Gender and Land in Mexico

Matthew Klein, University of Wisconsin—Madison, Agricultural & Applied Economics, mjklein2@wisc.edu
Travis McArthur, University of Florida, Food & Resource Economics, tmcarthur@ufl.edu

Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association Annual Meeting, Washington, D.C., August 5-August 7

Gender and Land in Mexico*

Matthew Klein† and Travis McArthur‡

May 23, 2018

Abstract: Control over land can provide women with an income source, insurance against shocks, and greater bargaining power within the household. Investigation into which policies and economic phenomena may promote greater land ownership among women has been hindered by scarcity of data, however. To shed light on this topic, we transform an administrative dataset of an agricultural subsidy program to build a panel of landholdings for millions of Mexican farmers covering the period 1995 to 2016. The data reveals that the share of land owned and managed by women increased by 50 percent over this twenty year period, from 15 percent to 23 percent. We identify the causal impact of Mexico's conditional cash transfer program and its land titling program on women's control of land by exploiting the staggered rollout of these programs across the Mexican countryside. The conditional cash transfer program raised the share of a community's land that was controlled by women, but implementation of the land titling program wiped out this positive effect. Male out-migration, on the other hand, had a substantial role in reallocating land from men to women. Our analysis suggests that the government programs could have been better coordinated to more effectively empower women. (*JEL* J16, Q15)

Keywords: Gender, Land, Migration, Procede, Progresa

*The authors would like to thank Carmen Diana Deere, Kaitlyn Sims, and the participants at seminars at the University of Wisconsin–Madison and at the University of Florida for their useful comments, suggestions, and support.

†University of Wisconsin–Madison, Agricultural & Applied Economics, mjklein2@wisc.edu

‡University of Florida, Food & Resource Economics, tmcarthur@ufl.edu

1 Introduction

Despite global attempts to promote the empowerment of women, gender gaps still exist in asset holdings and access to certain markets (Sachs, 2012). Land ownership, in particular, is an area where progress towards equality can be valuable but has been slow. Boosting women's access to land can increase female decision makers' welfare (Panda and Agarwal, 2005; Doss, 2013 and 1996), their household bargaining power (Allendorf, 2007; Walther, 2016), and increase their access to markets that suffer from information asymmetries, like credit markets (Stiglitz and Weiss, 1981). Part of the challenge in promoting gender equality in land holdings is a lack of individual-level data. Typically, surveys ask about asset holdings for the household as a whole rather than recording the identity of each asset's owner, masking men's greater control of resources (Doss et al. 2015; FAO, 2010). Without measurement of key individual-level variables like the percent of plots owned or managed by women in a community, it is not possible to assess progress on women's access to land or evaluate its causes.

We contribute to the limited body of knowledge on this important topic by constructing an exceptionally comprehensive longitudinal dataset on women's control of land in Mexico. We transform 34 million records of administrative data from Mexico's main agricultural subsidy program — the "Program of Direct Payments to the Countryside," or Procampo — to measure the amount of agricultural land managed by women from 1995 to 2016 in 23,000 agricultural communities called *ejidos*. We use a string matching technique to match individual's observations over time and then assign genders to individuals by matching their first names to the most likely associated gender. By transforming this administrative data, we address the classic problem of a lack of data on gender and land management.

This data reveals that the share of farmers in Mexican *ejidos* who are women increased by 53 percent from 1995 to 2016, from 15 percent to 23 percent. We find that the proportion of land cultivated by women nearly doubled, rising from 11 percent to 21 percent in this period. The sharp rise in this key metric of women's

empowerment calls for investigation into its cause.

We suggest that three possible mechanisms might explain this shift in land management from men to women. First, Mexico rolled out a land titling program, Procede, following a 1992 constitutional amendment that liberalized the land market. The government granted titles to 3.4 million farmers from 1993 to 2006. We suggest that this land titling program may have affected men and women differently, perhaps by prompting changes in bequeathing patterns, leading to a change in who owns land over time. Second, Mexico enacted a massive conditional cash transfer program starting in 1997, which explicitly aimed to empower women. The government launched an innovative program that gave mothers large cash transfers every month if their children attended school. Today, this conditional cash transfer program continues under the name Prospera and reaches roughly one fourth of Mexican families. The 50 percent increase from 1995 to 2016 could be partially explained by women's empowerment as decision makers in the family. Third, migration could be causing the observed trend if more men migrate away from rural areas than women, and if men leave their land to be managed by women when they migrate. Migration is an important part of Mexico's economy; roughly 15 percent of Mexican workers migrated in 2000 (Mishra, 2007). Such a large scale phenomenon could plausibly explain the increase in plots owned and managed by women over the last twenty years.

We exploit the panel dimension of our data to generate causal evidence on whether these three possible mechanisms explain the increase in women's land ownership. We explore the dynamics of the program impacts by measuring lagged effects. To study the impact of migration on women's land ownership, we estimate the effect of the proportion of women to men in a community on the percent of landholders who are female and on the percent of land controlled by women.

We find that migration partially explains the increase in female landownership from 1995 to 2016. With most migrants being male, the gender ratio in sending communities shifted. This generated significant general equilibrium effects in the

land market, leading to reallocation from men to women. In 1995, women made up 50.34 percent of the population of the average municipality. By 2005, this figure had increased to 51.41. Every percentage point increase in the female population percentage caused a 0.74 percentage point increase in the share of land managers that are women, and a 0.64 percentage point increase in the share of land managed by women. Given these results, migration explains roughly 10 percent of the change over time in land management trends. We provide the some of the first causal evidence on this important, but understudied, general equilibrium effect in origin-communities.

We also find that the cash transfer program partially explains this increase. Over time, the impact of Progresa on women's land ownership increases, with significant positive program impacts detectable starting three years after Progresa began operating in a community. Overall, the cash transfer program caused a rise in the share of farmers who were women by 0.44 percentage points. However, when Procede enters a community, the cash transfer program effects are negated. These titles were typically distributed to men (Deere and Leon, 2000). We suggest that men's outside options improved upon receiving land titles, bettering their bargaining position as much as if the government had targeted the Progresa cash transfer to them. Thus, while the gender asset gap began closing because of Progresa's empowerment effect, titles allocated to men canceled the empowerment effect out for the median household. However, the migration effect persists regardless of what programs are active in a community. This suggests that migration has important general equilibrium effects in sending communities that the package of government programs failed to generate.

Our results suggest that measuring program effects in tandem is important. If the land titling program had been more carefully designed to consider women's position in the household, the canceling out effect would likely not have occurred. For the international aid community, too, these results are important. Different policy environments will lead to different outcomes for women when cash transfer

programs are implemented.

Our study differs from the existing literature in two ways. First, to the best of our knowledge, panels with gender-specific land holdings are rare, and are typically much shorter and less comprehensive than the data we have constructed. Meinzen-Dick et al. (2017) review the existing literature and identify only two longitudinal surveys, both of which analyze the effects of changing land tenure *rights*. Asfaw and Maggio (2017) use panel data from Malawi to analyze how land tenure rights influence responses to risk for men and women. Menon et al. (2014) and Newman et al (2015) analyze a Vietnamese panel to analyze the relationship between land tenure rights and household productivity and allocations. These authors do not analyze individual level land holdings, but the impact of changes in *rights* on outcomes. They don't provide an understanding of trends in women's land ownership, or of what market forces or government programs might influence women's land ownership.

Second, our data cover a large portion of the Mexican population. More than half of Mexico's land is contained within ejidos. Based on a comparison with the 2007 agricultural census, we estimate that the Procampo dataset has landholding data for 88 percent of all farmers in ejidos. Further, this data covers 90 percent of arable land in Mexico (Cord and Wodon, 2001). As such, our data provides insight into a significant portion of the Mexican population over the past twenty years. In contrast, many of the studies on women's land ownership in Mexico are limited by much smaller sample sizes. For instance Códova Plaza (2000), Nuijten (2003), Almeida (2012), Hausermann (2014), and Vázquez-García (2015) study the effects of Mexico's land titling reform on women's land holdings using cross-sectional data from one *ejido* each. This literature in general suffers from external validity problems, making estimates of general program impacts impossible. We contribute to this discussion by estimating average treatment effects at a national level.

The rest of our study is laid out as follows. Section 2 reviews the three bodies of literature to which we contribute. Section 3 outlines the panel construction and provides a description of the changes gender equality in land holdings over time.

Section 4 outlines our empirical strategy. Section 5 provides results and Section 6 concludes.

2 Literature Review

We contribute to three bodies of literature: those on migration, land titling reforms, and conditional cash transfers. In this section we briefly summarize each and situate our work within them.[1]

The average effects of Procede at a national level are well studied, but how the program impacted men and women differently is not. Valsecchi (2014) and de Janvry et al. (2015) show how Procede, by increasing the rights individuals had over their land, caused an increase in migration out of rural areas.[2] Johnson (2001) show no average impact of the program on credit access. These studies, while they use rigorous identification strategies to assess the effects of Procede at the average, do not take into account the fact that men and women might be affected differently.

Procede's heterogeneous effects for men and women have been studied in small samples. Hausermann (2014) studies how women's participation in local governance increased in an *ejido* in Veracruz because of Procede. Stephen (1996) and Vázquez-García (2015) argue that PROCEDE increased women's vulnerability to dispossession of land. Almeida (2012) argues that the individualization of property rights increased women's landholdings absolutely and in relation to men's. Nuijten (2003) studies this heterogeneity, but finds no evidence that the land reforms impacted men and women differently. These studies seem to contradict each other, but they all use small samples from different areas of Mexico. It is possible that each is accurately identifying the effect of Procede on women's landholdings in each respective area.

[1] For a more complete summary of trends in migration, see Passel, D'Vera Cohn, and Gonzalez-Barrera (2012). For a more complete discussion on Procede, see World Bank (2001). For a more complete summary of Progresa, Oportunidades, and Prospera, see Parker and Todd (2017).

[2] Prior to 1992, land was held collectively and individuals had informal, use-based rights (Gordillo, de Janvry, Sadoulet, 1998). If individuals left the ground fallow, or left the community for more than two years, they risked losing the land. These stringent usage requirements incentivized families to allocate a large amount of labor to farming this land. When Procede entered a community and granted individuals full land rights, opportunities increased for land holders and their families.

While these studies show that men and women were impacted differently by land titling in some settings, they fail to shed light on the average phenomenon. There is no estimate of the effect of Procede on women's land ownership at a national level in this literature, simply because of the scope of the studies. In this paper, we identify the average effect of Procede on women's land holdings relative to men's across Mexico.

In studying migration, many economists have found evidence that inequality increases in origin-communities, both across households and between genders.[3] Barham and Boucher (1998) show that remittances increase income inequality in the sending community. However, McKenzie and Rapoport (2007) show that there is an inverse U-shaped relationship between inequality and remittances, with inequality increasing early in a village's migration-sending history and decreasing later. Mishra (2007) shows that wages increase in origin-communities because of migration while Lokshin and Glinskaya (2009) review a large literature showing that labor force participation decreases when households receive remittances, particularly for women. McKenzie and Rapoport (2012) also consider heterogeneity in origin-communities, showing that migration reduces the educational attainment for children in origin-households, especially for boys. We contribute to this literature by analyzing how equality in holdings of an important productive asset changes over time because of migration. While migration and the feminization of agriculture is well studied, the impact of migration on women's land holdings in origin-communities is not.[4] In contrast with much of the literature on migration and inequality in origin communities, we show that equality in land holdings increases along with (male) migration.

We contribute to the literature on conditional cash transfers (CCTs) by analyzing one of their long-term impacts. While there are many evaluations of the short-term impacts of cash transfers, and of Mexico's CCTs in particular, there are relatively

[3]See Hansen (2006) for a literature review on Mexican migration to the United States.

[4]See, among others, Pedraza (1991); Lastarria-Cornhiel (2008); Deere (2009); Gartaula, Niehof, and Visser (2010); and Radel et al (2012). See Deere and León (2003) for a discussion on how migration can lead to different bequeathing choices that may explain changes in the land asset gap over time in Mexico.

few studies of their longterm impacts (Parker and Todd, 2017). We study whether CCTs can explain an increase in gender equality in land holdings over an 18 year period. Understanding the long term effects of cash transfers, especially on how they impact women's asset ownership, is an important outstanding research area.

3 Data and Trends in Land Management

In this section we discuss the data we use, how we construct the gender[5] and land ownership variables, and trends in women's land ownership from 1995 to 2015 in Mexican *ejidos*. We also present summary statistics for gender ratios in *ejidos*, land titling, and the cash transfer program.

Our panel is constructed from the Mexican administrative dataset of the beneficiaries of their most important agricultural subsidy program, Procampo. Initiated in 1994, Procampo distributed a transfer to farmers based on the amount of land they cultivated.[6] Farmers of roughly 90 percent of Mexico's arable land receive this transfer and are recorded in the administrative data (Cord and Wodon, 2001). The data collected to determine the value of these subsidies includes the beneficiaries' name, the name of the *ejido* where their land is located, and the amount of land they cultivate. According to law, in cases where land is rented, the person who actually cultivates the land receives the payment and is therefore the individual recorded in the database of beneficiaries.[7] In 1998 and in 2013-2016, the individual's gender is recorded for all observations. In 2012, the individual's gender is recorded in some states. This data has roughly 50 million observations, of which we study 34 million. The millions of observations we drop are non-*ejido* farms, and are only geographically identified at the municipality level, of which there are 2,448. Since farmers outside of ejidos were not eligible for the land titling program, their data is not

[5]While many gender identities exist, and many individuals do not identify as either male or female, we restrict our study to these binary gender identities in accordance with the survey data.

[6]The program continues today under the name "Proagro Productivo." We refer to it as Procampo throughout the paper, regardless of what year we are referencing.

[7]An example of the subsidy application, which indicates how the data is collected from beneficiaries, is available at http://goo.gl/8SFVf1

included in the statistical analysis. As released by the Mexican government in its raw form, the data does not link individual farmers over time; the data is organized as a series of cross sections.

We use a fuzzy string matching technique, the Jaro-Winkler algorithm, to match farmers' observations over time, using their full names (Yancey, 2005; Christen, 2006). This method is commonly used to match names in data linkage exercises like this one (Winkler, 2006). We are aided by naming conventions in Mexico. People have two surnames, one that corresponds to their father's family, and one to their mother's. This gives us additional information to match with, and also allows us to track individuals even if they get married or divorced since it is not customary for wives to take their husband's surname at marriage in Mexico.[8] This algorithm accounts for misspellings and alternative spellings by calculating the number of common characteristics and transpositions between two names. We calculate a distance between names based on these characteristics, and accounting for the fact that misspellings occur less frequently within the first four letters of a name (Pollack and Zamora, 1984). There may be misspellings generated by the data entry process (the entrant types "n" when they intended to type "m" or some other such mistake).[9] Therefore, it is important that the name matching technique be flexible enough to correctly match observations over time even when the name might not be exactly the same in all years.

We pool all names in each *ejido* over time, then calculate a Winkler similarity value for each pair of names in an *ejido*. To avoid Type II errors, we specify that two names correspond to the same person in different waves if the similarity score is above 0.96, where a score of 1 indicates that the two names are identical. Approximately 93% of the observations had identical names listed in the database over time, allowing for clear matches. The remaining 7% of the observations had names that met the 0.96 similarity score threshold with another observation and were matched with names in other years that exhibited slight spelling variations. The result is a

[8] See Angelucci et al. (2009) for an example of a similar matching process.
[9] See Friedman and Sideli (1992) for further discussion.

panel at the individual level, which can be aggregated up to a locality level. For more information on this textual analysis, see Appendix A.

We use the following algorithm to assign a gender to individuals in the waves that do not have gender information (1995-1997 and 1999-2012). First, the algorithm determines which names are associated with what gender from the 1998 and 2013-2016 data. We drop names that appear with less than 0.01 percent frequency. The sample size for these names is too small to reliably assign genders in other years to individuals with these names. Then, we analyze the percent of times that a name is associated with a gender. We characterize a name as "female" if it is listed as female at least 50 percent of the time. We characterize a name as "male" if it is listed as male at least 60 percent of the time.[10] Then, we match names from each remaining wave to the constructed database of gendered names. We assign genders to names in this way for all waves, even 1998 and 2013-2016, for consistency. Some uncommon names remain un-gendered because there was ambiguity in the match. This typically resulted from the names being dropped in the first step of the algorithm due to infrequency. To the extent that any mislabeling of the gender of Procampo beneficiaries generates classical measurement error, only the precision of estimated program effects would suffer since the measurement error would affect the dependent variable rather than the independent variables. The standard errors may be larger, but the coefficients would remain unbiased.

It is important to clarify the nature of the main variable in our analysis. The Procampo data collects information on individuals with usufruct land rights, but does not distinguish between those who own and rent the land. If someone rents the land, and makes managerial decisions about how the land is used, they are indistinguishable from individuals who own the title and rent the land. As such our analysis is about women with these usufruct land rights, whether granted via title

[10]We use asymmetric cutoff rules to account for potential misreporting. The genders may have been listed as "M" for "Masculino," which is Spanish for "male," or as "M" for "Mujer," which is Spanish for "woman." This higher cutoff for men's names minimizes the impact of this possible misreporting error. This is not an issue for male names since the corresponding character for women is "F", which is not easily confused as an abbreviation for "male."

Figure 1: Trend in Women's Land Management in Mexico

or lease.

Figure 1 depicts the percent of agricultural land managers who are female in Mexican *ejidos* from 1995 to 2016 as well as proportion of land managed by women. The percent of agricultural land managers who are female increased by over five percentage points from 1995 to 2005, and then by another two percentage points from 2005 to 2016. In addition to this increase, we seek to explain the concavity exhibited in Figure 1.

The increase in the proportion of land managed by women is larger and exhibits slightly less concavity. Roughly 11 percent of land was managed by women in 1995, which increased to about 18 percent in 2005 and to 21 percent in 2016. That is a

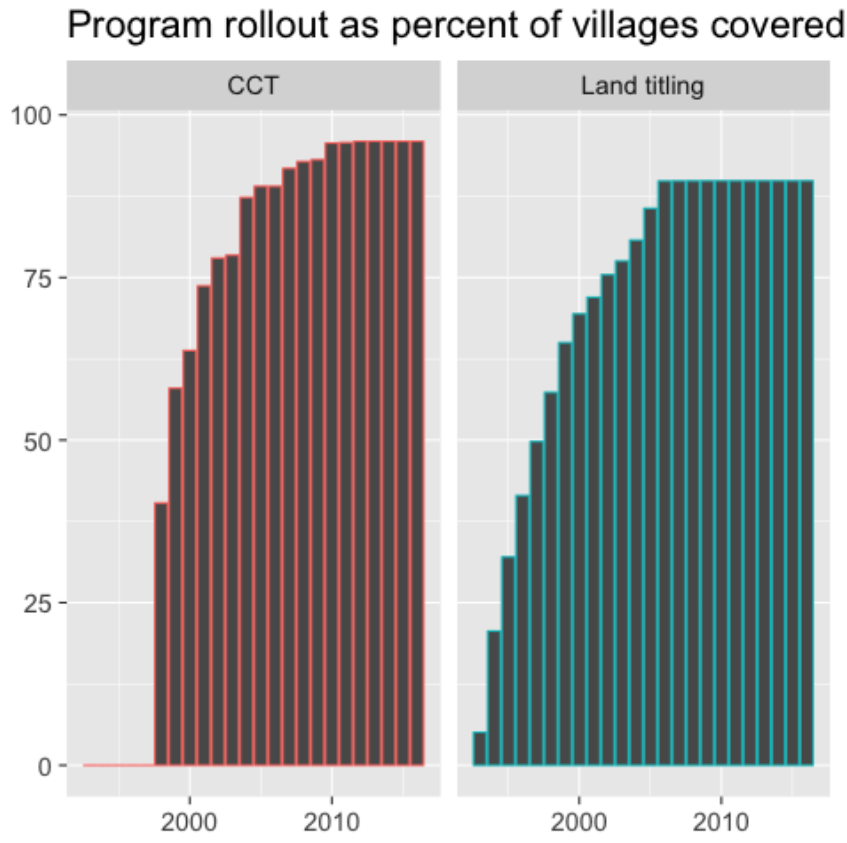

Figure 2: Rollout of Mexico's Cash Transfer (Left) and Land Titling (Right) Programs.

rise of nearly 100 percent, with most of that increase coming in the first ten years we examine. Given the social and market benefits associated with managing land, such as access to credit markets that require collateral, this doubling is quite economically meaningful.

It's also important to clarify our dependent variable with respect to Progresa. We're interested in land use patterns at the *ejido* level, but Progresa was allocated to slightly different geographic administrative units, called localities. One *ejido* may contain households that live in many localities. We construct an *ejido* level dummy variable equal to one when more than fifty percent of the population of the localities in an *ejido* are eligible for Progresa. This variable takes on the value of one in all years after this threshold is met.

Figure 2 displays the rollout schedules for the two national programs. The correlation between the year of implementation of the two programs in the ejidos was

-0.03, indicating that the rollout schedules were unrelated. The government granted titles to all the individuals in a village at one time. The rollout across villages for this government program was random, conditional on observables that were largely time-invariant. That is, villages that were smaller, wealthier, easier to reach, more politically coherent internally, and which had political leanings that matched the federal party's were more likely to be reached first by the land titling program (de Janvry, Gonzalez-Navarro, and Sadoulet, 2014). Controlling for these characteristics, and so comparing only *ejidos* that are similar along those characteristics, the program was randomly rolled out. We exploit this conditionally random rollout in our empirical analysis to identify causal effects.

The rollout schedule for the cash transfer program was based on locality-level marginality (poverty) indices calculated by the government with 1995 data. Since the rollout was based on the time-invariant marginality index, estimation with fixed effects removes endogeneity concerns stemming from a biased implementation schedule. Our strategy that identified the effect of Progresa is similar to that used by Alix-Garcia et al. (2013).

The gender ratio data is derived the population censuses carried out in 1995, 2000, 2005, and 2010 by INEGI, the national statistics agency of Mexico. This data is available at the level of the municipality, a geographic concept roughly equivalent to a county in the United States. Male out-migration was the primary factor causing shifts in the local gender ratio in Mexico. However, the Mexican drug war also impacted the gender ratio. With more than 100,000 deaths between 2006 and 2012, this national-scale conflict was certainly impactful for many communities. Since the murder victims were largely male, the areas of Mexico where the drug war has been most intense experienced measurable changes in their gender ratio as a result of the violence.

4 Empirical Strategy

We test three sets of hypotheses. The first analyzes whether Progresa and Procede had an effect on women's land holdings on average from 1995 to 2015. The second tests whether the programs had dynamic effects. The third set is aimed at understanding the effects of male out-migration on women's land management.

We begin by testing the three null hypotheses of no program effects for Progresa, Procede, and their interaction against the three alternative hypotheses of some non-zero effect. To generate effect estimates for inference, we regress:

$$y_{v,t} = \beta_1 Progresa_{v,t} + \beta_2 Procede_{v,t} + \beta_3 (Progresa_{v,t} \times Procede_{v,t}) + \mu_{t \times s} + \psi_v + \epsilon_{v,t} \tag{1}$$

where $y_{v,t}$ is the percent of plots owned by women in a *ejido* v in time t, $Progresa_{v,t}$ is a dummy variable for Progresa implementation, $Procede_{v,t}$ is a dummy variable equal to one when the program distributed titles to an *ejido* and afterwards, $\mu_{t \times s}$ is a state-by-year fixed effect, ψ_v is a locality fixed effect and $\epsilon_{v,t}$ is the error term, clustered at the state level. This fixed effects strategy forces all identifying variation in equation (1) to come from trends in a location over time. So, $\hat{\beta}_1$ is an estimate of the effect of Progresa on the percent of plots owned by women in an *ejido*, and $\hat{\beta}_2$ is an estimate of the effect of Procede on the percent of plots owned by women in an *ejido*, and $\hat{\beta}_3$ is an estimate of the effect of both programs being simultaneously present in a community that is in addition to the individual effects of each program separately. By controlling for ejido-level time-invariant characteristics, we ensure that these results can be interpreted as being causal.

Second, we test the hypothesis that the programs had dynamic empowerment effects that increase over time. We estimate:

$$y_{v,t} = \theta_1 Procede_{v,t} + \theta_2 Progresa_{v,t} + \sum_{k=1}^{6} \theta_{3+k} Progresa_{v,t+k} +$$

$$\theta_{10}(Progresa_{v,t} \times Procede_{v,t}) + \sum_{k=1}^{6} \theta_{10+k}(Progresa_{v,t+k} \times Procede_{v,t}) + \mu_{s\times t} + \psi_v + \epsilon_{v,t} \tag{2}$$

where $Progresa_{v,t+k}$ denotes the lag terms. We use six total. The interacted terms allow us to estimate the effect of Progresa on the percent of plots controlled by women, conditional on whether Procede had already distributed land titles in a community. The interactions times the lags show us whether the dynamic Progresa effects exist in villages with Procede. We cluster standard errors at the state level.

Third, we test the null hypothesis that we analyze the impacts of male out-migration on the percent of land controlled by women. We regress the percent of land controlled by women in a municipality on the percent of the population that is female, $femalepop$:

$$y_{m,t} = \beta_1 femalepop + \mu_{s\times t} + \psi_m + \epsilon_{m,t} \tag{3}$$

where ψ_m is a municipality level fixed effect. We cluster standard errors at the state level. We also use the percent of landholders that are female as a left hand side variable. As such, the variable $\hat{\beta}_1$ from equation (3) is an estimate of the effect of a change in the number of women relative to the number of men on women's relative land holdings. This explanatory variable is driven by the large flows of male migrants out of rural areas in this twenty year period.

5 Results

We find that the Progresa transfer causes an increase in the percent of land managed by women, and in the percent of managers that are women. However, when Procede distributes titles in that community, the effects cancel out, perhaps because the titles

typically went to men, improving their outside options, and undoing the transfer's empowerment effect. We report the equation (1) estimates in Table 1.

Table 1: Women's control of land, relative to men

	Dependent variable:	
	Percent Female Owners	Percent Land Owned by Women
Procede	0.175	0.042
	(0.134)	(0.129)
Progresa	0.438***	0.316**
	(0.146)	(0.148)
Interaction	−0.398***	−0.261**
	(0.124)	(0.124)
Dependent variable mean	18.27	16.89
Observations	472,839	472,839
R^2	0.771	0.740
Adjusted R^2	0.759	0.726

Note: *p<0.1; **p<0.05; ***p<0.01
Ejido and state-by-year fixed effects
Standard errors, in parentheses, clustered at state level

The effect of Progresa alone on women's land management is positive and significant. However, we cannot reject the null hypothesis that Procede alone had no effect on women's land management. More importantly, since a vast majority of *ejidos* in Mexico have beneficiaries from both programs, we cannot reject the null hypothesis that the combined effect of the programs was zero. It is possible that the positive Progresa effect increased women's land management in the programs early years, before Procede was active almost everywhere. Then when Procede had been implemented everywhere, the upward trend in women's access to land was blunted. This could explain the concavity in Figure 1.

The results of estimating equation (2) are presented in Table 2 and Figure 3. These results show the dynamic effects of the cash transfer program on women's land ownership. Progresa did not have an immediate effect, but starting in the fourth year of continual monthly transfers, there is a sustained, positive, and significant treatment effect on women's land management. This lag is likely explained by the small magnitude of the transfer relative to the price of land. The annual Progresa

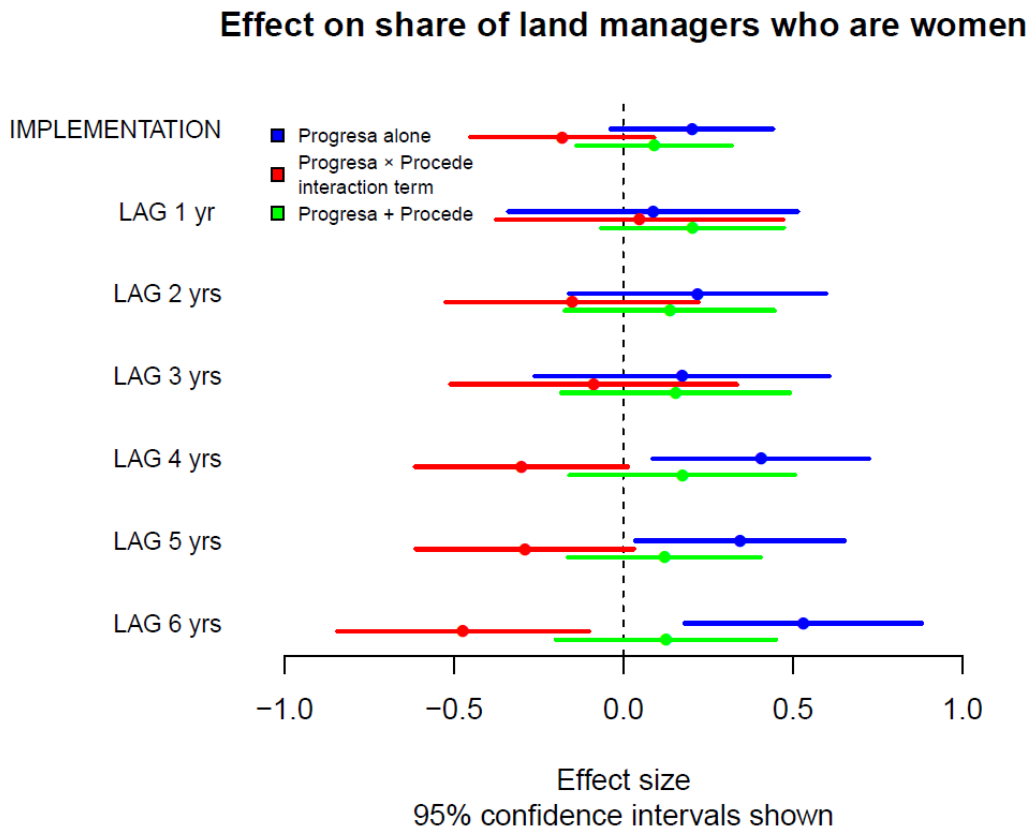

Figure 3: Progresa and Procede Effects Grow Over Time, But Always Cancel Each Other Out

Table 2: Women's Control of Land Relative to Men with Lagged Effects

	Dependent variable:	
	Percent Female Owners	Percent Land Owned by Women
Procede	0.068	−0.030
	(0.111)	(0.113)
Progresa	0.202*	0.180
	(0.122)	(0.133)
Progresa Lag 1	0.088	0.034
	(0.218)	(0.233)
Progresa Lag 2	0.219	0.151
	(0.193)	(0.176)
Progresa Lag 3	0.173	0.105
	(0.221)	(0.201)
Progresa Lag 4	0.406**	0.324*
	(0.163)	(0.169)
Progresa Lag 5	0.343**	0.259*
	(0.158)	(0.147)
Progresa Lag 6	0.530***	0.380**
	(0.179)	(0.157)
Interaction	−0.180	−0.141
	(0.138)	(0.148)
Interaction Lag 1	0.048	0.115
	(0.216)	(0.254)
Interaction Lag 2	−0.151	−0.109
	(0.190)	(0.189)
Interaction Lag 3	−0.087	−0.071
	(0.216)	(0.198)
Interaction Lag 4	−0.301*	−0.183
	(0.160)	(0.156)
Interaction Lag 5	−0.291*	−0.196
	(0.164)	(0.155)
Interaction Lag 6	−0.473**	−0.327*
	(0.189)	(0.170)
Dependent variable mean	18.27	16.89
Observations	472,839	472,839
R^2	0.771	0.740
Adjusted R^2	0.759	0.726

Note: *p<0.1; **p<0.05; ***p<0.01
Ejido and state-by-year fixed effects
Standard errors, in parentheses, clustered at state level

transfer for an average family amounted to 10 percent of the price of a hectare of land (Concheiro Bórquez, Diego Quintana, and Juan Pablos 2001; Skoufias 2001). In addition, the degree of empowerment might be an increasing function of how long Progresa provided cash for women. However, as before, these lagged effects are canceled out when Procede is implemented in a village.

We find that migration partially explains the increase in women's land management. As men migrate out of *ejidos*, the gender ratio shifts in favor of women, and land is reallocated. By estimating equation (3), we find that for every 1 percent increase in the ratio of women to men in a municipality, there is a 0.742 increase in the percent of owners who are female and a 0.635 increase in the percent of land owned by women. The results for this estimation are presented in Table 3.

Table 3: Relationship between women as percent of population and women share of land management, municipal-level

	Dependent variable:	
	Percent Female Owners	Percent Land Owned by Women
Ratio of Women to Men	0.742***	0.635***
	(0.179)	(0.167)
Dependent variable mean	19.84	17.57
Observations	8,907	8,907
R^2	0.887	0.863
Adjusted R^2	0.849	0.816

Note: *p<0.1; **p<0.05; ***p<0.01
Municipality and state-by-year fixed effects
Standard errors, in parentheses, clustered at state level

The general equilibrium effects of migration in origin-communities, but not the bundle of government transfers, caused an increase in the percent of female managers and the percent of land controlled by women. These results support the argument that Procede had a negative effect on women's welfare (Stephen, 1996; Deer and Leon, 2000; Vázquez-García, 2015; and others), since it canceled out Progresa's empowerment effect. These results also shed new light on the feminization of agriculture in response to male outmigration by explicitly analyzing land ownership, rental, and management.

6 Conclusion

In this paper, we pose and partially explain a puzzle about gender equality in land ownership and management. We show that a panel can be constructed to reflect land management at the individual level from 1995-2016. We show that genders can be assigned to the individuals in this panel using records of first names. We analyze this unique data to show that the percent of land managed by women, either as a result of ownership or rental, increased by 50 percent over this twenty year period.

The puzzle is what prompted this large change in women's asset ownership. We show that migration, but not government intervention, partially explains this trend. However, we are unable to attribute roughly 90 percent of this change to any mechanism we study. General social trends toward the status of women in society may have been a contributing factor. For example, divorce rates tripled during the period we study and no-fault divorce was introduced in 2008.

Fully uncovering the cause of this change over time remains an important research agenda. To achieve the Sustainable Development Goal of gender equality, it is critical that researchers understand the causes of increased gender equality in land holdings over time. Only through this understanding can policies be generated to successfully engender this reallocation of land. We contribute to this discussion by suggesting that policy bundling is important. If Progresa and Procede had both allocated resources (cash and land titles) to women, we suggest the canceling out would not have occurred, and women would have been more empowered.

7 Works Cited

Agarwal, B. (1994). A field of one's own: Gender and land rights in South Asia (Vol. 58). Cambridge University Press.

Alix-Garcia, Jennifer , Craig McIntosh, Katharine R. E. Sims, and Jarrod R. Welch. (2013). The Ecological Footprint of Poverty Alleviation: Evidence from Mexico's Oportunidades Program. The Review of Economics and Statistics, 95(2): 417–435.

Allendorf, K. (2007). Do women's land rights promote empowerment and child health in Nepal?. World development, 35(11), 1975-1988.

Almeida, E. (2012). Ejidatarias, posesionarias, avecindadas. Mujeres frente a sus derechos de propiedad en tierras ejidales de México. Revista de Estudios Agrarios, 18(52), 13–57.

Asfaw, S., & Maggio, G. (2018). Gender, weather shocks and welfare: Evidence from Malawi. The Journal of Development Studies, 54(2), 271-291.

Barham, B., & Boucher, S. (1998). Migration, remittances, and inequality: estimating the net effects of migration on income distribution. Journal of development economics, 55(2), 307-331.

Behrman, J. R., Parker, S. W., & Todd, P. E. (2005). Long-term impacts of the Oportunidades conditional cash transfer program on rural youth in Mexico (No. 122). Discussion papers//Ibero America Institute for Economic Research.

Christen, P. (2006). A comparison of personal name matching: Techniques and practical issues. In Data Mining Workshops, 2006. ICDM Workshops 2006. Sixth IEEE International Conference on (pp. 290-294). IEEE.

Códova Plaza, R. (2000). Gender roles, inheritance patterns, and female access to land in an ejidal community in Veracruz, Mexico. In A. Zoomers & G. van der

Haar (Eds.), Current Land Policy in Latin America: Regulating Land Tenure under Neo-liberalism.

Concheiro Bórquez, Luciano, Roberto Diego Quintana, and Casa Juan Pablos. (2001). *Una perspectiva campesina del mercado de tierras ejidales: Siete esudios de caso*. Centro Cultural : Universidad Autónoma Metropolitana - Xochimilco.

Cord, L., & Wodon, Q. (2001). Do Agricultural Programs in Mexico Alleviate Poverty?: Evidence from the Ejido Sector. Cuadernos de economía, 38(114), 239-256.

De Janvry, A., Emerick, K., Gonzalez-Navarro, M.,& Sadoulet, E. (2015). Delinking land rights from land use: Certification and migration in Mexico. American Economic Review, 105(10), 3125-49.

De Janvry, A., Gonzalez-Navarro, M., & Sadoulet, E. (2014). Are land reforms granting complete property rights politically risky? Electoral outcomes of Mexico's certification program. Journal of Development Economics, 110, 216-225.

Deere, C. D., & León, M. (2000). Neo-liberal agrarian legislation, gender equality, and indigenous rights: the impact of new social movements. In A. Zoomers & G. van der Haar (Eds.), Current Land Policy in Latin America: Regulating Land Tenure under Neo-liberalism.

Deere, C. D. (2009). The Feminization of Agriculture?: The Impact of Economic Restructuring in Rural Latin America. In The Gendered Impacts of Liberalization (pp. 115-144). Routledge.

Deere, C. D., & León, M. (2003). The gender asset gap: land in Latin America. World Development, 31(6), 925-947.

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., & Bold, M. (2015). Gender inequalities in ownership and control of land in Africa: myth and reality. Agricul-

tural Economics, 46(3), 403-434.

Doss, C. R. (1996). Women's bargaining power in household economic decisions: Evidence from Ghana (No. 13517). University of Minnesota, Department of Applied Economics.

Doss, C. (2013). Intrahousehold bargaining and resource allocation in developing countries. The World Bank Research Observer, 28(1), 52-78.

Duflo, E. (2012). Women empowerment and economic development. Journal of Economic Literature, 50(4), 1051-79.

Food and Agricultural Organization for the United Nations (2010) Women in Agriculture, Closing the Gender Gap for Development. In *The State of Food and Agriculture, 2010*.

Friedman, C. & Sideli, R. (1992) Tolerating Spelling Errors During Patient Validation. Computers and Biomedical Research, 25:486–509

Gartaula, H. N., Niehof, A., & Visser, L. (2010). Feminisation of Agriculture as an Effect of Male Out-migration: Unexpected Outcomes from Jhapa District, Eastern Nepal. International Journal of Interdisciplinary Social Sciences, 5(2).

Haber, S. H., Klein, H. S., Maurer, N., & Middlebrook, K. J. (2008). Mexico since 1980. Cambridge: Cambridge University Press.

Gordillo de Anda, G., Janvry, A. D., & Sadoulet, E. (1998). Entre el control político y la eficiencia: evolución de los derechos de propiedad agraria en México. Revista de la CEPAL.

Hamilton, S. (2002). Neoliberalism, Gender, and Property Rights in Rural Mexico. Latin American Research Review, 37(1), 119–143.

Hanson, G. H. (2006). Illegal migration from Mexico to the United States. Journal

of Economic Literature, 44(4), 869-924.

Hausermann, H. E. (2014). Unintended Developments: Gender, Environment, and Collective Governance in a Mexican Ejido. Annals of the Association of American Geographers, 104(4), 784–800. http://doi.org/10.1080/00045608.2014.910075

Lastarria-Cornhiel, S. (2008). Feminization of agriculture: Trends and driving forces.

McKenzie, D., & Rapoport, H. (2007). Network effects and the dynamics of migration and inequality: theory and evidence from Mexico. Journal of development Economics, 84(1), 1-24.

Meinzen-Dick, R., Quisumbing, A., Doss, C., & Theis, S. (2017). Women's land rights as a pathway to poverty reduction: Framework and review of available evidence. Agricultural Systems.

Menon, N., Van Der Meulen Rodgers, Y., & Nguyen, H. (2014). Women's land rights and children's human capital in Vietnam. World Development, 54, 18-31.

Mishra, P. (2007). Emigration and wages in source countries: Evidence from Mexico. Journal of Development Economics, 82(1), 180-199.

Newman, C., Tarp, F., & Van Den Broeck, K. (2015). Property rights and productivity: The case of joint land titling in Vietnam. Land Economics, 91(1), 91-105.

Nuijten, M. (2003). Family property and the limits of intervention: The Article 27 reforms and the PROCEDE programme in Mexico. Development and Change, 34(3), 475-497

Panda, P., & Agarwal, B. (2005). Marital violence, human development and women's property status in India. World Development, 33(5), 823-850.

Parker, S. W., & Todd, P. E. (2017). Conditional Cash Transfers: The Case of

Progresa/Oportunidades. Journal of Economic Literature, 55(3), 866-915.

Passel, J. S., D'Vera Cohn, G. B. A., & Gonzalez-Barrera, A. (2012). Net migration from Mexico falls to zero–and perhaps less. Washington, DC: Pew Hispanic Center.

Pedraza, S. (1991). Women and migration: The social consequences of gender. Annual review of sociology, 17(1), 303-325.

Pollock, J. J. & Zamora, A. (1984) Automatic Spelling Correction in Scientific and Scholarly Text. Communications of the ACM, 27(4):358–368

Radel, C., Schmook, B., McEvoy, J., Mendez, C., & Petrzelka, P. (2012). Labour migration and gendered agricultural relations: The feminization of agriculture in the ejidal sector of Calakmul, Mexico. Journal of Agrarian Change, 12(1), 98-119.

Robles, Hector, Gloria Artis, Julieta Salazar, and Laura Munoz. (2000). Y Ando Yo También en el Campo!: Presencia de la Mujer en el Agro Mexicano. Procuraduría Agraria.

Sachs, J. D. (2012). From millennium development goals to sustainable development goals. The Lancet, 379(9832), 2206-2211.

Skoufias, Emmanuel. (2001), "PROGRESA and its Impacts on the Human Capital and Welfare of Households in Rural Mexico: A Synthesis of the Results of an Evaluation by IFPRI." International Food Policy Research Institute.

Stephen, L. (1996). Too Little, Too Late? The Impact of Article 27 on Women in Oaxaca. In L. Randall (Ed.), Reforming Mexico's Agrarian Reform.

Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. The American Economic Review, 71(3), 393-410.

Udry, C. (1996). Gender, agricultural production, and the theory of the household. Journal of political Economy, 104(5), 1010-1046.

Valsecchi, Michele. (2014). "Land property rights and international migration: Evidence from Mexico," Journal of Development Economics, Volume 110, 276-290.

Vázquez-García, V. (2015). Aging Ejidos in the Wake of Neo-Liberal Reform: Livelihood Predicaments of Mexican Ejidatarias. In C. S. Archambault and A. Zoomers (Eds.), Global Trends in Land Tenure Reform: Gender Impacts.

Walther, Selma (2016) Noncooperative Decision Making in the Household: Evidence from Malawi. Available at SSRN: https://ssrn.com/abstract=2781905

Winkler, W. E. (2006) Overview of Record Linkage and Current Research Directions. Technical Report RR2006/02, US Bureau of the Census

World Bank. (2001). Mexico Land Policy: A Decade after the Ejido Reform. Colombia, Mexico, and Venezuela Country Management Unit, Environmentally and Socially Sustainable Development Sector Management Unit, Latin America and the Caribbean Region, (Report 22187-ME).

Yancey, W. E. (2005) Evaluating String Comparator Performance for Record Linkage. Technical Report RR2005/05, US Bureau of the Census

Appendix A: Technical Details on Name Matching

The Jaro-Winkler algorithm is a continuous mapping from two names to the closed unit interval.[11] Two words with nothing in common map to 0; Two identical words map to 1. Words with some commonalities map to a value between 0 and 1. Consider two strings, s_1 and s_2. For instance, these strings could be "Travis" and "Matt". Denote string length as $|s|$. Denote the number of commonalities (The number of agreeing characters within half the length of the longer string) as c and the number of transposes as t. Then then Jaro similarity is

$$sim_{Jaro}(s_1, s_2) = \frac{1}{3}(\frac{c}{|s_1|} + \frac{c}{|s_2|} + \frac{c-t}{c}). \tag{4}$$

The Jaro-Winkler method improves on this by accounting for the stylized fact that name-entry errors typically occur at the end of names. This improvement increases the Jaro-similarity of two strings for up to four agreeing initial characters. Denote the number of agreeing characters at the beginning of two strings as s. The Winkler similarity is

$$sim_{Wink}(s_1, s_2) = sim_{Jaro}(s_1, s_2) + \frac{s}{10}(1 - sim_{Jaro}(s_1, s_2)) \tag{5}$$

We calculate a Winkler similarity value for all pairs of names in a given *ejido*. Then, we choose a cut off for the similarity values that reduces the chance of Type I and Type II errors: 0.96. If the similarity measure is greater than this cutoff for two observations in an *ejido*, we allocate the same personal identification number to those two, marking them as the same person with information presented in multiple waves.

[11] We draw heavily from Christen (2006) to explain this algorithm.