

Certified to Migrate: Property Rights and Migration in Rural Mexico

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Research Questions

- Improving security of tenure over agricultural land is expected to increase investments and productivity
- Countries have embarked on large certification or titling programs
- This paper: If previous regime had land tying elements, an important unanticipated effect of property rights improvement is substantial outmigration
- We study the Mexican case to ask:
 - ▶ *Question 1:* Does land certification lead to increased outmigration from farmer communities?
 - ▶ *Question 2:* Test comparative static predictions from the model, for example: Do we see evidence of sorting in which larger and more productive farmers stay while smaller less productive farmers migrate?
 - ▶ *Question 3:* Does certification lead to an aggregate reduction in cultivated land (fallowing)?

Overview of Results

- Becoming certified results in a 30% increase in the probability of a household having a migrant.
- Localities become 4% smaller after certification.
- Households with ex-ante weaker property rights, better off-farm wage opportunities, worse land quality respond by migrating more
- Evidence of sorting - Less well endowed families (lower landholdings) increase migration while families with larger landholdings do not.
- Land use: Ejidos in high productivity areas saw an increase in farmland after the certification program compared to those in low productivity areas.

Literature Review

- Property rights and agricultural productivity: Besley (1995), Alston, Libecap, and Schneider (1996), Banerjee et al (2002), Jacoby, Li, and Rozelle (2002), Deininger and Jin (2006), and Goldstein and Udry (2008)
- Property rights and urban labor: Field (2007)

Contents

- **Background of Program**
- Simple Model
- Results
- Identification strategy tests
- Conclusions

Land Allocation Prior to Reform

- Ejidos were communal properties created 1917-1992 to redistribute land from large to small landholders
- Over 50% of Mexican territory ultimately allocated under ejido system
- Land allocated as tracts of land (ejido) to *groups* of families divided in individual housing plots, individual agricultural plots, and common property.
- Individuals in the group had conditional usufruct rights
- *Use it or lose it*: If rights holder did not cultivate land himself, land subject to reallocation
- But no right to sell, lease or sharecrop or hiring of wage labor rights
- There were no titles, public registries, hence large degree of *individual* insecurity)

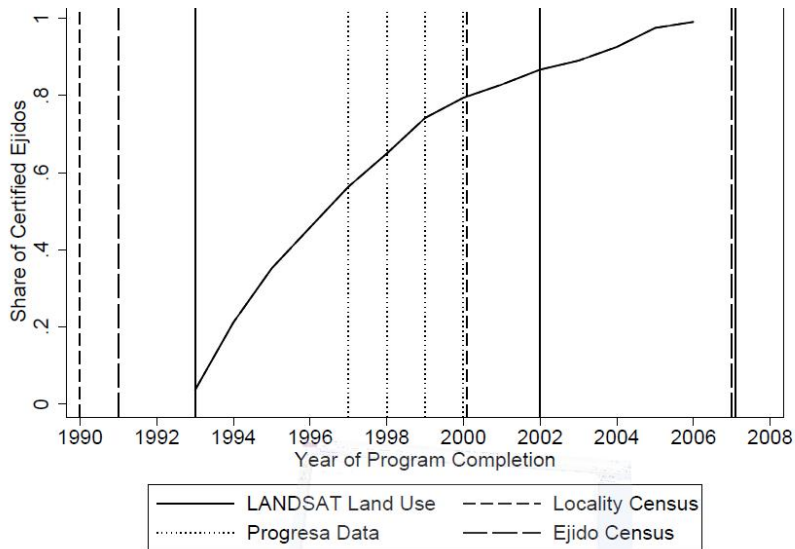
The *Procede* Program

- 1992 constitutional reform moved ejidos towards private property
- Certification program (*Procede*) was put into place to give ejidatarios individualized certificate of ownership for housing plot, agricultural plots, and shares of ejido common property.
- Intervention at the ejido level: All land disputes (internal and external) must be resolved, and proposed division of the whole ejido agreed upon.
- All ejidatarios of a given ejido received certificates simultaneously (no within ejido selection).
- Certificates short of full private property. Certificates allowed for leasing, selling, sharecropping, hiring wage labor, but restricted sales to non-ejido members.
 - ▶ Straightforward for ejido to switch partially or totally to full private property (*dominio pleno*)

Data and Identification

- Certification program rolled out in Mexico from 1993-2006
- Certificates materialized benefits of reform for ejidatarios (security of tenure)
- Use Progresa panel data to analyze household level migration between 1997-2000 (for individual behavior) - 7,600 households in 127 ejidos.
- Use matched locality census 1990-2000 (for community level behavior) - 18,000 localities.
- Matched Ejido census 1991-2007 (direct question on migration) - 19,700 ejidos.
- Use satellite land use panel data 1993, 2003, and 2007 (for land use changes).

Data



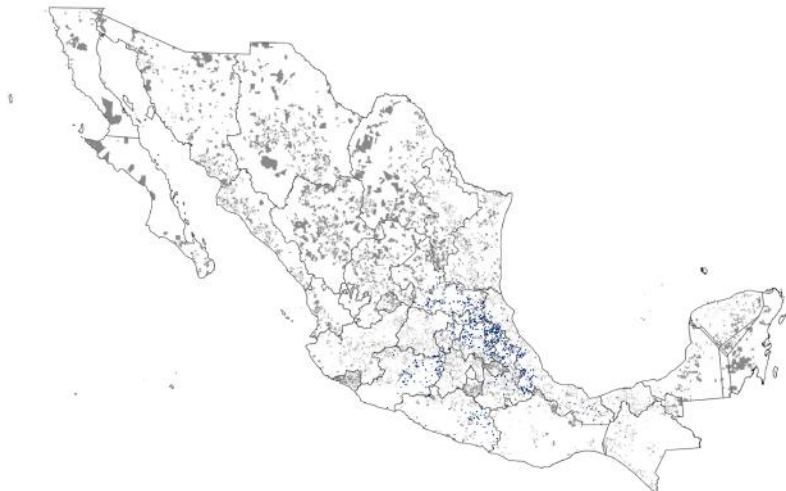
Ejidos and Communities Certified 1993



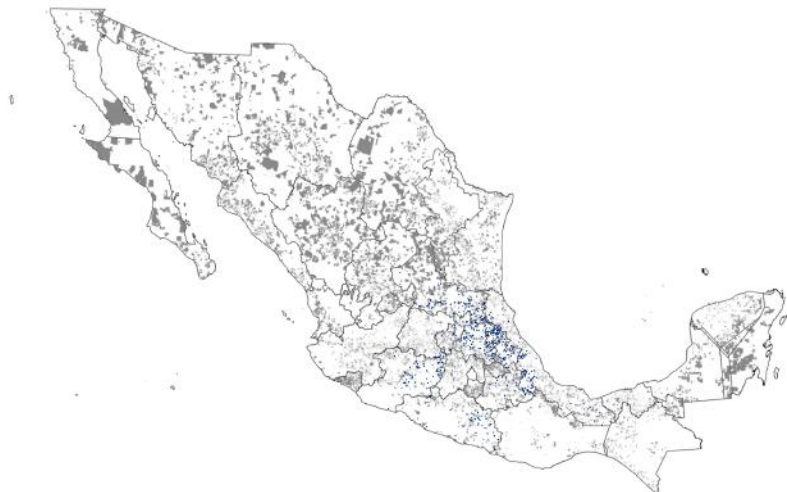
Ejidos and Communities Certified 1994



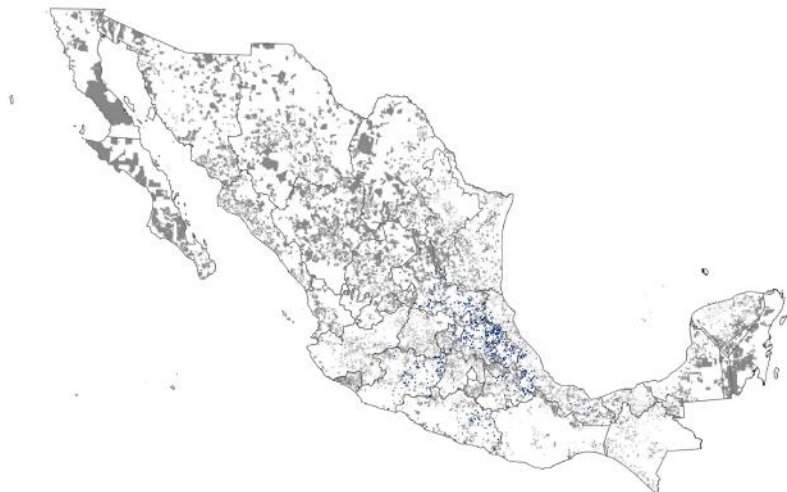
Ejidos and Communities Certified 1995



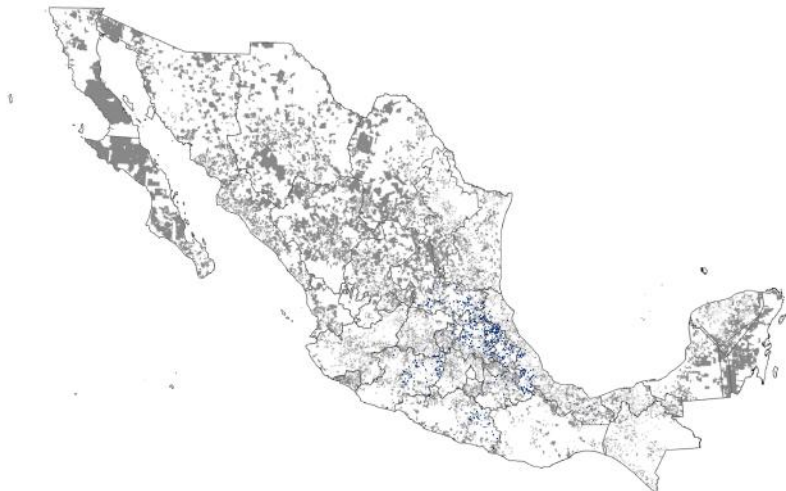
Ejidos and Communities Certified 1996



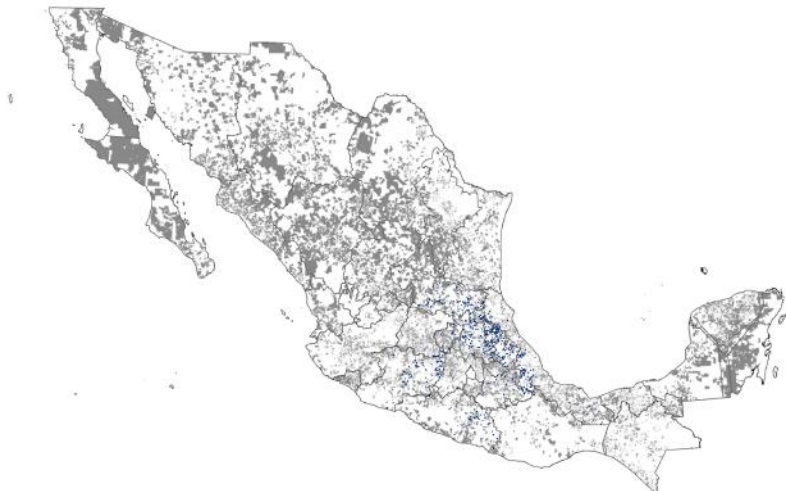
Ejidos and Communities Certified 1997



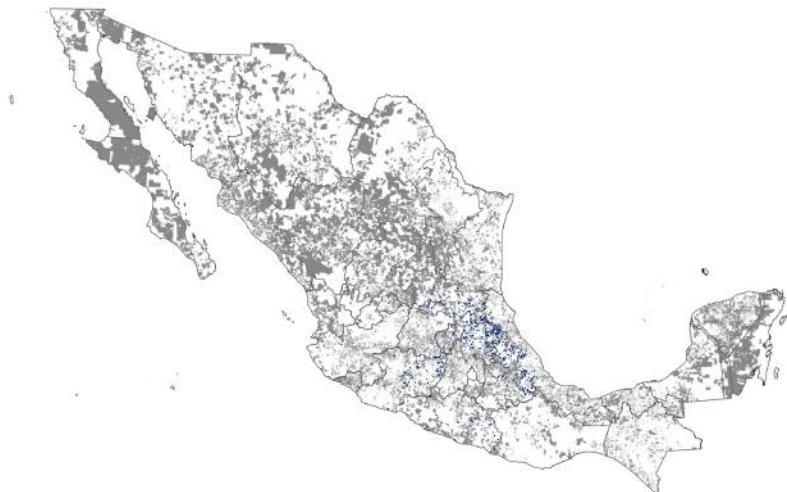
Ejidos and Communities Certified 1998



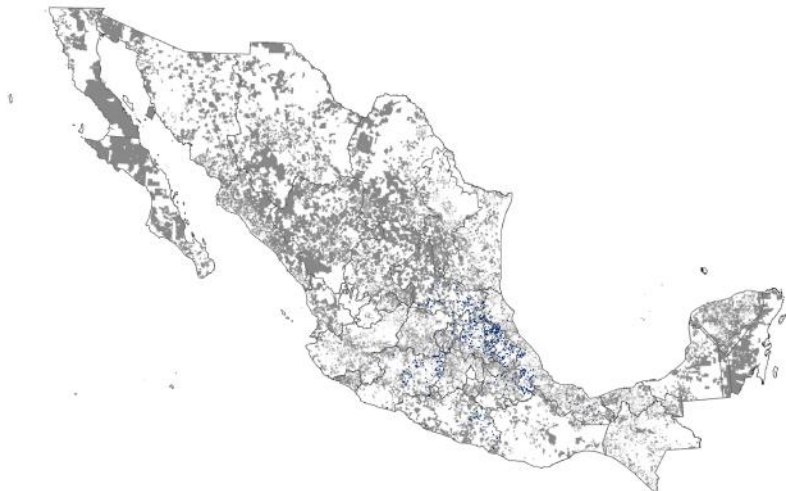
Ejidos and Communities Certified 1999



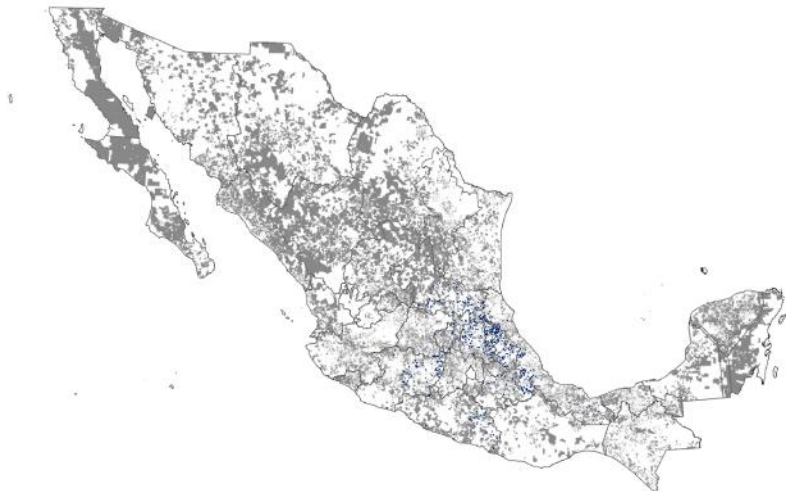
Ejidos and Communities Certified 2000



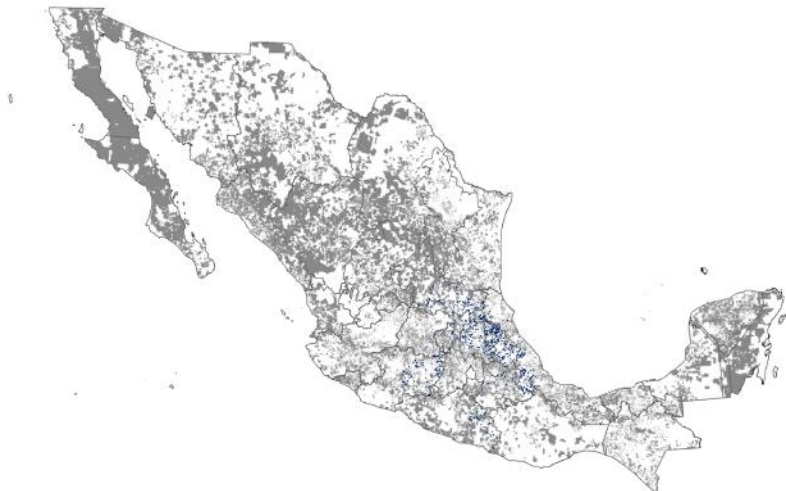
Ejidos and Communities Certified 2001



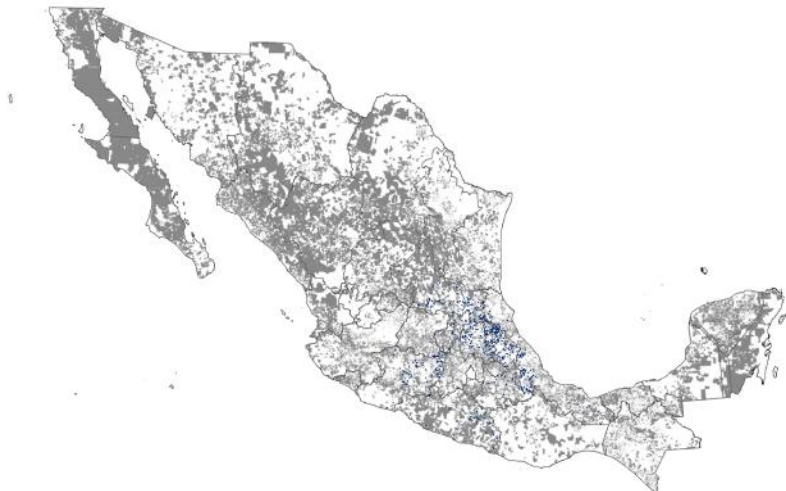
Ejidos and Communities Certified 2002



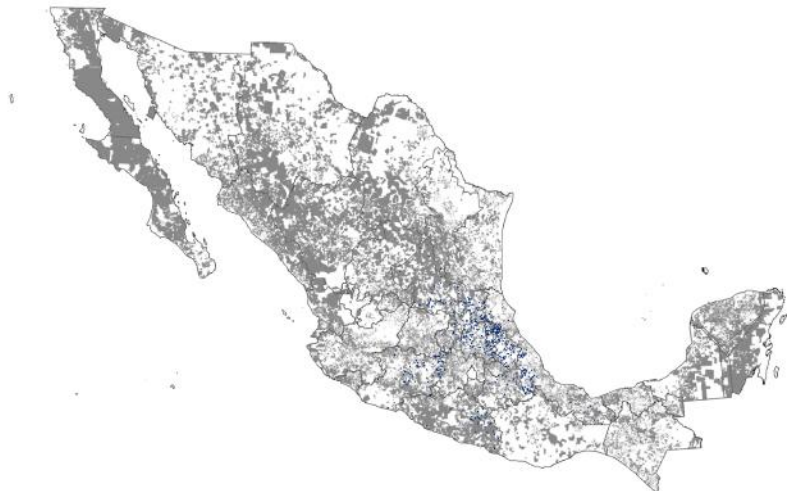
Ejidos and Communities Certified 2003



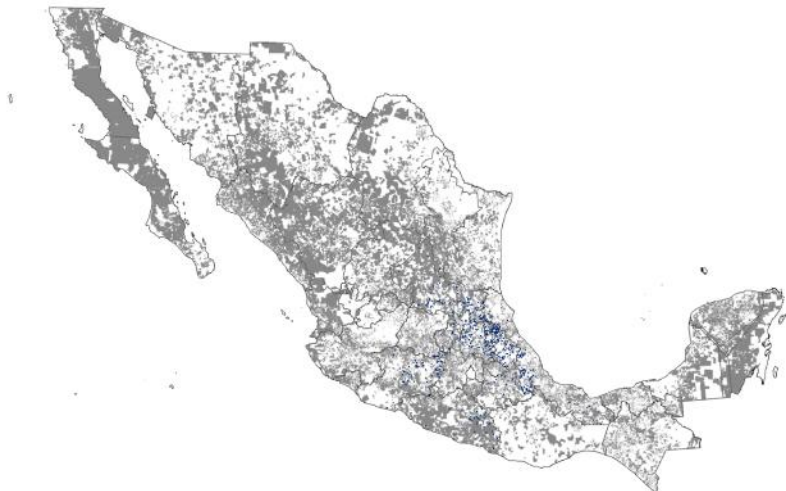
Ejidos and Communities Certified 2004



Ejidos and Communities Certified 2005



Ejidos and Communities Certified 2006



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Standard agricultural production model

- Expected output

$$Y_e = \gamma A^\alpha h_e^\beta$$

where h_e is farm labor, A is land, and γ a total factor productivity parameter.

- Assume non-decreasing return to scale $\alpha + \beta \geq 1$.
- There is no land market and hiring in is not allowed either.
- Migration = labor h_m in the non-farm market at the wage w_m .
- Utility

$$u(C, \ell) = C + v(\ell),$$

where C is consumption, ℓ is leisure.

- Time constraint is $T = h_e + h_m + \ell$
- Budget constraint is $C = \gamma A^\alpha h_e^\beta + w_m h_m + I$, where I is non-labor income

Model

Land insecurity and farm labor:

- The family is required to maintain a minimum production (yield) level in order to maintain use rights to the land:

$$\frac{Y_e}{A} \geq \frac{\pi_m}{s},$$

where π_m is the minimum yield

- Or else, family loses its land, i.e., $h_e = 0$
- $s \in (0, 1)$ is a parameter representing the individual-specific strength of property rights. Households with weaker property rights have to maintain a higher production level to keep their land.

Model

- Without constraint, the optimal labor allocation would be:

$$h_e^* = \left(\frac{\gamma\beta}{w_m} \right)^{\frac{1}{1-\beta}} A^{\frac{\alpha}{1-\beta}}$$

An increasing and convex function of land A .

- The minimum yield constraint requires the household to allocate a minimum labor to agricultural production:

$$\underline{h}_e = \left(\frac{\pi_m}{s\gamma} \right)^{\frac{1}{\beta}} A^{\frac{1-\alpha}{\beta}}$$

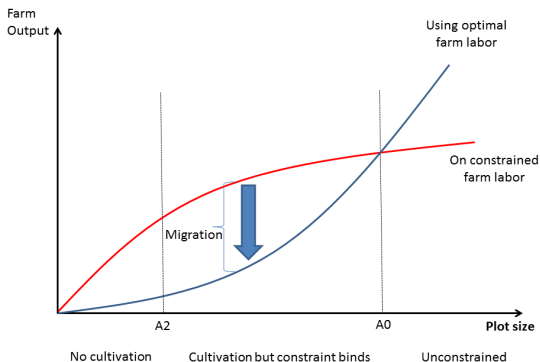
An increasing and concave function of land A .

Pre-Reform Labor Allocation

- Leisure is determined by the FOC: $w_m = v'(\ell)$
- Migrant/off-farm labor given by: $h_m = T - h_e - \ell$
- On farm labor given by:
 - (i) $h_e = h_e^*$, if $A \geq A_0$
 - (ii) $h_e = \underline{h}_e$, if $A_2 \leq A \leq A_0$
 - (iii) $h_e = 0$, if $A \leq A_2$,

where A_0 is defined by $h_e^* = \underline{h}_e$, and A_2 is defined by $\frac{Y_e}{\underline{h}_e} = w_m$

Program Effect



- Program allows household to move from restricted to unrestricted optimization

▶ $\Delta h_e = h_e^* - \underline{h_e} < 0 \rightarrow \Delta h_m > 0.$

Other Testable Comparative Statics

- Migration effect larger when pre-reform security was weak ($\frac{\partial \Delta h_m}{\partial s} < 0$)
- Migration effect larger when off-farm opportunities are higher ($\frac{\partial \Delta h_m}{\partial w_m} > 0$)
- Migration effect smaller when land is more productive ($\frac{\partial \Delta h_m}{\partial \gamma} < 0$)
- Migration effect smaller for larger landholders ($\frac{\partial \Delta h_m}{\partial A} < 0$)
- Farm size heterogeneity larger on more productive land ($\frac{\partial^2 \Delta h_m}{\partial \gamma \partial A} < 0$)

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Identification Strategy

Ejido Fixed Effects regression:

$$y_{ijt} = \delta \text{Certified}_{jt} + \alpha_t + \gamma_j + x'_{ijt}\beta + \varepsilon_{ijt}$$

$y_{ijt} = 1$ if HH i in ejido j has migrant away in year t (permanent migration).

$\text{Certified}_{jt} = 1$ if ejido j was certified by start of year t .

Parameter of interest is δ .

Estimated in three datasets, that present different levels of precision and coverage.

Migration effect in Progres data (1997-2000)

Progres Households Matched to Ejidos

| | (1) Has Migrant | (2) Has Migrant | (3) Has Migrant | (4) Has Migrant | (5) Has Migrant | (6) Has Migrant |
|--------------------------------------|----------------------|-----------------------|----------------------|-----------------------|-----------------------|----------------------|
| Certified | 0.0149** (0.0061) | 0.0158** (0.0064) | 0.0153** (0.0062) | 0.0172*** (0.0059) | 0.0157** (0.0063) | 0.0157** (0.0063) |
| HH is Landholder | | 0.0136*** (0.0044) | | | 0.0048 (0.0053) | |
| Number Males 17-30 in HH | | 0.0195*** (0.0046) | | | 0.0088** (0.0037) | |
| HH Head is Female | | 0.0127 (0.0101) | | | 0.0092 (0.0082) | |
| Age of HH Head | | 0.0009*** (0.0002) | | | 0.0004*** (0.0001) | |
| Time Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Ejido Fixed Effects | Yes | Yes | No | Yes | Yes | Yes |
| HH Fixed Effects | No | No | Yes | No | No | No |
| State x Time Effects | No | No | No | Yes | No | No |
| HH Characteristics x Time Effects | No | No | No | No | Yes | Yes |
| Ejido Characteristics x Time Effects | No | No | No | No | No | No |
| Mean of Dep Variable | 0.053 | 0.056 | 0.053 | 0.053 | 0.056 | 0.056 |
| Number of Observations | 27180 | 24533 | 27180 | 27180 | 24533 | 27180 |

Certification and migration using locality census data (1990 & 2000)

| | Census Localities Matched to Ejidos | |
|---|-------------------------------------|------------------------|
| | (1) ln(Population) | (2) ln(Population) |
| Year=2000 | -0.2069*** (0.0105) | -0.2069*** (0.0105) |
| Certified 1993-1999*Year=2000 | -0.0404*** (0.0128) | -0.0206 (0.0195) |
| Years Certified in 2000*Certified 1993-1999*Year=2000 | | -0.0054 (0.0039) |
| Ejido Fixed Effects | Yes | Yes |
| Mean of Dep Variable | 4.271 | 4.271 |
| Number of Observations | 34656 | 34656 |
| R squared | 0.035 | 0.036 |

Procede exacerbates the decline in population by 4% against a background decline of 21% between 1990 and 2000.

Certification and migration using ejido census data

| | Matched Ejidos in 1991 and 2007 Ejido Census | | | |
|---|--|-----------------------|-----------------------|-----------------------|
| | (1) Migrate | (2) Migrate | (3) Migrate US | (4) Migrate US |
| Years Certified in 2007 | 0.0035*** (0.0013) | 0.0039*** (0.0013) | 0.0037*** (0.0012) | 0.0031*** (0.0012) |
| Using Improved Seeds in 1991 | | -0.0178* (0.0100) | | 0.0009 (0.0095) |
| Using Tractors in 1991 | | -0.0048 (0.0105) | | 0.0123 (0.0104) |
| Electrical Lighting in 1991 | | 0.0384*** (0.0108) | | 0.0514*** (0.0110) |
| Log of Distance Between Ejido and PA Office | | 0.0528*** (0.0113) | | 0.0110 (0.0113) |
| State Fixed Effects | Yes | Yes | Yes | Yes |
| Mean of Dep Variable | 0.426 | 0.426 | 0.297 | 0.297 |
| Number of Observations | 19670 | 19600 | 19670 | 19600 |
| R squared | 0.086 | 0.092 | 0.128 | 0.131 |

Procede increases the probability that "the majority of the young people emigrate from the ejido".

Heterogeneity in pre-reform individual-level property rights security

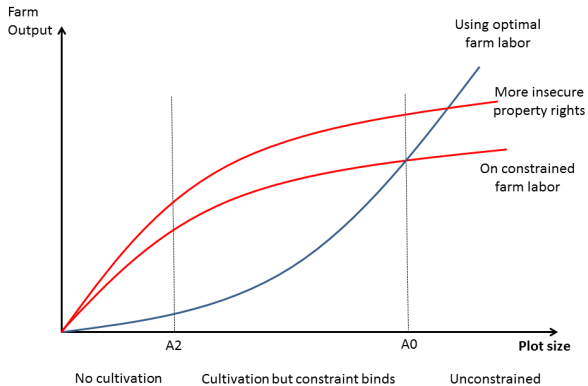
Migration induced by increased property rights is

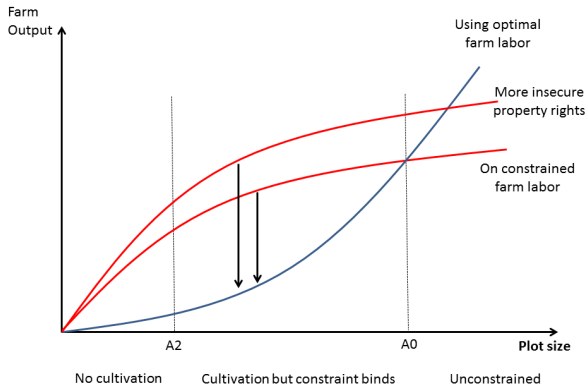
$$\Delta h_m = \left(\frac{\pi_m}{s\gamma} \right)^{\frac{1}{\beta}} A^{\frac{1-\alpha}{\beta}} - \left(\frac{\gamma\beta}{w_m} \right)^{\frac{1}{1-\beta}} A^{\frac{\alpha}{1-\beta}}$$



$$\frac{\partial \Delta h_m}{\partial s} < 0$$

- More insecure property rights (lower s) are reflected in a higher h_e . *Ceteris paribus*, this generates a higher migration response the more insecure property rights were in the old regime.





Heterogeneous effect w.r.t. prior insecurity

| | Progesa Households Matched to Ejidos | |
|--|--------------------------------------|---------------------|
| | (1) | (2) |
| Certified | 0.0081 (0.0086) | 0.010 (0.006) |
| Certified*Ejido Had Boundary Problems in 1991 | 0.028* (0.015) | |
| Certified*HH Head is Female | | 0.0648** (0.028) |
| Time Effects | Yes | Yes |
| Ejido Fixed Effects | Yes | Yes |
| Controls | Yes | Yes |
| Time Effects*Ejido Had Boundary Problems in 1991 | Yes | No |
| Time Effects*HH Head is Female | No | Yes |
| Mean of Dep Variable | 0.057 | 0.056 |
| Number of Observations | 21090 | 24533 |
| R squared | 0.060 | 0.059 |

Note: All specifications include ejido and time fixed effects as well as level terms for interactions. Variables interacted with certification are also allowed to have separate time effects.

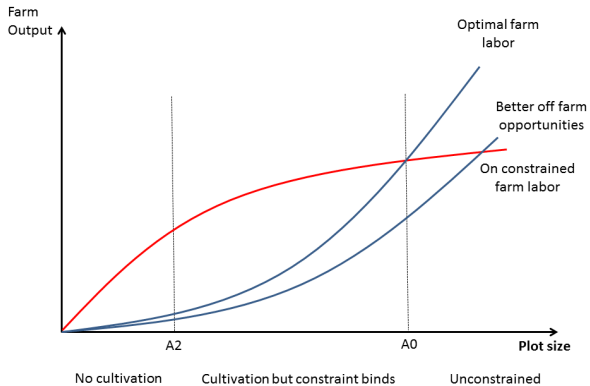
Heterogeneity in off-farm wages

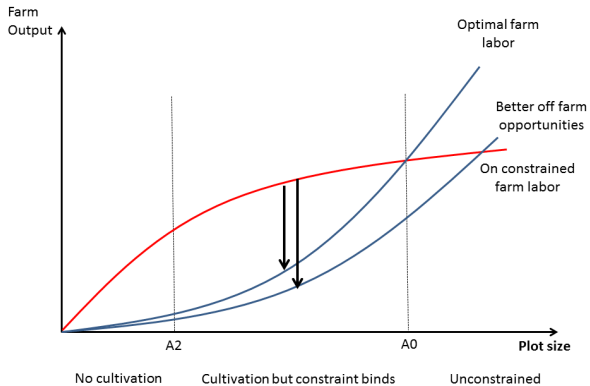
$$\Delta h_m = \left(\frac{\pi_m}{s\gamma} \right)^{\frac{1}{\beta}} A^{\frac{1-\alpha}{\beta}} - \left(\frac{\gamma\beta}{w_m} \right)^{\frac{1}{1-\beta}} A^{\frac{\alpha}{1-\beta}}$$



$$\frac{\partial \Delta h_m}{\partial w_m} = -\frac{\partial h_e^*}{\partial w_m} > 0$$

- Households with better outside wage opportunities will have a larger migration response to improvement in property rights.





Result 2: Heterogeneous effects w.r.t. potential off farm wages

| | Progresa Households Matched to Ejidos |
|---------------------------------------|---------------------------------------|
| | (1) |
| Certified | -0.004 (0.009) |
| Certified*Above Median Predicted Wage | 0.026* (0.015) |
| Certified*HH Head is Female | 0.070** (0.028) |
| Time Effects | Yes |
| Ejido Fixed Effects | Yes |
| Controls | Yes |
| Time Effects*High Pred. Wage | Yes |
| Time Effects*HH Head is Female | Yes |
| Mean of Dep Variable | 0.056 |
| Number of Observations | 24513 |
| R squared | 0.060 |

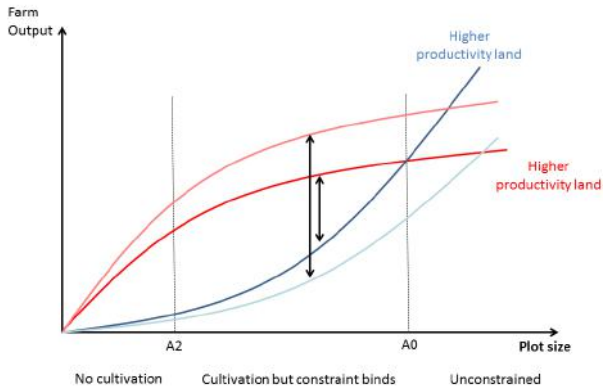
Note: All specifications include ejido and time fixed effects as well as level terms for interactions. Variables interacted with certification are also allowed to have separate time effects.

Heterogeneity in land productivity

$$\Delta h_m = \left(\frac{\pi_m}{s\gamma} \right)^{\frac{1}{\beta}} A^{\frac{1-\alpha}{\beta}} - \left(\frac{\gamma\beta}{w_m} \right)^{\frac{1}{1-\beta}} A^{\frac{\alpha}{1-\beta}}$$

- $$\frac{\partial \Delta h_m}{\partial \gamma} = \frac{\partial h_e}{\partial \gamma} - \frac{\partial h_e^*}{\partial \gamma} < 0$$

Farms with lower land productivity have more outmigration when moving from a restricted to an unrestricted property rights regime.



Heterogeneous effect w.r.t. land productivity (Col. 1)

| | All Mun. | High Yield Mun. | Low Yield Mun. |
|---|---------------------|---------------------|---------------------|
| | (1) | (2) | (3) |
| | Has Mig | Has Mig | Has Mig |
| Certified | 0.031*** (0.010) | 0.020** (0.010) | 0.037*** (0.013) |
| Certified*High Yield Municipality | -0.026** (0.013) | | |
| Certified*Land per Adult > Ejido Median | | -0.034** (0.016) | -0.014 (0.016) |
| Ejido Fixed Effects | Yes | Yes | Yes |
| Time Effects | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes |
| Time Effects*High Maize Yield Municipality | Yes | No | No |
| Time Effects*Land per Adult > Median in Ejido | No | Yes | Yes |
| Mean of Dep Variable | 0.056 | 0.057 | 0.054 |
| Number of Observations | 24372 | 14533 | 9839 |
| R squared | 0.058 | 0.052 | 0.068 |

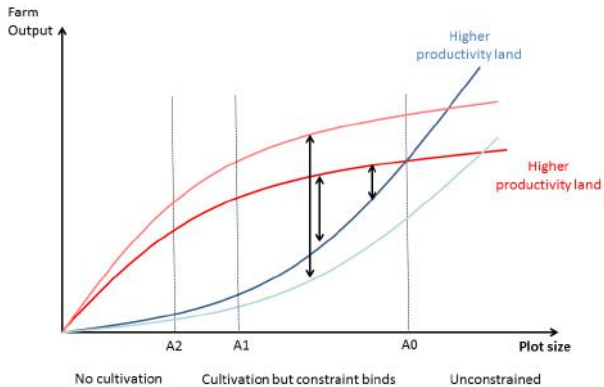
The migration response is 6 times larger in lower productivity areas.

Certification, sorting, and migration



$$\frac{\partial^2 \Delta h_m}{\partial \gamma \partial A} < 0$$

- Larger farmers in more productive regions are expected to respond the least to certification with labor re-allocation



Certification, sorting, and migration

| | All Mun. | High Yield Mun. | Low Yield Mun. |
|---|---------------------|---------------------|---------------------|
| | (1) Has Mig | (2) Has Mig | (3) Has Mig |
| Certified | 0.031*** (0.010) | 0.020** (0.010) | 0.037*** (0.013) |
| Certified*High Yield Municipality | -0.026** (0.013) | | |
| Certified*Land per Adult > Ejido Median | | -0.034** (0.016) | -0.014 (0.016) |
| Ejido Fixed Effects | Yes | Yes | Yes |
| Time Effects | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes |
| Time Effects*High Maize Yield Municipality | Yes | No | No |
| Time Effects*Land per Adult > Median in Ejido | No | Yes | Yes |
| Mean of Dep Variable | 0.056 | 0.057 | 0.054 |
| Number of Observations | 24372 | 14533 | 9839 |
| R squared | 0.058 | 0.052 | 0.068 |

In high productivity areas, only smaller farmers migrate.

In low productivity areas, both small and large farmers migrate.

Land use and migration

- We showed that certification induced migration.
What happened with cultivated land?
 - ▶ Fallowing now an option - inducing a decrease in cultivated land
 - ▶ Land rental /sales market - possibly no change in cultivated area
 - ▶ Security and functioning land markets can actually induce increases in investment/cultivated land
- Net effect on agricultural land use?

Effect on land used for agriculture (Landsat 93, 02, 07)

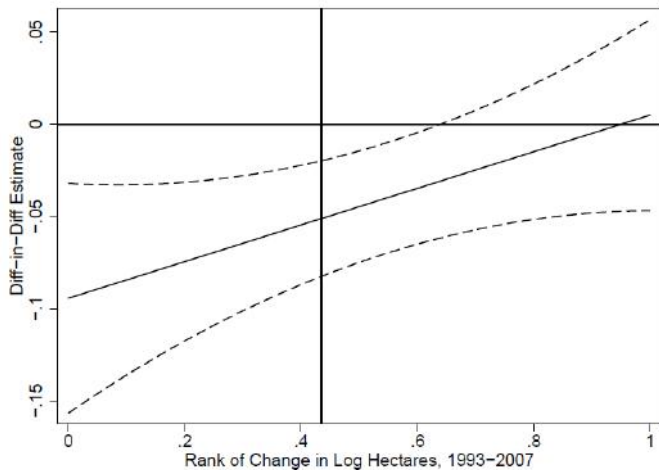
| Ejido-Level Panel Using LANDSAT Satellite Data | | | |
|--|----------------------|----------------------|----------------------|
| | (1) Log(Area Ag.) | (2) Log(Area Ag.) | (3) Log(Area Ag.) |
| Certified | 0.0013 (0.0093) | -0.0080 (0.0108) | -0.0175 (0.0136) |
| Certified * High Yield | | 0.0209** (0.0093) | 0.0332* (0.0182) |
| Ejido Fixed Effects | Yes | Yes | Yes |
| Time Effects | Yes | Yes | Yes |
| Time Effects*High Yield | No | No | Yes |
| Mean of Dep Variable | 5.718 | 5.714 | 5.714 |
| Number of Observations | 63392 | 58763 | 58763 |
| R squared | 0.012 | 0.012 | 0.012 |

- There is no aggregate change in land used for agriculture
- The decrease in low productivity areas is compensated by the increase in high productivity areas (significantly different at 10%)

Correlation between certification effect and change in farm land

| | Rank>0.5 | Rank<0.5 | All |
|---|------------------------|------------------------|------------------------|
| | (1) | (2) | (3) |
| | ln(Population) | ln(Population) | ln(Population) |
| Year=2000 | -0.2285*** (0.0143) | -0.1936*** (0.0195) | -0.1765*** (0.0239) |
| Certified 1993-1999*Year=2000 | -0.0230 (0.0183) | -0.0760*** (0.0232) | -0.0924*** (0.0292) |
| Rank of Ag Change * Year=2000 | | | -0.0705* (0.0368) |
| Rank of Ag Change * Certified 1993-1999 * Year=2000 | | | 0.0876* (0.0461) |
| Ejido Fixed Effects | Yes | Yes | Yes |
| Mean of Dep Variable | 4.240 | 4.324 | 4.278 |
| Number of Observations | 15200 | 12420 | 27624 |
| R squared | 0.035 | 0.041 | 0.038 |

Loss of population and Rank of Agricultural Land Change



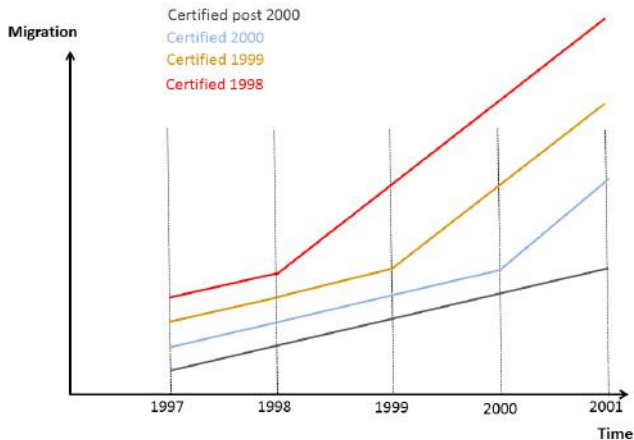
Liquidity, Labor Markets, and Land Concentration

| | (1) Migration | (2) Hectares | (3) Herfindahl |
|--------------------------------|--------------------|------------------------|--------------------|
| Certified | 0.0049 (0.0086) | -0.1135 (0.1670) | 0.0268 (0.0320) |
| Certified*Progresa locality | 0.0164 (0.0122) | | |
| Adults in HH | | 0.4314*** (0.0393) | |
| Certified*Adults in HH | | 0.0296 (0.0414) | |
| HH Head is Female | | -0.4606*** (0.0741) | |
| Age of HH Head | | 0.0268*** (0.0027) | |
| Locality Fixed Effects | Yes | No | No |
| Ejido Fixed Effects | No | Yes | Yes |
| Time Effects | Yes | Yes | Yes |
| Time Effects*Progresa Locality | Yes | No | No |
| Time Effects*Adults in HH | No | Yes | No |
| Mean of Dep Variable | 0.054 | 2.121 | 0.116 |
| Number of Observations | 26690 | 24211 | 506 |
| R squared | 0.050 | 0.288 | 0.547 |

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Identification Assumption: Similar changes in migration before certification



Test of differential changes in migration before certification

| Progesa Households Matched to Ejidos, Pre-Program Period | | | | |
|--|--------------------------|--------------------------|--------------------------|---------------------|
| | (1) | (2) | (3) | (4) |
| | Δ Migration,97-98 | Δ Migration,97-99 | Δ Migration,97-00 | Migration,97-00 |
| Procede Completed in 1999 | -0.0011 (0.0113) | | | |
| Procede Completed in 2000 | -0.0040 (0.0110) | -0.0087 (0.0092) | | |
| Procede Completed After 2000 | -0.0131 (0.0090) | -0.0102 (0.0086) | 0.0015 (0.0046) | |
| Year Procede Completed (0/1) | | | | 0.0018 (0.0150) |
| Year Before Procede (0/1) | | | | -0.0021 (0.0107) |
| 2 Years Before Procede (0/1) | | | | -0.0015 (0.0089) |
| Time Fixed Effects | No | Yes | Yes | Yes |
| Ejido Fixed Effects | No | No | No | Yes |
| Mean of Dep Variable | 0.022 | 0.020 | 0.018 | 0.050 |
| Number of Observations | 111 | 187 | 225 | 406 |
| Number of Ejidos | 111 | 94 | 76 | 127 |
| R squared | 0.047 | 0.019 | 0.002 | 0.774 |
| Pvalue of joint test | 0.190 | 0.493 | | |

Robust standard errors are reported in parentheses. In columns 2-4, standard errors are clustered at the ejido level.

The dependent variable in columns 1-3 is the change in ejido migration rate. The dependent variable in column 4 is the ejido migration rate. All regressions are for the pre-treatment period.

Progresa Data Attrition and Certification Status

| | (1) Attrition |
|--------------------------|----------------------|
| Certified | -0.003 (0.025) |
| HH is Landholder | -0.043*** (0.010) |
| Number Males 17-30 in HH | 0.005 (0.004) |
| HH Head is Female | 0.030** (0.012) |
| Age of HH Head | -0.000 (0.000) |
| Ejido Fixed Effects | Yes |
| Time Fixed Effects | Yes |
| Mean of Dep Variable | 0.112 |
| Number of Observations | 12895 |
| R squared | 0.115 |

Standard errors that allow for clustering at the ejido level are reported in parentheses. Asterisks indicate statistical significance at the 1% ***, 5% **, and 10% * levels. Data are for all households that were surveyed in the Fall 1998 ENCEL survey. Observations are from 1999 and 2000. Dependent variable = 1 if household did not have survey completed. Certified indicator = 1 if household held title at the start of the year.

Conclusions

- Strong reduced form effect of Mexican land certification program on migration.
 - Migration response is larger in lower land quality environments
 - In high productivity areas, only small farmers migrate after getting certificate.
 - Amount of land in agriculture does not change after the program, suggesting increased labor productivity.
 - In high productivity areas, the certification program actually led to increases in cultivated land compared to low productivity areas.
 - Migration effect stronger in areas where agricultural land decreased, suggesting some fallowing as a result of certification in low productivity areas.
- Combined results suggest that labor re-allocation may be an additional benefit of rural land certification programs.