Tierra y libertad: Will Tenure Reform Improve Productivity in Mexico's *Ejido* Agriculture?*

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I. Introduction

The relationship between land tenure and agricultural productivity is one of the most thoroughly analyzed in the field of economic development. Early research identified a positive link between tenure security and investment.[1] Later researchers argued that the relationship is more complex and suggested a variety of possible mechanisms that would relate tenure security, land title, credit demand and supply, investment, farm size, and productivity.[2] Recent attempts to sort out empirically the competing theories in Africa and Latin America confirm a positive relationship between tenure security and productivity but are unable to identify which of the possible mechanisms is responsible.[3] The main problem is that existing data are not sufficiently precise to permit distinctions between multiple hypotheses.

In spite of the lack of conclusive empirical evidence on causality, land titling continues to be a popular policy designed to stimulate agricultural development.[4] Many governments around the world are enacting or contemplating land privatization programs in order to boost output and productivity. Privatization and titling programs and the economic theory that underlies them are particularly common among governments committed to increasing the role of the market in allocating resources.

While there is undoubtedly an important relationship between land rights and productivity, understanding the exact nature of this relationship within the context of a particular economy may be critical to the success of privatization and titling policies. For example, if traditional land rights are secure, then issuing a title may not have an impact on a farmer's willingness to make long-term investments. Similarly, if no formal credit is available, or none demanded, a title that can be mortgaged will be of little value in the short run. Furthermore, a title that is not

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enforceable or supported by an adequate legal system cannot be considered an improvement in land rights. Making land titling policies effective requires a clear understanding of whether and how the current tenure system is constraining production. If necessary, this information can be used to design complementary policies that will help the tenure reforms achieve their intended goals.

In this article, I examine the case of land tenure reform in Mexico. In 1992, the Mexican government initiated a program to title *ejido* land. *Ejidos* are communities that own land communally and work it under a system of permanent but nontransferable use rights. The new legislation offers *ejidos* the option to participate in a voluntary titling program and to receive individual, private titles. The goal of the reform is to give farmers both the ability and incentive to invest in new technologies and improved production practices.[5] This is mainly expected to come about through the increased access to credit that a title that can be mortgaged will provide. As mentioned above, transferable titles could also increase tenure security or stimulate the development of a land market. However, it can be convincingly argued in the case of Mexico that *ejidal* titles have always offered security and that land markets have always been active in spite of the transfer prohibitions. Thus, in practice the main impact that the reform is likely to have is to increase farmers' access to collateralized credit. Success of the program will therefore depend on the extent to which farmers were previously rationed in their access to credit.

I test the land titling program's underlying hypothesis, namely, that farmers face asset-based credit rationing, which limits their ability to borrow money and invest in agriculture. The hypothesis will be tested using data on participation in the titling program. Evidence of a positive relationship between the asset value of land and participation in the program would support this hypothesis and suggest that the reform is releasing a binding credit constraint for participating farmers. The lack of a relationship, by contrast, would suggest that increasing mortgageable assets alone is not sufficient to increase farmer borrowing and investment in agriculture. Complementary policies may be required in order for the reform to achieve its intended impact of increasing agricultural investment and output. The results of the analysis will also make a useful contribution to the empirical literature on tenure and titling. The voluntary nature of the land titling program in the Mexican context provides a rare opportunity to analyze the impact of titles in an environment in which tenure is endogenous.

The article is organized as follows. Section II reviews the recent changes in Mexican agriculture and agrarian policy. In Section III theories and empirical evidence on the relationships between land tenure, credit, and agricultural productivity are discussed. Section IV presents a conceptual model showing how asset ownership affects credit demand, supply, and use in the context of agricultural production. The implica-

tions of this model are compared with an analysis of the determinants of participation in the Mexican titling program in Section V. Section VI summarizes and concludes.

II. Mexico's Second Agrarian Reform

A. Agricultural Production and Policy, 1917–92

In 1992, the Mexican Constitution was amended to permit the voluntary privatization of *ejido* land, land granted to groups of peasants through the 1917 postrevolutionary land reform. Prior to 1992, all *ejido* land was owned by the community, and *ejido* members had use rights that could be inherited but not rented, mortgaged, or sold. The 1992 legislation ended the creation of new *ejidos*—bringing to an end Latin America's longest running land reform—and offered existing *ejido* members the opportunity to obtain private titles to their *ejidal* land.

The *ejido* claims as antecedents both a pre-Colombian communal land tenure regime and a Spanish tradition of public lands. However, the creation of the *ejido* during the 1910–20 revolution was less a resurrection of a past system than a compromise between the warring factions.[6] The Mexican Revolution was in large part a peasant rebellion against a highly unequal distribution of land ownership and wealth. The demands of Emiliano Zapata's rebel forces were expressed in their famous battle cry *Tierra y libertad* (Land and liberty).

As a program of land redistribution, the *ejido* system worked relatively well. By 1990, half of Mexico's agricultural land—and half its irrigated land—was in the *ejido* sector. With regard to the demand for liberty, however, the *ejido* system does not seem to have been as successful. Land was given not to individuals but to groups, and its use was highly restricted. In addition to the transfer restrictions, *ejidatarios* could not work their land with hired labor, nor could they reside away from the *ejido* for more than 2 years without risking loss of *ejidal* rights. Contracts between *ejidatarios* and private farmers or processors were also prohibited.

While in practice these restrictions were often far from binding,[7] they reflect the fact that in exchange for land, *ejido* members surrendered to the state a great deal of effective control over their economic activities. One consequence was that as technological progress increased the capital intensity of agriculture, *ejidos* became increasingly dependent on the state for subsidized credit, inputs, and other services, in part because the rigidities of the system impeded their participation in many private factor and product markets.

At the beginning, the *ejido* system showed little sign of being a constraint on productivity. In fact, between 1940 and 1965, the growth rate of Mexican agricultural production was the fastest in Latin America, averaging about 7% per year.[8] By the 1970s, however, the major irrigation

projects were ending, the new land coming into production was generally marginal, and the growth rate had dropped to 3% a year.[9] Despite significant government support, by the late 1980s the growth rate of Mexican agricultural production had turned negative.[10]

As growth in output declined, criticism of the *ejido* system on efficiency grounds began to grow.[11] Critics considered it to be an institutional impediment to increased productivity in agriculture, arguing that it distorted incentives regarding investment, production practices, and land stewardship and that it undermined the ability of farmers to respond to a changing technological and demographic environment. However, attempts to reform the system met with resistance from *ejido* members and their supporters. *Ejidos* remained politically popular in Mexico in part because they served as a visible sign of the government's continuing commitment to the principles of the revolution.[12] During most of the 1980s, significant reform was considered politically infeasible.[13]

The Carlos Salinas administration (1988–94), with its focus on market reform and international competitiveness, took on agricultural and *ejido* reform as part of its preparation of the Mexican economy for the North American Free Trade Agreement. Many subsidies, price controls, and tariffs were reduced or eliminated,[14] and in November 1991 a proposed constitutional amendment authorizing the privatization of *ejido* land was announced. The plan was rapidly approved by the Congress and the state legislatures and became law in January 1992.[15]

B. The 1992 Reforms

The new legislation immediately lifted some restrictions on *ejido* land use, for example, the ban on land rental. It also established a process through which *ejido* members could obtain individual, transferable titles to their land. To receive a title, the entire *ejido* must complete a certification and titling program known by its Spanish acronym PROCEDE.[16] Participation in PROCEDE is voluntary and free. The decision to join is made by majority vote of the *ejido* members. Once incorporated into the program, *ejido* members work with program officials to resolve inter- and intra-*ejido* boundary disputes; clarify membership status; and measure, map, and title all agricultural and residential land within the *ejido*. On completion of the program, each *ejido* member receives a new title that reaffirms his or her right to land in the *ejido*. If the *ejido* contains parceled land—that is, crop land that is farmed by individuals[17]—*ejidatarios*' new titles will contain a map showing the exact size and location of their parcels.

While PROCEDE is often referred to as a privatization program, the titles it issues are not fully private titles. Rental rights are unrestricted; however, sale of the land is technically only permitted within the *ejido*. The PROCEDE titles can be exchanged for fully private titles (*dominio pleno*) by individual *ejidatarios* through a petition to the National Agrar-

ian Register.[18] Under the new law, unparceled lands, such as grazing areas, can be privatized if two-thirds of the members agree. However, they can only be sold as a single piece of land and cannot be broken up into smaller parcels.[19]

One important new economic benefit of the 1992 reforms that is only available for those *ejidos* that have completed PROCEDE is that titled land can be used as collateral to guarantee loans from formal lending institutions such as banks. The mortgaging of *ejido* land does not appear to have occurred prior to the reforms.[20] Increasing an *ejidatario*'s access to this type of credit is important because commercial banks are accounting for a growing share of agricultural lending as public sources of credit shrink.[21]

The PROCEDE program was to have completed its work by the end of 1994. Despite major efforts on the part of the Salinas and, later, Ernesto Zedillo administrations, that goal proved overly optimistic. The program is now expected to continue in operation until the end of the Zedillo administration in 2000.[22] Work is proceeding quickly, however. By the end of 1996, 72% of *ejidos* were incorporated in the program, and 48% had received their titles.[23]

III. Land Tenure, Credit, and Productivity: Theory and Evidence

The relationship between land tenure and productivity has received a great deal of attention from researchers. Three main mechanisms have been identified through which tenure could potentially affect productivity. T. Besley calls them the security-based investment demand hypothesis; the collateral-based credit supply hypothesis; and the transferability-based gains from trade hypothesis.[24] Secure land tenure can increase the demand for capital—and also for credit—by increasing farmers' expected returns from investments in their land. Reducing the risk of losing the land would increase the expected value of future income from the land. In empirical work on tenure security, it is tempting to equate security with possession of a title. However, titled land is not necessarily secure in the absence of legal protection of property rights, while lack of title is not always insecure, especially if local or traditional property rights institutions are strong.[25]

The credit supply hypothesis is based on the observation that in the presence of high information costs, lenders often require collateral. Farmers without assets can be rationed out of the market in spite of positive demand at or above the market interest rate.[26] The fact that land is often a farmer's major asset—and the asset most suitable for use as collateral—implies a close relationship between credit access and landholdings.[27]

Finally, the "gains from trade" hypothesis is based on the fact that if land tenure is transferable, then land can be passed from less to more productive farmers. The overall size of landholdings—in terms of own-

ership and operational size—can also adjust in response to market signals, increasing overall efficiency, and productivity.

In his empirical analysis, T. Besley examines what implications each of the different, and by no means mutually exclusive, hypotheses would have for investment behavior. While he finds mixed support for the idea that better land rights facilitate investment, in terms of causality, he is unable to distinguish definitively between the three theoretical models.[28] However, he does find evidence that tenure on a specific plot matters for investment on that plot, which he interprets as evidence against the collateral-based credit supply hypothesis. If the collateral-based view holds, total household land rights rather than rights for a specific plot should affect investment decisions.

M. Carter and P. Olinto, in an attempt to distinguish empirically between demand and supply effects of property rights, reach the opposite conclusion with regard to credit. In an analysis of panel data from Paraguay, they find support for both hypotheses but conclude that the provision of land title would have strong credit effects and weaker, but positive, investment demand effects.[29]

However, the authors note that the credit supply effect is stronger for larger scale producers. The implication is that other factors—such as transaction costs or wealth-based rationing—may constrain credit access by small farmers.

Carter and Olinto allow for both credit-constrained and unconstrained farmers in their analysis, reflecting the fact that not all farmers may have a positive demand for formal credit. While their specification of the formal and informal credit markets is somewhat restrictive—they assume limited liability in formal markets, which is inconsistent with collateral requirements—their acknowledgment of the real choices that farmers face regarding capital and credit use is an important advance. Recent work on informal credit markets, risk, and transactions costs have shown that collateralized credit is not the only source of capital available to farmers, nor is it necessarily the most desirable.[30] A positive demand on the part of farmers for collateralized credit cannot be assumed, as it often was in the past.

IV. A Model of Credit Use under Asset-Based Rationing

In this article, I assume that the main effect of the Mexican land titling program will be to increase the supply of credit available to farmers. Because farmers already had secure title to their land, the demand for credit, especially short-term production credit, which is the major type of collateralized credit used by *ejido* farmers, is unlikely to be substantially affected by the titling program.[31] The hypothesis to be tested is that farmers face asset-based credit rationing, which means that they would like to have more credit but are unable to get it because of lack of assets. If this is true, then they would have an incentive to participate in the titling program in order to increase access to credit. Evidence in favor of this

hypothesis would support the idea that the reform will release a binding credit constraint and therefore have a positive impact on farmer investment and on agricultural production.

The following model, based on work by G. Feder and D. Feeny, shows how credit supply constraints—in the form of collateral requirements—affect farmer's input and output decisions.[32] The model is used to generate hypotheses about the circumstances under which an increase in a farmer's available collateral would lead to an increase in expected utility. In the model, farmers allocate resources between risky agricultural production (f) and riskless saving (A) to maximize the expected utility of income (Y). Production is a function of capital (K^f) whose rental price is set equal to one. Credit (B) is available at interest rate r; however, collateral is required. Farmers are endowed with cash reserves (A_0) and physical capital (K_0). The physical capital endowment is divided between collateralizable capital (K') and uncollateralizable capital ($K_0 - K'$).

Risk to agricultural income is represented by θ, which is assumed to have a mean value of one and a finite variance. Farmers face both a cash constraint, which says that capital inputs must be purchased before income from agricultural production is realized, and the collateral constraint, which says that borrowing cannot exceed the value of mortgageable assets.

In addition there is a transaction cost (ϕ), which has the effect of driving a wedge between the market interest rate and the effective rate paid by agents at the local level. The transaction cost represents the fact that there are many costs associated with getting a loan, such as lost work time and travel time. A potential borrower must often make multiple trips, not only to the bank but also to other offices such as the local government records archive or the notary public. In developing countries, these types of transaction costs can be significant, and they have the effect of raising the real cost of borrowing above the interest rate.

The model can be written as:

$$\max_{(K^f, A, B)} EU(Y), \tag{1}$$

subject to:

$$Y = \theta P^f f(K^f) - K^f + K_0 + A - (1 + r\phi)B, \tag{2}$$

$$K^f + A \leq K_0 + B + A_0 (\text{cash constraint}), \tag{3}$$

and

$$B \leq P^k K' (\text{collateral contraint}). \tag{4}$$

Expressions P^f, P^k are relative prices for agricultural output and capital. All capital has the same price, whether or not it is possible to collateral-

ize it, since the ability to collateralize capital is not associated with its productivity. Again, r is the interest rate at which farmers can borrow money from banks, and the rental rate of capital is the numeraire. The parameter ϕ is assumed to be greater than one, and it is also assumed that both the utility function and the production function are concave, that is, U' and $f' > 0$, and U'' and $f'' < 0$.

This model explicitly shows how borrowing affects agricultural production decisions and expected utility and how mortgageable assets affect borrowing. If the collateral constraint is binding, that is, at the optimum, $B = P^k K'$, then an increase in the percentage of total mortgageable assets (K') leads to an increase in borrowing (B), that is, $\partial B/\partial K' > 0$. The borrowed money is then invested in agricultural production, leading to higher expected output, income, and utility.

The model can also be used to derive relationships between borrowing and other parameters. In particular, it can be shown that if the collateral constraint binds, then $\partial B/\partial A_0 = \partial B/\partial \phi = 0$. Marginal changes in the value of initial wealth (A_0) or the transactions costs of obtaining credit (ϕ) would not affect borrowing (B). This is to be expected, since when the collateral constraint binds, the shadow price of credit is higher than the effective interest rate paid by the farmer ($r\phi$). Changes in wealth or transaction costs might affect the shadow price but would not affect the observed quantity borrowed.

If the collateral constraint is not binding, then clearly $\partial B/\partial K' = 0$. Changes in the percentage of mortgageable assets would have no effect on borrowing because the demand for credit is not a function of such assets. In this case, it can also be shown that $\partial B/\partial A_0 < 0$ and $\partial B/\partial \phi < 0$. An increase in initial wealth decreases borrowing because farmers prefer to finance production out of savings to reduce both cost and risk exposure. An increase in the transaction cost parameter (ϕ) decreases borrowing because it has the same effect as an increase in the interest rate.

If Mexican farmers are currently rationed in their use of credit, then possession of a land title, which essentially increases K', would increase their borrowing and their expected utility. Therefore, they would be expected to complete PROCEDE. If, on the other hand, they are not currently constrained in their credit use by lack of collateral, then a land title may not increase their expected utility, and they would not have an economic incentive to complete the program. In Section V, I analyze data from the first 4 years of the land titling program to determine whether there is evidence of a relationship between the asset value of land and program completion.

V. Analysis of Participation in the Land Titling Program

A. Empirical Model and Data

Existence of a binding credit constraint would imply a positive relationship between mortgageable landholding and program participation. In

principle, the voluntary nature of the PROCEDE program and the diversity of land holdings within *ejidos* makes this hypothesis empirically testable. In some *ejidos,* farmers have individual, arable parcels, while in others they have access to a communal pasture, forest land, or a share in one of the few remaining collective *ejidos.* If the incentive to participate comes from the desire to increase access to credit, then we would expect farmers with individual plots, which are the most mortgageable, to have participation rates that are higher than those of other farmers, other things being equal. Since the time and administrative costs of completing the program are essentially fixed, we would expect farm size to be positively correlated with participation.[33] From the perspective of an individual farmer, the transaction costs of dealing with lenders are also essentially fixed, which also would imply a positive relationship between farm size and the value of a title.

I can test for such a relationship using data on PROCEDE participation and *ejido* characteristics. Ideally, data would be available on individual *ejidatarios* and on how they voted on the issue of PROCEDE participation. All that can be observed, however, is the outcome of the *ejido*-level vote, not how each member voted. The office of PROCEDE maintains data on participation of *ejidos* in the process, and these are the data on which the dependent variable, PROCEDE participation, is based.

A further level of aggregation is added in order to obtain data on explanatory variables. The National *Ejidal* Census only reports data on *ejido* characteristics at the *municipio,* or county, level. Therefore, in order to do the analysis, *ejido*-level data on PROCEDE participation are aggregated to the county level, resulting in a dependent variable that is the percentage of *ejidos* in the *municipio* that are participating in PROCEDE. Independent variables on *ejido* characteristics—the vector $\mathbf{x}_i$ in the empirical model—are the average values of the variables for *ejidos* in the county.

Whenever data are aggregated, information and precision are inevitably lost. Of particular importance in this case is that aggregation masks the internal dynamics of the *ejido*'s group decision making and voting process. Understanding these internal dynamics would be interesting, and in some cases they are undoubtedly critical in explaining how the ultimate decisions are made.[34] However, as long as the internal organizational characteristics of the *ejido* are random and not correlated with any of the variables in the statistical model, failure to account for them will not bias the results of the analysis. I made specific attempts to control for possible aggregation bias and discussed them with the definition of variables and the results of the estimation.

In the following analysis, the dependent variable (P_i) is the percentage of *ejidos* in a *municipio* that is actively participating in PROCEDE, where i denotes the *municipio.* Actively participating is defined as having completed all program requirements but not necessarily having re-

ceived the title, which could be delayed for bureaucratic reasons. I chose this measure because while it is conceptually useful to think of the vote of the *ejido* to join the process as the most significant choice, in practice the vast majority of *ejidos* vote to join, while a much smaller number actually do what is necessary to obtain titles.[35] Defining participation as completing the program requirements is intended to capture only those *ejidos* that are truly participating with a serious intention to obtain a title.

The data come from the November 1995 report on the progress of the PROCEDE program.[36] The office of PROCEDE maintains statistics on the progress of *ejidos* through the process, noting which *ejidos* have been contacted by PROCEDE, how they had voted on the question of participation, and where they were in the process. Getting *ejidos* through PROCEDE was a high priority for the government, and a significant effort was made to expedite the process. At the national level, in just over a year, more than 95% of *ejidos* had been contacted, and a third had already received titles.[37] By late 1995, the program had been in operation for almost 2 years, sufficient time for *ejidos* interested in titles to complete the requirements. Again, because I want to identify *ejidos* that had real demand for titles, it is appropriate to focus on those that completed the process in a timely manner.[38]

The empirical model is essentially a linear probability model, in which the probability that an *ejido* in a given *municipio* participates in PROCEDE is explained by the characteristics of *ejidos* in the *municipio*. This model can be estimated using the minimum logit χ^2 method, whose estimators have been shown to have the same properties as the maximum likelihood estimators.[39]

If P_i estimates the true population parameter $\pi_i = F(\beta'\mathbf{x}_i)$, then $P_i = F(\beta'\mathbf{x}_i) + \epsilon_i$. If F is the logistic distribution, then taking the inverse yields the log odds ratio, $\ln [P_i/(1 - P_i)] = \beta'\mathbf{x}_i + u_i$, where $E[u_i] = 0$ and $\mathrm{Var}\ [u_i] = 1/n_i P_i(1 - P_i)$, which can be estimated using weighted least squares.[40] The results of this regression will be coefficients measuring the relationship between the levels of $\mathbf{x}_i$ and the log of the odds ratio, which is equal in terms of signs and significance to the relationship between $\mathbf{x}_i$ and P_i.

Table 1 compares the average values of the independent and dependent variables for the two states chosen for the analysis, Sonora and Chiapas.[41] I selected these states because they are important agricultural states for which data were available. Sonora, which borders Arizona, is an arid state where cattle ranching and irrigated crop production predominate.[42] *Ejido* lands largely consist of rangelands and irrigated crop land. By contrast, in the southern state of Chiapas most of the land is rain-fed, and there is significantly more forested area; 80% of crop land is devoted to basic grains, in particular, to corn.[43] Sonora and Chiapas reflect the diversity of Mexican *ejido* agriculture and land use and, therefore, form an appropriate sample for this empirical analysis.

TABLE 1

CHARACTERISTICS OF *Ejidos* IN SONORA AND CHIAPAS

Variable	Sonora[a]	Chiapas[a]
Number of *ejidos* in state	890	2,072
All state land that is in *ejidos* (%)	31	42
Average number of *ejidos* per *municipio*	13	19
Average number of members per *ejido* (AVSIZM)	101	133
Average hectares per *ejido*	10,946	1,791
Average hectares per member	120	15
Average parceled hectares per member[b]	10	9
Average irrigated hectares per member (AVPRIEM)[c]	11	.21
Land that is forested (PCTBOSQ) (%)	3	11
Land that is irrigated (%)	6	2
Land in pasture (PCTPAST) (%)	87	27
Ejidos that are collective (PCTCOLL) (%)	15	0
Ejidos that report raising animals (PCTCRIA) (%)	90	99
Ejidos that have agricultural machinery (PCTEQUIP) (%)	65	32
Ejidos with basic services (PCTSER) (%)[d]	97	93
Ejidos reporting nonagricultural activity (%) (PCTNOAG)	12	31
Ejidos finished with PROCEDURE (P_i) (%)	32	15

SOURCES.—Data come from the Produraduria Agraria, *Advance del Procede a Noviembre de 1995* (Progress of PROCEDE to November 1995) (Mexico City: Office of PROCEDE, 1995); and Instituto Nacional de Estadistica, Geografia e Informacion (INEGI), "Final Results of the VII Agricultural Census" (INEGI, Aguascalientes, Ags., 1994, data file).

[a] The first three variables are for the entire state (n = 70 for Sonora and n = 111 for Chiapas). The rest of the variables are only for the sample used in the empirical analysis (n = 66 for Sonora and n = 56 for Chiapas).

[b] There are three types of ejido land: parceled, unparceled, and collective. Parceled land has been divided up for use by individuals. Unparceled land, such as pasture, is used communally. Collective land, by far the smallest of the three categories, is worked jointly by all members. Most *ejidos* contain both parceled and unparceled land.

[c] The variable is the average hectares of irrigated land per member with access to a parcel. Since not all *ejidos* have parceled land, not all *ejidatarios* have access to parceled land. The majority of irrigated land is parceled, but not all of it, the difference being the collective *ejidos*.

[d] Basic services include electricity, potable water, and access to a dirt or a paved road.

B. Results

The results of the regression of *ejido* characteristics on PROCEDE participation rates are presented in table 2. As suggested in the theoretical model, an *ejidatario*'s decision to participate will depend on two things, how much his or her mortgageable asset base can be improved by participating and how big that asset base currently is. Credit rationing would imply a positive relationship between the size of the increase in the asset base that would result from participating, and a negative relationship between existing mortgageable assets and PROCEDE.

To measure the increase in the asset base that would result from participation in PROCEDE, the variable "average amount of parceled irrigated land per member" (AVPRIEM) is used. Parceled, irrigated land

TABLE 2

RESULTS OF LOGISTIC REGRESSION ANALYSIS OF PROCEDE COMPLETION RATES

Variable	Coefficient
Average parceled hectares per member (AVPRIEM)	.001
	(.004)
Ejidos that have agricultural machinery (PCTEQUIP) (%)	−.237
	(.390)
Ejidos with services (PCTSER) (%)	4.909**
	(1.062)
Ejidos that report raising livestock (PCTCRIA) (%)	−2.686**
	(.484)
Average number of members per *ejido* (AVSIZM)	−.000
	(.002)
Ejidos reporting nonagricultural activity (PCTNONAG) (%)	1.248**
	(.549)
Land that is forested (PCTBOSQ) (%)	−2.791*
	(1.608)
Dummy variable (STATE)	−.444*
	(.262)
Constant	−2.446**
	(.720)
R^2	.58
N	109
Durbin-Watson test statistic	2.15[a]
White test statistic	−3.2[b]

NOTE.—Standard errors are in parentheses.

[a] Does not fall within the inconclusive region of 1.484 to 1.874, so there is no evidence of multicollinearity.

[b] Critical value for χ^2 (8) = 16.92, so homoscedasticity is not rejected.

* Significant at a level of .10.

** Significant at a level of .05.

per member was chosen as the most appropriate measure of the change in mortgageable assets that would come with participation, since in practice it is much more likely that irrigated land will be used as collateral for a loan than rain-fed land. Banks are more likely to loan money for irrigated agriculture, and farmers with irrigated land are more likely to want bank credit. Another reason for using irrigated land per member as a measure of the benefit of participation at the level of the *ejido* is that irrigated land is often more evenly distributed within the *ejido* than is rain-fed land.[44] As reported in table 2, the average amount of parceled, irrigated land per member was not significantly related to participation in PROCEDE.[45]

In order to control for the fact that, ceteris paribus, *ejidatarios* who already have high levels of mortgageable assets have less incentive to participate in PROCEDE than do *ejidatarios* with low asset levels, I also included in the analysis a measure of agricultural machinery ownership in the *ejido*. The agricultural census reports the percentage of *ejidos* in each *municipio* that have agricultural machinery. While this definition of

the variable has some shortcomings—for example, it cannot distinguish between different types of machinery, nor can it recognize differential access within *ejidos*—the importance of machinery as collateral justifies its use in the analysis. Agricultural machinery is one of the most widely used forms of collateral among *ejido* farmers.[46]

The regression analysis also fails to find a significant relationship between machinery ownership and PROCEDE participation. Taken together, the lack of significance of both the irrigated land and machinery ownership variables suggests that neither existing nor expected future asset levels played a role in the PROCEDE participation decision. This result does not support the hypothesis that *ejidatarios* faced widespread credit rationing prior to the implementation of PROCEDE.

The variable PCTSER, the percentage of *ejidos* with basic services such as electricity, potable water, and access to paved or graded dirt roads, was included as a measure of transactions costs associated with engaging in economic activity outside the community. The variable PCTSER, the inverse of ϕ in the economic model, should not affect the demand for credit or for a land title if farmers' credit is rationed. In this analysis, PCTSER is positively and significantly associated with finishing the program. This suggests that higher accessibility (lower transaction costs) does affect the demand for credit, which is what would be expected in the absence of credit rationing. Lower transaction costs might also increase the amount a lender is willing to lend to a farmer, which would have the same effect on the participation decision.

The percentage of *ejidos* with livestock (PCTCRIA) is taken as a measure of liquid assets, denoted as A_0 in the theoretical model. The selection of this variable is based on the fact that households without access to savings institutions often hold livestock because it is a relatively liquid asset whose price is unlikely to be strongly correlated with local crop or land prices.[47] The coefficient on PCTCRIA is negative and significant, which is what theory would predict in the absence of credit rationing.

In addition to the variables suggested by the model, other variables were included in recognition of the fact that the real choice faced by *ejidos* is more complex than that posited in the theoretical model. The average number of members per *ejido* (AVSIZM) was included as a measure of internal administrative and transaction costs associated with completing the program, the assumption being that fewer members would result in lower costs.[48] Smaller average size was not significantly associated with higher completion rates, nor were other measures of internal transaction costs, such as the average number of membership associations within an *ejido*.

The percentages of area in collective *ejidos* (PCTCOLL) was included to control for the fact that these *ejidos*, which are often characterized by highly mechanized, irrigated agriculture in the northern states,

face a different process under PROCEDE and therefore it is likely that is takes them much longer to complete the process. Collective *ejidos* were jointly owned and managed collectively, so individual property rights were never assigned. Unlike in *ejidos* with parceled land, titling collective *ejidos* is not simply a process of confirming existing rights. The variable PCTCOLL is negatively and significantly associated with participation in PROCEDE, which is to be expected. Similarly, the percentage of forested area in an *ejido* (PCTBOSQ) is also negatively associated with participation.

I included the percentage of *ejidos* reporting nonagricultural activity (PCTNONAG) to control for the increasing demand for land for nonagricultural purposes. The risks and returns associated with nonagricultural investments are likely to be very different from those associated with agricultural investments, which are the primary focus of the reform and, therefore, of this analysis. As expected, *ejidos* with higher amounts of nonagricultural activities were more likely to participate.

Finally, I included a dummy variable (STATE = 1 for Chiapas) to capture any systematic differences between the two states, which were not accounted for by the other regressors. The variable STATE is significantly negatively associated with participation. *Ejidos* in Chiapas are less likely to participate than *ejidos* in Sonora.

VI. Summary and Conclusions

Overall, this analysis does not support the hypothesis that *ejido* farmers in Mexico face asset-based rationing in formal credit markets. If the primary motivation for participation in PROCEDE was to gain access to collateralized credit, then we would have expected to see relationships between *ejido* assets and participation. Specifically, we would expect to see a negative relationship between existing assets and participation, and a positive relationship between mortgageable assets to be gained through participation in PROCEDE. Controlling for other factors, these relationships were not confirmed by the data. This would imply that, by itself, the PROCEDE program is unlikely to achieve its goals of increasing the capital intensity and productivity of *ejido* agriculture. To the extent that PROCEDE resolves once and for all any boundary disputes or tenure insecurities within or between *ejidos*, it could have a positive impact on production. However, PROCEDE does not appear to release a binding constraint on capital access and, therefore, may not have a significant direct impact on farmers' decisions regarding credit and capital use.

The main implication of this analysis for policy, both in Mexico and elsewhere, is that lack of collateral and credit may not be the cause of the low capital use and low productivity often observed among farmers in developing countries. Increasing investment and output may require improving the productivity of agriculture through support of basic crop and production system research. The results also suggest that input and

investment demand could also be increased by reducing the impact of risk and transaction costs on expected income from agriculture. Public investment in rural infrastructure may be one way to reduce transaction costs associated with participation in the formal credit market. Improved infrastructure would also benefit rural residents in other ways and is generally considered to be a sound use of scarce public resources. Reduction of risk is more problematic, as the poor performance of many public insurance schemes has demonstrated.[49]

Before advocating government intervention in formal insurance and financial markets, it is also worth examining other ways though which small farmers get access to capital. Recent research in the area of rural factor markets has demonstrated not only that publicly administered programs are likely to suffer from severe incentive problems but also that rural residents can and do develop their own arrangements for overcoming the market imperfections they face.[50] Informal lenders may offer higher interest rates, but the flexibility and low transaction costs of their terms are often appealing to farmers.

Indeed, preliminary evidence from Mexico suggests that farmers with farms of all sizes are responding to the recent economic liberalization policies, increasing their production and incomes as a result.[51] This would suggest that farmers are sensitive to the incentives offered by market liberalization and that the formal credit market is not the only source of capital. Therefore, policies that build on or facilitate the functioning of alternative or informal markets, for example, group lending schemes that use social pressure rather than individual collateral to ensure compliance, are likely to contribute to the increased capital intensity and productivity among small farmers and thus further the goals of the current titling program.

Notes

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1. Gershon Feder and Tongroj Onchan, "Ownership Security and Farm Investment in Thailand," *American Journal of Agricultural Economics* 69, no. 2 (1987): 311–20.

2. Michael Roth, Richard Barrows, Michael Carter, and Don Kanel, "Land Ownership Security and Farm Investment: A Comment," *American Journal of Agricultural Economics* 71, no. 1 (1989): 211–14; Michael Carter and Pedro Olinto, "Getting Institutions Right for Whom? The Wealth-Differentiated Impact of Property Rights Reform on Investment and Income in Rural Paraguay" (Madison: University of Wisconsin—Madison, Department of Agricultural Economics, 1996, mimeographed).

3. Timothy Besley, "Property Rights and Investment: Theory and Evidence from Ghana," *Journal of Political Economy* 103, no. 5 (1996): 903–37.

4. Unlike land reform programs, which redistribute land, land titling programs simply grant legal titles to current landholders. The new titles may change the type of land tenure—as in the case of the *ejidos* where land goes from communal to private—or they may simply reaffirm the existing tenure system.

5. Luis Téllez Kuenzler, "La reforma al artículo 27 y la modernización del campo" (The reform of Article 27 and the modernization of the countryside) *Examen* (April 1992).

6. Jesus C. Morret Sanchez, *Alternativas de modernización del ejido* (Alternatives for modernizing the ejido) (Mexico City: Instituto de Proposiciones Estratégicas, A.C., Editorial Diana, 1992).

7. It has been estimated that between 50% and 90% of *ejido* land in the irrigated northwest and about 35%–50% in the rain-fed areas was rented. See P. Lamartine Yates, *Mexico's Agricultural Dilemma* (Tucson: University of Arizona Press, 1981); Billie R. DeWalt and Martha W. Rees, "The End of Agrarian Reform in Mexico: Past Lessons, Future Prospects" (paper prepared for Center for U.S.-Mexican Studies, University of California, San Diego, La Jolla, 1994).

8. Yates.

9. Kuenzler.

10. Ibid.; see also Roger Paguaga, Mike von Massow, and Larry Martin, "Mexico's Agriculture" (paper prepared for International Trade Policy Directorate, Policy Branch, Agriculture Canada, by the George Morris Centre, University of Guelph, Canada, 1991).

11. For a comprehensive review of studies comparing the productivity of *ejidos* and private farms, see John Richard Heath, "Enhancing the Contribution of Land Reform to Mexican Agricultural Development," Working Paper no. WPS-285 (World Bank, Washington, D.C., 1990).

12. William C. Thiesenhusen, "Mexican Land Reform, 1934–1991: Success or Failure?" (paper presented at the Conference on the Reform of Mexican Agrarian Reform, Columbia University, New York, April 1995).

13. Kirsten Appendini, "Changing Agrarian Institutions: Interpreting the Contradictions" (paper presented at the research workshop of the *Ejido* Reform Project, Center for U.S.-Mexican Studies, University of California, San Diego, La Jolla, August 25–26, 1995).

14. Mario Bassols, ed., *Campo y ciudad en una era de transición: Problemas, tendencias y desafíos* (Countryside and city in an era of transition problems, tendencies, and challenges) (Mexico City: Universidad Autonóma Metropolitana, Unidad Iztapalapa, 1994); David Myhre, "Appropriate Agricultural Credit: A Missing Piece of Agrarian Reform in Mexico," in *Reforming Mexico's Agrarian Reform*, ed. Laura Randall (Armonk, N.Y.: Sharpe, 1996).

15. Kuenzler (n. 5 above); DeWalt and Rees.

16. *Programa de Certificación de Derechos Ejidales y Titulación de Solares Urbanos* (Program for Certification of *Ejidal* Rights and Titling of Urban Areas).

17. There are three types of *ejido* land: parceled, unparceled, and collective. Parceled land has been divided up for use by individuals. Unparceled land, such as pasture, is used communally. Collective land, by far the smallest of the three categories, is worked jointly by all members. Most *ejidos* contain both parceled and unparceled land.

18. Moises Bailón, "Reformas a la legislacion agraria, sistemas de domino regional y pueblos indios en el sur de Mexico: el caso de Oaxaca" (Reform of the agrarian legislation, regional property rights systems, and indigenous populations in the south of Mexico: The case of Oaxaca) (paper presented at the research workshop of the *Ejido* Reform Project, Center for U.S.-Mexican Studies, University of California, San Diego, La Jolla, August 25–26, 1995).

19. Gary D. Thompson and Paul N. Wilson, "*Ejido* Reforms in Mexico: Conceptual Issues and Potential Outcomes," *Land Economics* 70, no. 4 (1994): 448–65.

20. Myhre.

21. Ibid.

22. "Avances en la regulación de la tenencia de la tierra" (Advances in the regulation of land tenancy), *La Jornada* (January 8, 1997), p. 18.

23. Ibid.

24. Besley (n. 3 above).

25. Roth et al. (n. 2 above); Frank Place and Peter Hazell, "Productivity Effects of Indigenous Land Tenure Systems in Sub-Saharan Africa," *American Journal of Agricultural Economics* 75 (January 1993): 10–19.

26. Joseph E. Stiglitz and Andrew Weiss, "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71, no. 3 (1981): 393–410; Michael Carter, "Equilibrium Credit Rationing in Small Farm Agriculture," *Journal of Development Economics* 28 (1988): 83–103.

27. Hans P. Binswanger and Mark Rosenzweig, "Behavioral and Material Determinants of Production Relations in Agriculture," *Journal of Development Studies* 22, no. 3 (1986): 503–39.

28. Besley, p. 936.

29. Carter and Olinto (n. 2 above), p. 2.

30. Anjini Kochar, "An Empirical Investigation of Rationing Constraints in Rural Credit Markets in India," *Journal of Development Economics* 79, no. 3 (1997): 754–63; Gershon Feder, Lawrence Lau, Justin Lin, and Xiaopeng Luo, "The Relationship between Credit and Productivity in Chinese Agriculture: A Microeconomic Model of Disequilibrium," *American Journal of Agricultural Economics* 72, no. 5 (1990): 1151–57.

31. There is some debate over how secure *ejido* titles really were. In some *ejidos*, powerful individuals were able to appropriate additional lands at the expense of other *ejidatarios*, though this often occurred during a land transfer when legitimate heirs did not exist or had difficulty supporting their claims. In general the titles can be considered secure, at least as secure as a private title would be under similar social and political circumstances.

32. Gershon Feder and David Feeny, "The Theory of Land Tenure and Property Rights," in *The Economics of Rural Organization: Theory, Practice and Policy*, ed. Karla Hoff, Avishay Braverman, and Joseph Stiglitz (New York: Oxford University Press, 1993).

33. The costs of completing PROCEDE are essentially time costs: time spent going to meetings, documenting *ejido* membership, and working with PROCEDE officials to determine the internal and external boundaries of the *ejido*. The community must approve of the boundaries before titles can be issued.

34. A simple majority voting mechanism would imply that a simple majority of members are credit rationed. If a simple majority is not in fact the voting mechanism used, then it may not be the case that the majority of *ejidatarios* faced credit rationing. If a few *ejidatarios* feel severely rationed and the rest do not, e.g., those few may convince the others to vote for participation. Whether a minority can convince the majority actually to complete the process is another matter, however. Some of the time costs that are involved may have to be compensated by the minority interests.

35. In reality, very few *ejidos* vote to reject PROCEDE. In the sample used in this study, less than 2% voted to reject; however, many more simply never vote or vote yes and never complete the follow-up process to get titles, actions that are essentially equivalent to rejecting the process.

36. Procuraduría Agraria, *Avance del PROCEDE a Noviembre de 1995* (Progress of PROCEDE to November 1995) (Mexico City: Office of PROCEDE, 1995).

37. Bailón.

38. Another reason for using data from the early years of the program is that the voluntary nature of the program may change over time. If participation in future government programs is made contingent on possession of a PROCEDE title, the incentives for participation change dramatically.

39. William H. Greene, *Econometric Analysis* (New York: Macmillan, 1993), pp. 653–54; G. S. Maddala, *Limited Dependent Variables and Qualitative Variables in Econometrics*, Econometrics Society Monograph no. 3 (New York: Cambridge University Press, 1983), pp. 28–29.

40. In the data there are many cases where the dependent variable takes a value of zero or one. Following Greene, an ad hoc correction is used to permit calculation of the dependent variables.

41. All *ejidos* and *municipios* in the two states were included in the analysis, except those where there were significant irregularities in the data.

42. Other researchers have speculated that the large, irrigated *ejidos* in northern states such as Sonora would be the most likely focus of any privatization program because they are the most likely to respond to the incentives offered by a title. Politicians have also suggested that these *ejidos* were the main target of the privatization program.

43. Olaf Erenstein and Walter López, eds., "Taller sobre proyectos productivos para productores de maíz en el estado de Chiapas" (Workshop about productive projects for corn producers in Chiapas), Secretariat of Agriculture and Livestock, National Agrarian University, Chiapas, National Institute for Forestry and Agricultural Research, International Center for Maize and Wheat Improvement, Tuxtla Gutiérrez, Chiapas (May 4, 1995). As is well known, the implementation of agricultural reforms in Mexico coincided with an armed uprising in the state of Chiapas. This social unrest could have prevented the implementation of PROCEDE in certain parts of the country. In many of the *municipios* where the conflict was most intense, a significant discrepancy between the Instituto Nacional de Estadística, Geografía e Informática (National Institute for Statistics, Geography, and Information Systems) and PROCEDE estimates of the number of *ejidos* in the municipio. There are several reasons why this could be the case. One is that PROCEDE officials had limited access to the areas. Another is that some say that failure to fully implement the *ejidal* system in the first place in certain areas of Chiapas contributed to a sense of frustration that people felt when the *ejido* policy was ended. In order to avoid problems in the empirical analysis, *municipios* where the discrepancy was more than 20% were dropped from the sample.

44. Nancy L. Johnson, "Agricultural Organization with Imperfect Markets: An Analysis of *Ejido* Reform in Mexico" (Ph.D. diss., University of Minnesota, 1997).

45. Other measures such as "total hectares per member," "average parceled land per member," and "percentage of *ejido* land that is parceled," were also tried, and none was significant.

46. Most of this machinery was bought in the 1970s and 1980s through government programs offering low interest loans to *ejidatarios* for the purchase of tractors. Since these programs were abolished as part of the agricultural reforms of the late 1980s, it is very likely that machinery has been in *ejidatarios'* possession for some time and that machinery ownership is therefore independent of the titling program.

47. Using livestock as a measure of liquid assets could be a problem in the

empirical analysis if livestock are also used as collateral. It would not affect the conclusion that land titles are unlikely to affect borrowers' demands for credit; however, it would undermine the interpretation of that result to mean that farmers do not have a demand for collateralized credit. However, livestock are not commonly used as collateral. Their value depends on their physical condition, which can vary greatly and is especially sensitive to treatment (see Binswanger and Rosenzweig [n. 27 above]). In interviews with Mexican farmers, none reported using livestock as collateral (see Johnson).

48. It has been suggested that, by this same logic, PROCEDE officials initially focused their efforts on smaller *ejidos* in order to get them through the program as quickly as possible. Inclusion of the variable "average number of members per *ejido*" would control for this bias as well.

49. Binswanger and Rosenzweig; Duane Edward Wilcox, "Credit, Cooperatives and Politics: A Case Study of Mexico's *Ejido* Bank" (master's thesis, Cornell University, 1972).

50. Karla Hoff, "Designing Land Policies: An Overview," in Hoff, Braverman, and Stiglitz, eds.

51. Ramon Lopez, John Nash, and Julie Stanton, "Adjustment and Poverty in Mexican Agriculture: How Farmers' Wealth Affects Supply Eesponse," Policy Research Working Paper no. 1494 (World Bank, Washington, D.C., 1995).

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