	(0.001)	(0.004)	(0.007)
$k = +4$	-0.035*	-0.037	-0.028***	0.001	-0.019***	-0.005
	(0.021)	(0.026)	(0.007)	(0.001)	(0.005)	(0.009)
N	30,601	30,601	30,601	30,601	30,601	30,601
$\bar{Y}_{pre}$	0.070	0.074	0.017	0.000	0.007	0.007
R^2	0.258	0.273	0.199	0.105	0.237	0.237
Pretrend p-value	0.220	0.142	0.379	0.451	0.091	0.401

Notes: Estimates are based on RAN data (2013–2022). The table reports event-study estimates of the quota reform's effect on allocations of government support programs by category. $\bar{Y}$ denotes the prereform sample average of the dependent variable. Each column corresponds to a separate estimation of equation (2). For "Tech. & Infra.", estimates are shown in raw form and after detrending using the extrapolated prereform trend (GMM). Standard errors clustered at the agrarian community level are reported in parentheses. The indicator k measures years relative to the first postreform election ($k = 0$). The sample includes agrarian communities with at least 10% forest cover in 2013. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6 | CONCLUSION

Sustainable development in rural settings requires both preservation of forest ecosystems and advancement of political inclusion, particularly given women's persistent underrepresentation in public life. Nevertheless, rigorous evidence connecting women's representation to environmental performance remains limited.

The Mexican Agrarian Reform of 2016 presents an ideal context for answering this question, as the staggered election calendars of agrarian communities give rise to a natural experiment. Our results highlight both the potential and limits of institutional reforms designed to promote gender equality. The 2016 candidate quota law successfully increased women's representation in agrarian governance, but this progress was uneven across positions. The largest gains occurred in administrative and monitoring roles, while the most

powerful executive posts remained largely dominated by men. Formal inclusion did not automatically translate into equal influence.

Despite the partial character of this electoral uptake, its political and environmental consequences were meaningful. We find that the greater participation of women led to measurable reductions in deforestation, concentrated among small agrarian communities where collective decision-making remains viable and enforcement mechanisms are stronger. These improvements did not come at the expense of local economic activity: Nighttime light intensity—a proxy for production—remained stable after women's entry into leadership. This points to a form of gender-driven conservation that enhances sustainability without constraining livelihoods.

Our results on government program participation show that women apply to productive and environmental programs at rates similar to men yet receive less support. They are also overrepresented among applicants to gender-empowerment initiatives and face lower approval rates. Several policy implications follow directly from this asymmetry, which likely reflects both supply- and demand-side constraints. On the supply side, implicit bias or limited inclusion capacity among program officers could hinder women's access to funding, which would call for gender-responsive training within implementing agencies. Addressing procedural and gender biases in the evaluation of public program applications might be important to ensure that women-led communities can access and manage resources on equal terms. On the demand side, women's applications may be less competitive because of time constraints, limitation in their prior leadership experience, or weaker networks—factors that can be addressed through targeted managerial and technical training. Although the available data do not allow us to empirically distinguish which of these channels the effects we identify operate through, both point to the need for differentiated capacity-building strategies that strengthen women's participation and improve institutional inclusion practices in rural development programs.

Finally, integrating gender inclusion into the design of conservation policies would not only promote equity but also enhance environmental effectiveness. Recognizing and fostering women's leadership can catalyze more sustainable governance of the commons.

7 | ACKNOWLEDGEMENTS

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A | ONLINE APPENDIX

A.1 | Background information and descriptive statistics

TABLE A.1 Overview of reforms of the Agrarian Law, 2016–2023

Date	Article	Description
Dec 19, 2016	Article 37	Candidate slates for the ejido Commissariat and Oversight Committee may not exceed 60% of one gender. Assemblies should seek to include women as commissioners and assistant secretaries in the ejido Commissariat.[a]
Dec 19, 2016	Article 80	Subsection B: The spouse, common-law partner, and then children have right of first refusal, exercisable within 30 days of written notice; any waiver must be in writing before two witnesses and registered with the National Agrarian Registry.[b]
Dec 19, 2016	Article 115	*Latifundios*—estates exceeding small-property limits—are prohibited in Mexico.[c]
Dec 19, 2016	Article 166	Agrarian tribunals must take precautionary measures to protect parties and may temporarily suspend actions by other authorities that could harm them until trial.[d]
Mar 27, 2017	Arts. 71, 108	The assembly may reserve land to establish a UAIM for women aged 16+, including facilities to serve and protect rural women. Women may also self-organize as a UAIM and, within it, form unions.[e]
Mar 27, 2017	Article 185	At any stage before a final ruling, the court must encourage settlement; if reached, the trial ends by formal contract; otherwise, the court issues a decision.[f]
Jun 22, 2018	Article 20 Bis	If an *ejidatario* is declared legally absent, Article 18 procedures apply; disappearance is not grounds to lose ejidatario or resident status.[g]
Jun 25, 2018	Article 95	Prior occupation of land during expropriation is prohibited unless approved by affected ejidatarios or, for communal lands, the assembly; the Agrarian Attorney's Office must participate in the agreement.[h]
Mar 8, 2022	Arts. 17, 18	Ejidatarios may designate successors via a succession list (spouse, common-law partner, children of any gender, parents, others). Article 18 explicitly allows sons and daughters to inherit.[i]
Apr 25, 2023	Arts. 4, 32	The federal executive must promote integral and equitable rural development with a gender focus. Article 32 specifies that the ejido Commissariat executes assembly decisions and must observe gender parity.[j]
Apr 25, 2023	Article 37	Commissariat and Oversight Committee positions are chosen by secret ballot; repeated ties are resolved by lottery. Candidate slates must observe gender parity, including commissions and auxiliary secretaries.[k]

Source: Own elaboration based on reforms of the Agrarian Law.

TABLE A.2 Overview of Forest Program Categories

Category	Subcategories	Explanation
Empowerment and Inclusion	Women-only programs	Initiatives primarily designed to support women's participation and leadership in the sustainable management of forest resources. These programs provide targeted resources, capacity building and inclusion mechanisms.
Technology and Infrastructure	Technology adoption; forest operations infrastructure	Modernization of forest management through investments in advanced technologies and essential physical infrastructure. This includes adopting scientific methods for improved cultivation and management practices and building/maintaining roads and facilities that enable timber transport, surveillance and access to natural resources for efficient operations.
Conservation and Maintenance	Certification for sustainable practices; technical consulting; water capture and management; soil conservation; reforestation; protected-area protection; forest maintenance; soil maintenance; payments for environmental services (PES); fire management; forest sanitation; monitoring & surveillance	Activities that ensure the long-term health and preservation of forest ecosystems. They include certification and preventive technical audits to verify sustainable practices; consulting and planning support; restoration (water capture and micro-watersheds), soil conservation and large-scale reforestation; protection of specific areas; routine forest/soil maintenance; PES schemes; fire prevention and control; forest sanitation and monitoring/surveillance. Community-based promoters reinforce compliance and local stewardship.
Production	Management plans & harvest documentation; commercial plantation cultivation; promotion of forestry sector; entrepreneurship activities	Measures aimed at improving the commercial viability of the forestry sector. They finance required technical documents and management plans for harvesting, support cultivation of commercial forest plantations, promote investment for sector development, and encourage entrepreneurship that integrates and strengthens the forestry value chain.

Source: Own elaboration based on CONAFOR documentation.

TABLE A.3 Agrarian community characteristics

	Mean	Median	Std.	Min.	Max.
Size (ha)	3,824	1,513	9,985	5	465,907
Small	318	308	169	5	626
Medium	1,708	1,514	819	626	3,612
Large	11,567	6,722	17,788	3,613	465,907
Forest area (ha)	1,715	503	6,147	2	401,513
Small	123	93	97	2	573
Medium	681	507	545	65	3,291
Large	5,376	2,848	11,806	402	401,513
% Forest area	0.406	0.367	0.223	0.100	0.975
Small	0.403	0.359	0.224	0.100	0.974
Medium	0.394	0.349	0.222	0.100	0.975
Large	0.433	0.413	0.222	0.100	0.972
Deforestation rate (pp)	0.869	0.131	1.932	0.000	58.920
Small	1.028	0.092	2.334	0.000	46.469
Medium	0.875	0.167	1.788	0.000	58.920
Large	0.703	0.124	1.582	0.000	46.255
Nighttime lights (original)	988	16.445	20,874	0.000	1.72×10^6
Nighttime lights (std)	-0.007	-0.023	0.340	-0.023	28,048
Small	-0.010	-0.023	0.091	-0.023	3,630
Medium	-0.002	-0.023	0.475	-0.023	28,048
Large	-0.014	-0.022	0.063	-0.023	1,477
Forest programs: applications	0.511	0.000	1.710	0	126
Small	0.221	0.000	0.935	0.000	33
Medium	0.445	0.000	1.428	0.000	92
Large	0.867	0.000	2.376	0.000	126
Forest programs: allocations	0.149	0.000	0.752	0.000	89
Small	0.070	0.000	0.369	0.000	32
Medium	0.137	0.000	0.760	0.000	89
Large	0.241	0.000	0.984	0.000	64
Percentage of women	0.146	0.167	0.178	0.000	1.000
Commissariat					
President	0.064	0.000	0.245	0.000	1.000
First secretary	0.192	0.000	0.394	0.000	1.000
Treasurer	0.234	0.000	0.423	0.000	1.000
Oversight Committee					
President	0.049	0.000	0.217	0.000	1.000
First secretary	0.148	0.000	0.355	0.000	1.000
Second secretary	0.183	0.000	0.387	0.000	1.000

Full sample: 10,892 communities. Forest area is derived from high-resolution satellite data from Hansen Global Forest Change (Hansen et al., 2013). The dataset is composed of pixels of 30×30 meters. Within agrarian communities, pixels are classified as forest area when canopy density is at least 30%. Forest area is then calculated as the average across all pixels within an agrarian community. The deforestation rate is based on forest loss, defined as the complete removal of tree canopy cover within a pixel area during a given year. The deforestation measure is normalized relative to tree cover in 2012. Nighttime lights are standardized and calculated per capita. Agrarian units are grouped by size tercile: *small* (first tercile), *medium* (second tercile), and *large* (third tercile).

TABLE A.4 Persistence of pretrends in women's representation across specifications

	(1)	(2)	(3)	(4)
$k = -4$	0.008**	0.008**	0.008***	0.008**
	(0.003)	(0.003)	(0.003)	(0.003)
$k = -3$	0.006***	0.006***	0.006***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
$k = -2$	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
$k = 0$	0.056***	0.056***	0.056***	0.056***
	(0.002)	(0.002)	(0.002)	(0.002)
$k = +1$	0.056***	0.056***	0.056***	0.056***
	(0.002)	(0.002)	(0.002)	(0.002)
$k = +2$	0.059***	0.059***	0.059***	0.059***
	(0.003)	(0.003)	(0.003)	(0.003)
$k = +3$	0.065***	0.065***	0.065***	0.065***
	(0.004)	(0.004)	(0.004)	(0.004)
$k = +4$	0.064***	0.064***	0.064***	0.064***
	(0.005)	(0.005)	(0.005)	(0.005)
FE: State×Year			X	X
FE: Municipality×Year	X	X		
Control: Night lights (pc)		X		X
Observations	92,322	91,838	92,322	91,838
R^2	0.701	0.702	0.701	0.702
Mean dep. var.	0.173	0.173	0.173	0.173
Clustered SEs	Agrarian community (ID)			

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable: Share of women in the governing body (pp). Omitted category is the period immediately before the first postreform election ($k = -1$).

A.2 | Identification assumptions

A.2.1 | Parallel trends assumption

Since in our setting a standard comparison of treated and control units is not feasible because all units eventually received the treatment and it constitutes an absorbing state, the only viable approach to a DiD design is to construct a group of late adopters. To validate the parallel trends assumption, we construct this group from the agrarian communities whose first election after the reform fell in 2019 or later and compare them to the early adopters, those whose first election occurred after the reform in 2017. We first visualize the pretreatment trends of the outcome variables for the two groups to assess any initial differences. We do so by plotting the average of the outcome variable (percentage of women) per year for each group (see Figure A.1).

Subsequently, we restrict the sample to pretreatment years ($\leqslant$2016) for both cohorts and estimate a regression of the pretreatment outcome on a linear time trend, an indicator for

the late-adopter cohort, and their interaction, clustering standard errors at the unit level. The interaction captures whether, before the treatment, these two cohorts had distinct time trends. The equation is as follows:

$$Y_{it} = \alpha + \beta(Late\_Adopters_i \cdot Year_t) + \gamma Late\_Adopters_i + \lambda Year_t + \epsilon_{it}, \quad (1)$$

where Y_{it} is the outcome for agrarian community i in year t. Y_{it} is the percentage of elected women; $Late\_Adoptersi$ is a dummy variable taking value 1 if the agrarian community had its first postreform elections on or after 2019. The coefficient of interest is β: It shows whether the time trend of the outcome variable for the late-adopter cohort differs significantly from that for the early-adopter cohort in the pretreatment period. A statistically insignificant β provides support for the parallel trends assumption, suggesting that, in the absence of treatment, the average outcomes for both groups would have followed a similar trajectory.

Our results from estimating equation (1) are displayed in Table A.5. The coefficient on the interaction term is not statistically significant, which indicates no differential evolution over time between early and late adopters prior to treatment, thus supporting Assumption 1.

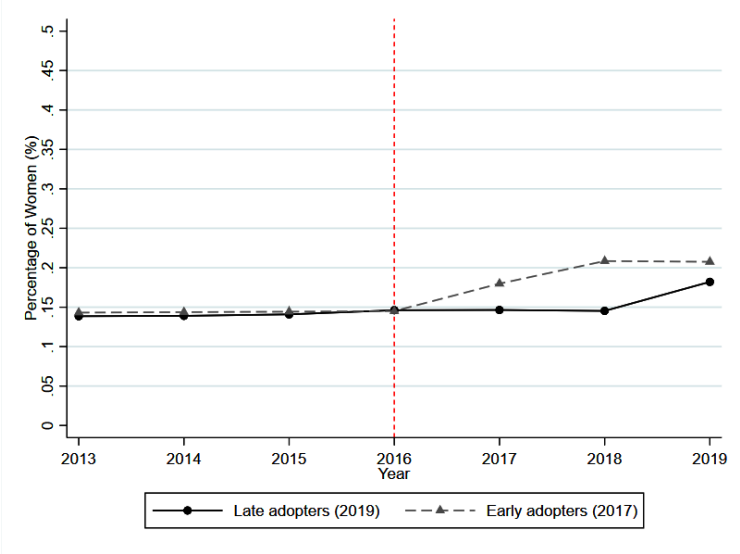


FIGURE A.1 Women's representation in agrarian communities (%), 2013–2019

Notes: Our calculations based on RAN data (2013–2022). Figure shows the percentage of women in all representative bodies of agrarian communities in Mexico among early adopters (whose first postreform election was in 2017) and late adopters (whose first postreform election fell in or after 2019).

TABLE A.5 Percentage of women in agrarian communities

	Percentage of women			
	(1) Full sample	(2) Small	(3) Medium	(4) Large
Interaction term	0.001	-0.002	0.002	0.002
	(0.001)	(0.002)	(0.002)	(0.003)
Observations	18,347	6,116	6,118	6,113
R^2	0.001	0.000	0.002	0.003

Notes: Standard errors are clustered at the agrarian community level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

A.2.2 | Stable unit treatment value assumption

To assess the plausibility of SUTVA and rule out potential spillover effects across neighboring agrarian units, we augment our baseline event–study specification by including an indicator for whether any geographically adjacent unit had already undergone its first postreform election (that is, was a "treated neighbor"). The rationale is that if women's participation in one community was indirectly affected by the treatment status of its neighbors (for instance, through information diffusion or intercommunity networks), we would expect the neighbor treatment variable to display a significant association with women's participation even for the years before the focal community itself became treated. The estimated equation is as follows:

$$Y_{it} = \alpha + \sum_{k=-4}^{4} \beta_k \cdot T_{i,t+k} + \delta_{it} \cdot \texttt{Treated\_Neighbor}_{it} + \lambda_t + \mu_i + \epsilon_{it}, \tag{1}$$

where Y_{it} is the outcome for agrarian community i in year t. Y_{it} is the percentage of elected women; $\texttt{Treated\_Neighbor}_{it}$ is a dummy variable taking value 1 if the neighbor of the specific agrarian community i has been treated; $T_{i,t+k}$ denotes event-time indicators as defined above; μ_i and λ_t are community and year fixed effects; and the β_k trace dynamic ITT effects relative to $k = -1$. The sample is the same as that in the main specification. The coefficient of interest is δ, which shows whether the treatment status of neighboring communities has a significant effect on the percentage of elected women in community i, net of the effects of the treatment in community i itself.

Across all specifications, however, the estimated coefficients on the neighbor treatment indicator are small in magnitude and statistically indistinguishable from zero. These results suggest that our estimates are not confounded by spatial spillovers, lending support to the validity of SUTVA in our empirical setting.

TABLE A.6 Percentage of women in agrarian communities

	Percentage of women			
	(1) Full sample	(2) Small	(3) Medium	(4) Large
Treated neighbor	0.002	0.000	0.002	-0.005
	(0.002)	(0.005)	(0.003)	(0.005)
R^2	0.682	0.714	0.680	0.641

Notes: Standard errors are clustered at the agrarian community level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

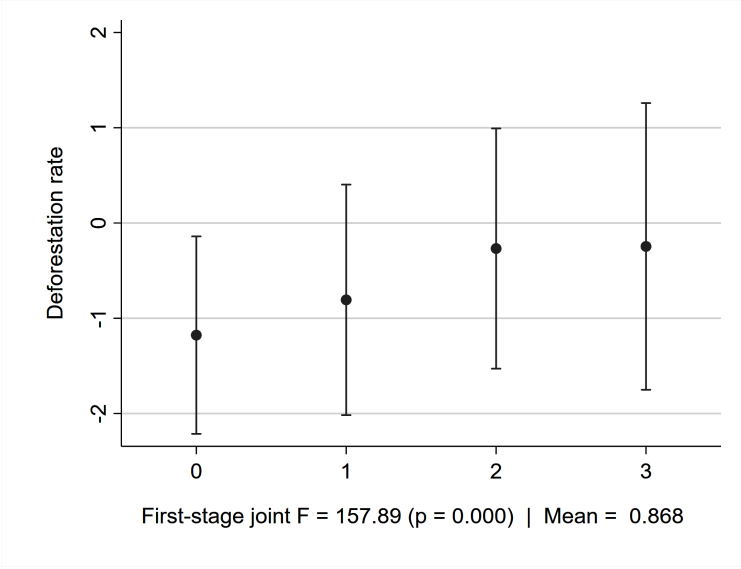
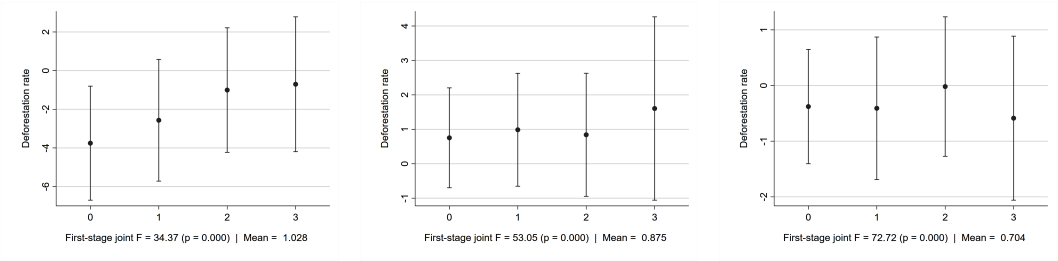


FIGURE A.2 Deforestation rate – LATE

Notes: Our estimates using high-resolution satellite data from Hansen Global Forest Change from 2001 to 2022 (Hansen et al., 2013). The graph shows the LATE of women's representation on deforestation as defined in equation ((2)). The deforestation rate is based on forest loss, defined as the complete removal of tree canopy cover within a pixel area during a given year. The deforestation measure is normalized relative to tree cover in 2012. The horizontal axis shows years relative to the first postreform election ($k = 0$). Because $\hat{\tau}_k$ is a ratio of two estimated effects, standard errors cannot be obtained directly. We therefore rely on a nonparametric bootstrap: From a sample of size s, we draw N replicates with replacement and, for each draw, reestimate both the reduced form and first stage following equation (1). At baseline, we set $N = 800$ and $s = 1{,}000$. The empirical distribution of the bootstrapped estimates of $\hat{\tau}_k$ is then used to construct confidence intervals, with the 95% interval given by the 5^{th} and 95^{th} percentiles. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.



(a) Small (b) Medium (c) Large

FIGURE A.3 Deforestation rate by size of the agrarian community

Notes: Our estimates using high-resolution satellite data from Hansen Global Forest Change from 2001 to 2022 (Hansen et al., 2013). Each panel reports the LATEs as estimated with equation ((2)) of women's representation on deforestation for agrarian communities grouped by size tercile. Agrarian communities are categorized as follows: *small* (first tercile), *medium* (second tercile), and *large* (third tercile). The deforestation rate is based on forest loss, defined as the complete removal of tree canopy cover within a pixel area during a given year. The deforestation measure is normalized relative to tree cover in 2012. The horizontal axis shows years relative to the first postreform election ($k = 0$). Because $\hat{\tau}_k$ is a ratio of two estimated effects, standard errors cannot be obtained directly. We therefore rely on a nonparametric bootstrap: From a sample of size s, we draw N replicates with replacement and, for each draw, reestimate both the reduced form and first stage following equation (1). At baseline, we set $N = 800$ and $s = 1{,}000$. The empirical distribution of the bootstrapped estimates of $\hat{\tau}_k$ is then used to construct confidence intervals, with the 95% interval given by the 5^{th} and 95^{th} percentiles. The sample is restricted to agrarian communities with at least 10% forest cover in 2013.

A.2.3 | Nighttime light – LATE

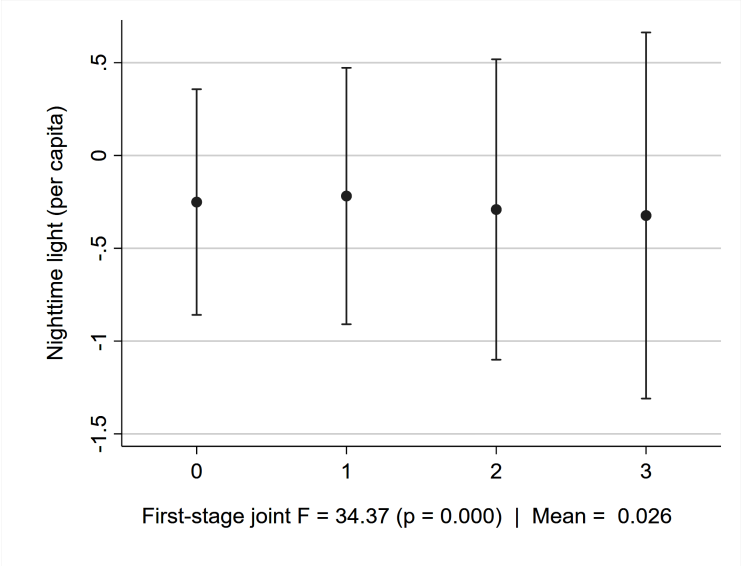
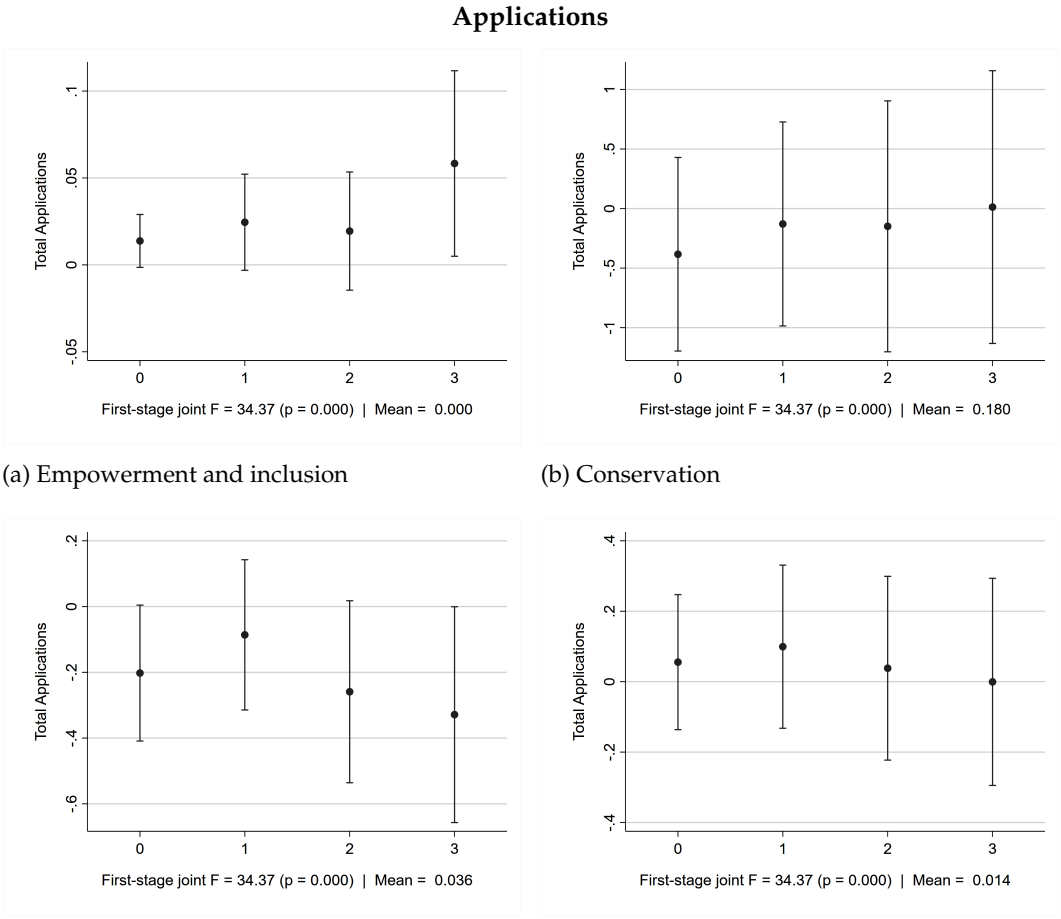


FIGURE A.4 Nighttime light (small agrarian communities) – LATE

Notes: Our estimates using Global NPP-VIIRS-like Nighttime Light data (2012–2022). The outcome variable represents the standardized annual average intensity per capita. The graph shows the LATE of women's representation on economic activity as defined in equation (2). Economic activity is approximated by nighttime light data. The horizontal axis shows years relative to the first postreform election ($k = 0$). Because $\hat{\tau}_k$ is a ratio of two estimated effects, standard errors cannot be obtained directly. We therefore rely on a nonparametric bootstrap: From a sample of size s, we draw N replicates with replacement and, for each draw, reestimate both the reduced form and first stage following equation (1). At baseline, we set $N = 500$ and $s = 31{,}172$. The empirical distribution of the bootstrapped estimates of $\hat{\tau}_k$ is then used to construct confidence intervals, with the 95% interval given by the 5^{th} and 95^{th} percentiles. The sample is restricted to agrarian communities with at least 10% forest cover in 2013, and to the first tercile of agrarian communities by size.



(a) Empowerment and inclusion

(b) Conservation

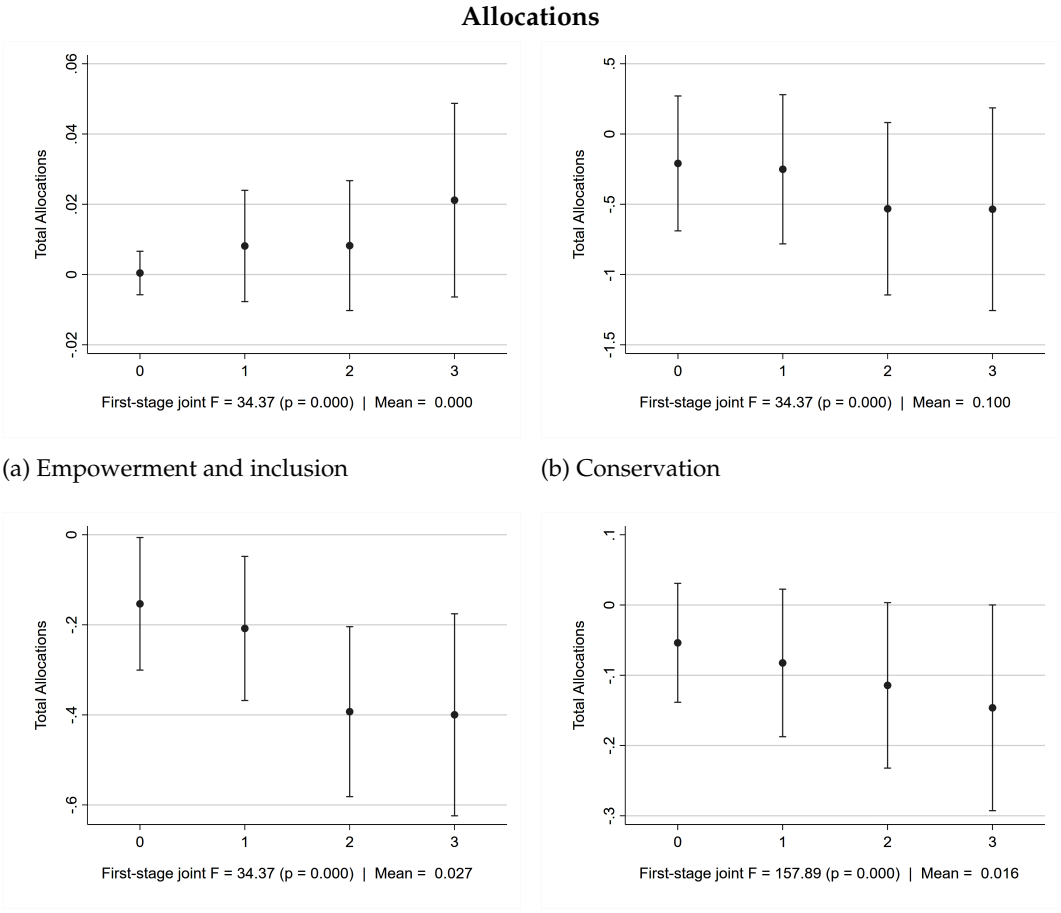
(c) Production

(d) Technology and infrastructure

FIGURE A.5 Total applications to forest programs

Notes: Our calculations based on CONAFOR data (2013–2022). Each panel reports the local effect of women's participation on program applications as defined in equation (2). The horizontal axis shows years relative to the first postreform election ($k = 0$). Because $\hat{\tau}_k$ is a ratio of two estimated effects, standard errors cannot be obtained directly. We therefore rely on a nonparametric bootstrap: From a sample of size s, we draw N replicates with replacement and, for each draw, reestimate both the reduced form and first stage following equation (1). At baseline, we set $N = 800$ and $s = 31{,}179$. The empirical distribution of the bootstrapped estimates of $\hat{\tau}_k$ is then used to construct confidence intervals, with the 95% interval given by the 5^{th} and 95^{th} percentiles. The sample is restricted to agrarian communities with at least 10% forest cover in 2013, and to the first tercile of agrarian communities by size.

A.2.4 | Government support programs



(a) Empowerment and inclusion

(b) Conservation

(c) Production

(d) Technology and infrastructure

FIGURE A.6 Total successful applications to government support programs

Notes: Our calculations based on CONAFOR data (2013–2022). Each panel reports the local effect of women's participation on program allocations as defined in equation (2). The horizontal axis shows years relative to the first postreform election ($k = 0$). Because $\hat{\tau}_k$ is a ratio of two estimated effects, standard errors cannot be obtained directly. We therefore rely on a nonparametric bootstrap: From a sample of size s, we draw N replicates with replacement and, for each draw, re-estimate both the reduced form and first stage following equation (1). At baseline, we set $N = 800$ and $s = 31{,}179$. The empirical distribution of the bootstrapped estimates of $\hat{\tau}_k$ is then used to construct confidence intervals, with the 95% interval given by the 5^{th} and 95^{th} percentiles. The sample is restricted to agrarian communities with at least 10% forest cover in 2013, and to the first tercile of agrarian communities by size.