Labor, Credit, and Markets: Evidence from the Philippines, 1970-2016

LABOR, CREDIT, AND MARKETS: EVIDENCE FROM THE PHILIPPINES, 1970-2016

by

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Abstract

We use panel data on rice farmers in the Central Luzon provinces of the Philippines between 1970 and 2016 to test for market completeness, following Benjamin (1992) and LaFave and Thomas (2016). We find that markets in this context are incomplete. This suggests that households rely on labor endowments for their labor demand decisions, rather than solely relying on their production technology to make production decisions. Previously, the recursion test has only been used to identify the existence of market completeness in general; however we show that it can be used to identify one market becoming complete over time. We apply the Benjamin (1992) test to investigate if credit constraints from land reform laws made credit markets incomplete. However, we do not find evidence that credit constraints from land reform laws made credit markets incomplete.

1. Introduction

The agricultural household model describes a household that is both a place of consumption and production (Singh, Squire, and Strauss (1986); deJanvry, Fafchamps, and Sadoulet (1991); Bardhan and Udry (1999)). Under conditions including market completeness, the household first maximizes farm profits like a canonical producer from standard micro-economic theory. Then, the household uses farm profits, wealth endowments, and wage income to maximize utility. The model is recursive, also called separable, when the household's production decisions are separate from the household's consumption decisions. The household's production decisions are separable from the household's consumption decisions if, at most, one market is incomplete, household labor and hired labor are perfect substitutes, and households are price takers (Singh, Squire, and Strauss (1986); Binswanger and Rosenzweig (1986); Benjamin (1992); LaFave and Thomas (2016)). Recursion holds when one market is incomplete and all other markets are complete. The household can adjust its inputs relative to the incomplete market input and maintain the marginal rate of technical substitution equal to the relative prices of inputs. When more than one market is incomplete the household's marginal rate of technical substitution is determined by its input endowments. Recent studies have found that in practice markets are often incomplete, so it is necessary to test for market completeness before assuming it is true (LaFave and Thomas (2016); LaFave, Peet, and Thomas (2020); Dillon, Brummund, and Mwabuc (2019)). The recursion test for market completeness from Benjamin (1992) is a useful and well known test for market completeness. The recursion test is used to detect when at least two markets are incomplete. The test has so far not been used to say much about the completeness of any single market. It is capable of testing for the completeness of one market.

In this paper, we study the recursion test's ability to detect one market becoming complete over time. We apply the recursion test to a panel of rice farmers in the Central Luzon provinces of the Philippines to investigate the completeness of markets. In addition, we test for the effect of land reform credit market constraints on the completeness of the agricultural

credit market of the Philippines.

We use the recursion test to identify market completeness in a long running panel of rice producing households in the Philippines. The household demographics are not significant to labor demand when markets are complete and decisions are recursive. We regress household demand for farm labor on household demographic characteristics. The significance of household demographic characteristics is measured with joint F-tests of their coefficients from the regression. This test tells us if there exists at least two incomplete markets. The recursion test can identify if there exists a market that changes from incomplete to complete. The logic is as follows: if recursion is rejected in the first period, then this implies at least two markets are incomplete. If recursion is not rejected in the second period, then this implies at most one market is incomplete. Therefore one market became complete. The test does not tell us which market became complete. But if a market becomes complete, or switches states, at the same time when constraints on a market end, then that new unconstrained market is likely the market that became complete. Land reform laws in the Philippines created credit market constraints. Markets are likely incomplete for all households while constraints exist for all households. The constraints end for some households in 1994. It is likely that markets will be complete for some households after credit constraints end. If constraints made markets incomplete, then we will reject recursion before 1994 for all households. If markets become complete after credit constraints end, then we will reject recursion after 1994 for households without constraints.

In our tests we do not detect a market becoming complete in the panel. We reject recursion in both time periods for both types of households. Without detecting one market becoming complete we do not have evidence that the constraints to credit markets resulted in market incompleteness. Although the land reform laws constrained formal credit, households may have been able to access informal credit. The credit market may have been complete as long as informal credit was available.

We reject market completeness in recursion tests on the entire panel. Joint F-tests show

that household demographics are significant factors for farm labor demand. When markets are incomplete the size and composition of the household's demographics have a significant effect on a household's demand for farm labor. We find that an additional member to the average household is associated with a 3% increase in labor demand or a 2.8 person-day increase in labor demand with respect to the average farm labor demand.

Our paper provides the first discussion in the literature about using the existing Benjamin (1992) test to identify the completeness of one market. The test requires running two tests of recursion on the same panel. Two require a large number of time periods or observations. The strength of our data is the long run horizon which may plausibly show switching market completeness of one market.

Previous tests of market completeness have found that markets are generally not complete. LaFave and Thomas (2016) use the recursion test on data from Indonesia and reject recursion and find that markets are incomplete. Their results contradict Benjamin (1992), who finds that markets are complete in Indonesia. LaFave and Thomas (2016) substantiate their contradictory results by arguing that their data is more accurate than Benjamin (1992) and that they have access to longer running data that allow them to use household fixed effects in their estimation. Dillon, Brummund, and Mwabuc (2019) use an alternative method to test for market completeness and also find that markets are not complete. According to deJanvry, Fafchamps, and Sadoulet (1991), markets fail for specific households, highlighting the need to test market completeness for sub-sets of households. Recently LaFave, Peet, and Thomas (2020) found that separation may be rejected for smaller households but not for larger households.

Other tests have been devised to find the completeness of specific markets. Dillon, Brummund, and Mwabuc (2019) devised a test for labor market incompleteness. Their test can effectively determine if credit is not a cause of labor market incompleteness. Their data did not have a precise measure of credit access so they had to rely on proxies for credit access. Without a precise measure of credit access it remains difficult to use their test to show that

credit is the cause of market incompleteness. We show that the Benjamin (1992) test can identify the completeness of one market. With additional evidence of a market's constraints it is possible to suggest a specific market that is likely the incomplete market. The shortcoming of the Benjamin (1992) test is that we can only identify if a market switched when we observe a switch in the recursive conclusion. If we do not see a switch, then our test just tests for overall market completeness.

In this thesis, we begin by describing the theory of complete markets on the agricultural household model. We then describe our data and the how key variables changed over time. In the context section we address the history of land reform in the Philippines, we highlight how land reform affected agricultural credit. The next section describes the empirical model which we will be using to detect recursion. We present the outcomes of our regression in the results section and describe the implications of our results. Our final section concludes.

2. Modeling the Agricultural Household

2.1 Under Complete Markets

The agricultural household model simultaneously models a household's consumption and production decisions. The household's decisions are recursive when farm production is separable from household consumption. We use the dynamic agricultural household model of LaFave and Thomas (2016), who in turn build on the static agricultural household model of Singh, Squire, and Strauss (1986). Households are consumers and producers: the model contains both a household utility function and a farm production function.

Following LaFave and Thomas (2016), we are agnostic about the precise form of the utility function as long as there is local-nonsatiation, the utility function is strictly increasing in at least one input, it is quasi-concave, non-decreasing, and inter-temporally separable,

$$U = E\left[\sum_{t=0}^{\infty} \beta^t u(x_{mt}, x_{ct}, l_t; a_t)\right]. \tag{1}$$

The household gains utility from goods purchased in the market, x_{mt}, goods produced on the farm, x_{ct}, and leisure, l_t. The utility function is parameterized by household characteristics, a_t. β^t is the present value discount rate.

The farm production is represented by a production function that is increasing in at least one input, quasi-concave, and non-decreasing:

$$Q_t = Q(L_t, V_t, A_t). \tag{2}$$

The inputs in the farm production function are labor, L_t, land area, A_t, and all other variable inputs, V_t. Farm labor is the sum of labor supplied by members of the household, L_t^f, and labor supplied by the labor market, L_t^h:

$$L_t = L_t^f + L_t^h. \tag{3}$$

Further, the household has a time endowment, $T(a)$, that it allocates to the activities of working on the farm, L_t^f, where it earns a shadow wage w^s; working outside the farm to earn a wage, w_t, as hired labor, L_t^m; and spending time in leisure, l_t:

$$T(a) = L_t^f + L_t^m + l_t. \tag{4}$$

The household's farm profit in any time period is farm output sales less the cost of inputs. Farm output is evaluated at a market price, p_{mt}, and farm labor, land, and variable inputs cost w_t, p_{At}, and p_{vt} per unit of input, respectively. The off-farm wage and the shadow wage are the same when the model is recursive. Since this is a dynamic model, the household's income includes a wealth stock, W_t, that could be an endowment or last period's wealth brought to the current period. The household's income in period t is:

$$Y_t = W_t + p_{ct}Q_t - w_tL_t - p_{vt}V_t - p_{At}A_t + w_tL_t^m. \tag{5}$$

The household uses its income to consume goods x_{mt} and x_{ct} and it buys leisure with the opportunity cost of lost wages. Time spent in leisure could be spent earning a wage as long as we assume the off-farm labor market is complete and the household could find as much work as they desire. The household's per-period budget constraint is thus,

$$p_{mt}x_{mt} + p_{ct}x_{ct} + w_t l_t \leq Y_t. \tag{6}$$

Combining the household's utility function and budget constraint gives the Lagrangian of the household utility maximization problem in the t^{th} time period,

$$\mathcal{L} = U(x_{mt}, x_{ct}, l_t; a) + \lambda(p_{mt}x_{mt} + p_{ct}x_{ct} + w_t l_t - Y_t). \tag{7}$$

The Lagrangian is maximized when all the first order conditions are satisfied. The first order conditions are found by taking the partial derivative of the Lagrangian with respect to its arguments and setting them to zero. For production variables, the first order conditions represent the point when farm profits will be maximized by demanding inputs until their marginal return equals their marginal cost. The farm production first order conditions are found by taking the partial derivative of the Lagrangian with respect to labor, land, and variable inputs. The first order condition for farm labor is:

$$\frac{\partial \mathcal{L}}{\partial L} = p_{mt}Q_t^L = w_t. \tag{8}$$

Q_t^L is the partial derivative of the production function with respect to labor. The first order conditions of the other production inputs take a similar form to the first order condition of labor demand.

The factor demand function of L_t may be solved directly from the first order condition of the Lagrangian with respect to labor if A_t and V_t do not appear in equation (8). Otherwise, the first order conditions of the inputs used in farm production form a set of equations that may be solved simultaneously to find the factor demand functions for each production input.

The factor demand function for farm labor is L_t^*:

$$L_t^* = L_t^*(w_t, p_{ct}, p_{A_t}, p_{V_t}). \tag{9}$$

p_{At} and p_{vt} are the prices of land and variable inputs. L^* is the profit maximizing level of labor employment. The choice of labor only depends on the price of output and the prices of inputs. L^* does not depend on the prices of consumption goods, the consumption bundle, household preferences, or the utility function. The profit maximizing condition is indifferent to whether the labor is household labor or hired when we assume that household labor is a perfect substitute for hired labor. The size of the farmer's household will not influence the amount of labor the farmer employs. Household demographic characteristics are not important to labor demand when recursion holds. The model is recursive because the household consumption decisions do not influence the household production decisions.

The reverse is not true as consumption depends on production choices through the income constraint. Greater farm profits will shift the budget constraint out and allow the household to choose a higher level of utility. To derive the utility maximizing choice of consumption and reveal the relationship between utility and farm income we take the first order conditions of the Lagrangian with respect to consumption goods, x_{mt} and x_{ct}, and leisure, l_t:

$$\frac{\partial \mathcal{L}}{\partial x_{mt}} = U^{x_{mt}} - \lambda p_{mt} = 0, \tag{10}$$

$$\frac{\partial \mathcal{L}}{\partial x_{ct}} = U^{x_{ct}} - \lambda p_{ct} = 0, \tag{11}$$

$$\frac{\partial \mathcal{L}}{\partial l_t} = U^{l_t} - \lambda w_t = 0, \tag{12}$$

The utility maximizing choice of consuming any good and leisure depends on the prices of goods and prices of leisure. Consumption choices are dependent on farm production choices

through farm profit.

Using the first order partial derivatives with respect to consumption goods and leisure we can solve for the household's Marshallian demand for leisure, l_t^*:

$$l_t^* = l_t^*(w_t, Y^*). \tag{13}$$

Y^* is the household's income after profit maximizing on the farm, $Y^* = W_t + \pi^* + w_t L_t^f + w_t L_t^m$. π^* is the maximized farm profit that occurs when labor, land, and variable inputs are each employed at a level that satisfies their respective first order conditions.

When a household (or individual therein) consumes leisure, it is done in lieu of supplying labor to their own farm and the market. The household's time endowment minus its leisure demand yields the household's labor supply function. Recalling equation (4) and substituting equation (13) into the time endowment we get,

$$T(a) = L_t^f + L_t^m + l_t^*(w_t, Y^*) \tag{14}$$

$$T(a) - L_t^f = L_t^m + l_t^*(w_t, Y^*)$$

Then we have household labor supply, L^s:

$$L^s = L_t^f + L_t^m = T(a) - l_t^*(w_t, Y^*) \tag{15}$$

The amount of leisure the household consumes is inversely related to the wage rate. As the wage goes up the household will not spend as much time on leisure because the opportunity cost of leisure time goes up with the wage. But as the household's income increases they will also want to spend more time in leisure because leisure is a normal good. Under complete markets, the household farm will hire as much labor as they need when the household's members want to consume more leisure. The amount of labor they want to hire

is the factor demand for labor, equation (9). The factor demand for labor is independent of the household's demand for leisure or any other consumption good.

Recursion holds if one market is incomplete and the other markets are complete. When one market is incomplete, the household cannot adjust its use of that input. The household can maintain the optimal marginal rate of technical substitution by adjusting its use of inputs from the complete market. Suppose that the labor market is incomplete and variable inputs markets and land markets are complete. The household can adjust its use of variable inputs and land to maintain an equality between the marginal rate of technical substitution and the relative prices of inputs (Bardhan and Udry (1999); Udry (1999); Barret (1996)).

The optimal use of production inputs can be described by the expansion path:

$$\frac{Q_t^L}{Q_t^A} = \frac{w_t}{p_{At}}. \tag{16}$$

Let the labor market be incomplete so that hired labor is fixed at $\bar{L^h}$. The labor available to the farm is $\bar{L}_t = L_t^f + \bar{L_t^h}$. Due to the incomplete market the marginal product of labor is limited to $\bar{Q_t^L}$. If the land market is complete, then the household can adjust its land holdings such that the ratio of the marginal product of land and the marginal product of labor is equal to the price ratio. All households with the same production technology will employ the same ratio of land and labor. A household's labor endowment would not determine the ratio of labor use and land use.

2.2 Labor Demand Under Constrained Hired Labor

When multiple markets are incomplete, the household's decisions about production and consumption are no longer separable. Households cannot adjust production inputs so that the marginal rate of technical substitution is equal relative prices. The ratio of inputs, in this case, depends on the household's input endowments. Households with the same production technology will have different labor demand according to their individual labor and land endowments.

One way for multiple markets to be incomplete is if a limit on the amount of hireable non-household farm labor exists, such that $L_t^h = \bar{L_t^h}$, and for a land market to not exist. Dillon, Brummund, and Mwabuc (2019) describe that a limit on the amount of hired labor can arise if the farmer has a liquidity constraint so there is an upper limit on the amount of labor that can be hired. A complete credit market would allow farmers with liquidity constraints to take out credit to finance the hiring of labor. In an incomplete credit market, a farmer's liquidity constraint would become binding.

The farm household faces a hiring constraint if labor demand L^* at wage w_t is greater than the household's labor supply to the farm L^f and $\bar{L_t^h}$:

$$L_t^*(w_t, p_{ct}, p_{At}, p_{vt}) > \bar{L_t^h} + L_t^f. \tag{17}$$

The household cannot meet its labor demand by employing more hired labor because hired labor is constrained. The household must meet its demand for labor by applying more household labor.

We can derive an expression for household labor supply to the farm by re-writing equation (14):

$$L_t^f = T(a) - L_t^m - l_t^*(w_t, Y^*). \tag{18}$$

The household's labor supply to the farm will increase if the household's labor endowment increases. At the wage rate, w_t, the household is not supplying enough labor to the farm to meet the demand for labor. A higher on-farm shadow wage will reduce the household's leisure demand and the labor supplied to the market. And, the household's labor supply to the farm will increase if the leisure the household consumes and the hours spent working off-farm fall. At the same time labor demand falls because labor is more expensive at the new shadow wage.

The farmer is now paying the shadow wage for household labor demand so that we have,

$$L_t^*(w_t^s, w_t, p_{ct}, p_{At}, p_{vt}) = \bar{L} + L_t^f(w_t^s). \tag{19}$$

The shadow wage will increase until the marginal product of household farm labor is equal to the marginal utility of leisure (Binswanger and Rosenzweig (1986)). Since the shadow wage depends on the household's preferences for leisure, and the shadow wage is a factor of labor demand, the household's labor demand depends on its preferences for leisure. Additionally, the household's labor supply depends on the household's labor endowment which depends on the household's demographics and size, parameterized by a_t. The production function is not separable from the utility function. The

3. Data

Our data come from a panel of rice-producing households from the central provinces of the largest island in the Philippine archipelago. The provinces are Bulacan, Nueva Ecija, Pampanga, Tarlac, Pangasinan, and La Union. The data was collected by the International Rice Research Institute (IRRI) between 1966 to 2016 in what is known as the Loop Survey. The dataset is called the Loop Survey because the sampling method was to select respondents if they cultivated a rice field laying adjacent to a distance marker along one of the main highways on the island running in a loop. The study was not at first conceived as a longitudinal survey. It was initially designed to elicit information about mechanization in rice production (Moya et al. (2015)). When a follow-up survey was conducted in 1970 the data became longitudinal so that changes in rice farming could be observed over time. At that time, a demographic section was added. As a result, we do not use data from 1966 or 1967 because it does not have data for the demographics of the household.

In total, 207 rice-producing households were surveyed; however, the number of households surveyed each year fluctuated from 15 households during the dry season of 1975 to 148 in the wet season of 1979. In the early years of the sample, dry season farming was not widely

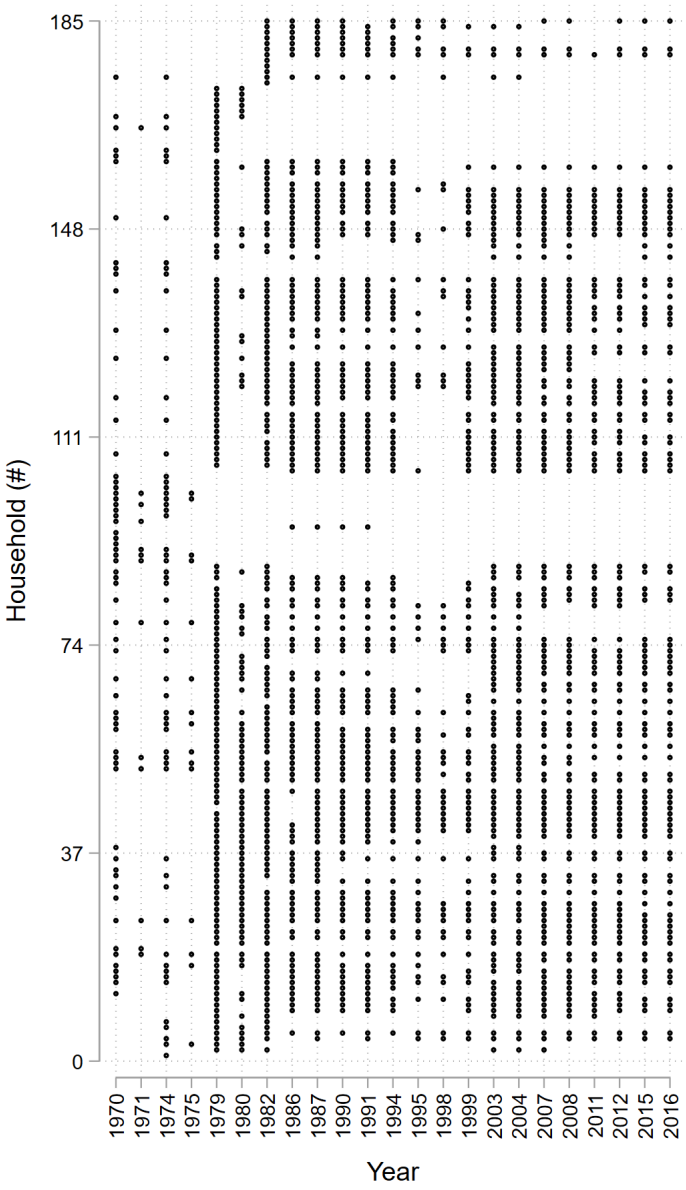
practiced. As such not every household appears in every year of the panel. The number of respondents fluctuated at times because of sample attrition when households moved or declined to be re-interviewed. New households were added to the survey to replace the lost households and increase the number of respondents. When a farm changed hands, the new farmer was asked to be included in the survey. Every effort was made to contact the previous cultivator of the field who moved. When surveyors could not trace the household or the household declined to be re-interviewed they sampled new participants. Unfortunately, the data does not include how many households declined to be interviewed or re-interviewed so we cannot calculate the response rate. We calculate a 53% recontact rate between 1970 and 1986, a 34% recontact rate between 1970 and 1999, and a 31% recontact rate between 1970 and 2016. [1] More households were added to the survey in 1979. We calculate a recontact rate of 65% between 1979 and 1990, and a 58% recontact rate between 1979 and 2016. These recontact rates are not excluding deaths, and it is possible that some of the attrition is due to death - our data does not measure deaths.

Our data contains 14 observations that are households that only appear once in the data, they are thus singletons in a regression with household fixed effects. There are 543 observations that are the only household in a village at a certain time, they are singletons in a regression with village-time fixed effects. Singleton observations are dropped in a fixed effect regression. The dry seasons in the early years have fewer observations than the wet season during the early years of the survey. That increases the likelihood that we have an observation that is the sole household in a village for a specific year. Figure 1 plots the years each household appears in the data. Each integer on the Y-axis is a unique household identification number. Each circle represents a household that appears in the data for that particular year. Notice, 1971 and 1975 are both sparsely populated with households, those are dry season interviews when very few households cultivated during the dry season.

The surveys were conducted every five years at the end of both the wet season and the

[1] Equation for recontact rate: $\frac{\text{Number of the same Households which appear in 1970 and 2016}}{\text{Number of Households in survey year 1970}}$

Figure 1: When Households Appear in the Data



Note: Circles represent a household that appears in the data for that particular year.

dry season for each survey round. The wet season in Central Luzon runs from May/June to October. The dry season runs from November to March/April. Households were asked questions about rice production in interviews during both the dry season and the wet season but only asked demographic questions in one of the seasons. The production data is at the plot level. The survey divided production into separate activities such as planting, harvesting, and fertilizing. For each task, respondents were asked how many person-days of labor were supplied from different sources, the cost of labor, and their use of inputs like fertilizer and pesticide. All of these questions were elicited with respect to a single plot so that for each plot it is known how many days of labor was applied. We aggregate the plot level data to the household level so that it could be matched to the demographic data that is at the household level.

The demographic data was not collected during both the dry season and the wet season in the early years. Demographic data was collected in both seasons in later panel years. Our model requires demographic data and production data from the same time period. In survey rounds where demographics were only collected in one season we matched the demographics to the production data in both seasons. This was done to avoid dropping production data from agricultural seasons which did not have demographic data. [2]

The demographic section collected each individual household member's age, sex, education, and other demographic basics. The definition of a household member changed several times in the panel. From 1970 to 1982, a household member was a member of the farmer's family who regularly lived at the farm. In 1986, the definition of a household member changed to include family members not living in the farmer's house and family members regularly living at the farm. After 2008, the survey changed the definition of a household member again to be a family member or non-family member living permanently in the house

[2]We tested if our results were sensitive to this assumption by estimating the main specification with (1) data that only includes rounds of interviews where demographic data and production data were collected during the same season and (2) data where we match demographic data to both seasons of production data. The results are presented in the appendix table A1. We find that the results and the significance did not change and that rough or precise matching demographic data did not affect our results.

and taking food from the same kitchen.

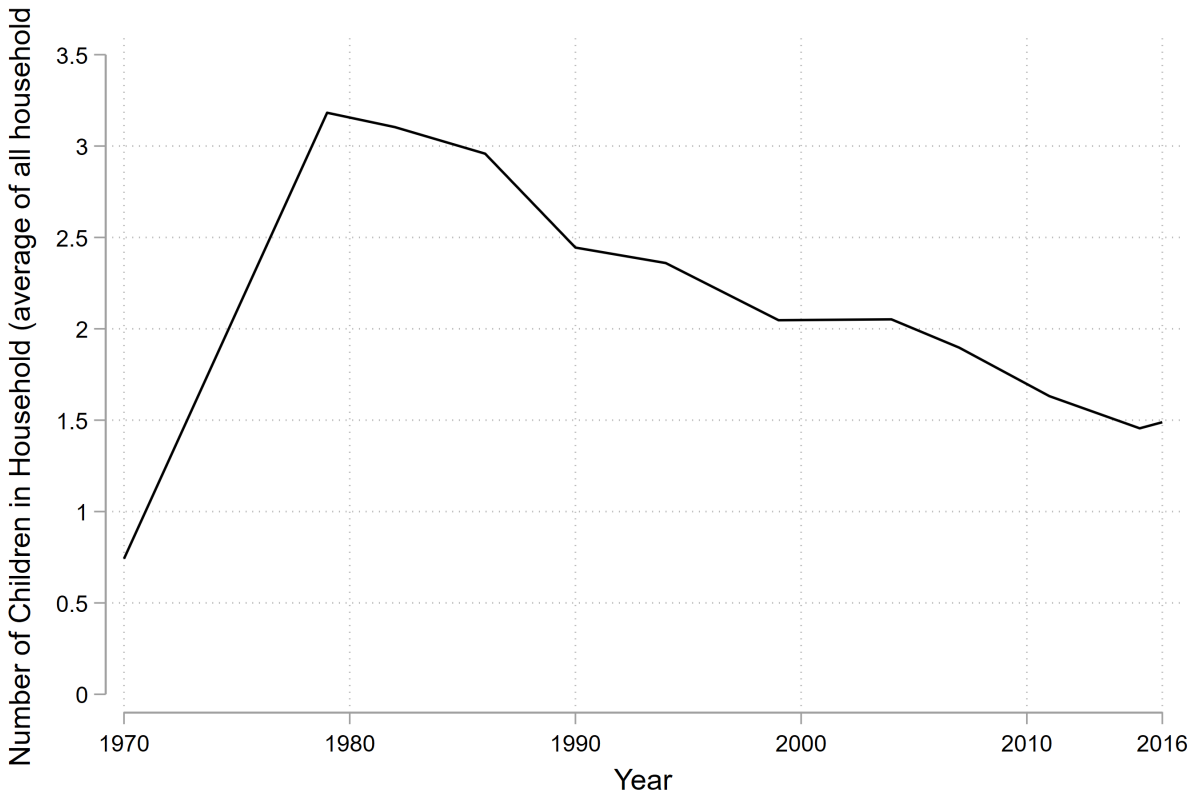
Table 1 present household demographic characteristic summary statistics. The means and standard deviations of important variables are reported separately for the first year, the last year, and all years together. The size of the average farm fell slightly from 2.48 hectares to 2.14 hectares. Land ownership increased, the share of households who own a parcel of land increased from 10% in 1970/71 to 50% in 2015/2016. This increase is driven by land reform which encouraged shareholder and tenant farmers to purchase land to become land owners.

Following LaFave and Thomas (2016) and Benjamin (1992) the main variables of interest in the recursion test are household demographics. Household demographic variables are counts of the number of male and female household members in these age brackets: 0-14 years, 15-19 years, 20-34, 35-49, 50-64, and 65 and older. In total, we have 12 demographic variables, a variable for each male and female age bracket.

The average household size increased between 1970/71 to 2015/2016 from 2.54 members to 4.77 members. This increase was driven by more children in the household in later years. We plot the average number of children in Figure 2. The average number of children per household increases dramatically between 1970 and 1979, from an average there were 0.5 children on average per household in 1970 to over three children on average per household. After 1979 and until the end of the panel, the average number of children per household falls steadily to one and a half children per household on average in 2016. The average number of children in 2016 is still higher than the average number of children in 1970. The increase in the number of children between 1970 and 2016 accounts for some of the increase in household size over that time period.

The older than 50 age group increased for both genders between 1970/71 and 2015/16. That is a sign that households experienced life expectancy gains over the study period. Increases in the average number of people in the older age group also accounts for some of the growth in family size over time.

Figure 2: Average Number of Children in a Household



Note: Line represent the average number of children for all households in a year. Children are household members younger than 19.

Table 1: Summary Statistics of Household Characteristics

	1970/71		2015/16		All years	
	Mean	St.dev	Mean	St.dev	Mean	St.dev
Number of males age [. . .]						
0 to 14 years	0.187	0.562	0.589	0.870	0.786	1.020
15 to 19	0.347	0.688	0.122	0.328	0.345	0.618
20 to 34	0.480	0.665	0.583	0.804	0.719	0.878
35 to 49	0.467	0.502	0.406	0.515	0.420	0.526
50 to 64	0.293	0.458	0.400	0.555	0.352	0.488
65 and older	0.147	0.356	0.267	0.443	0.222	0.418
Number of females age [. . .]						
0 to 14 years	0.0800	0.395	0.611	0.835	0.782	0.994
15 to 19	0.120	0.434	0.150	0.373	0.282	0.544
20 to 34	0.107	0.352	0.489	0.664	0.644	0.771
35 to 49	0.240	0.430	0.406	0.515	0.403	0.516
50 to 64	0.0800	0.273	0.389	0.489	0.337	0.477
65 and older	0	0	0.361	0.482	0.209	0.415
Household size	2.547	1.663	4.772	2.171	5.501	2.468
Male household head [...]						
Age	49.71	12.55	56.55	11.78	52.41	13.84
Education	4.560	3.227	9.419	3.186	7.387	3.342
Female household head [...]						
Age	45.42	6.008	55.94	12.66	50.15	13.68
Education	3.231	3.024	9.122	3.165	7.316	3.387
Farm size (ha)	2.483	1.421	2.144	2.117	1.851	1.443
Credit's Share of Farm Expenditure	0.001	0.009	0.005	0.028	0.012	0.039

Note: Mean and standard deviation presented. Statistics are aggregated across the wet and dry season for 1970/71 and 2015/16. The wet season runs from May/June to October in 1970 and 2015 and the dry seasons runs from November to March/April of 1971 and 2016. Last two columns aggregate across all years and seasons.

The main dependent variable in the recursion test is the log of farm labor demand. We created the variable by aggregating all the labor days from all sources of labor used on a plot in a season. Then we add together the aggregate labor used on all the household's plots to get the total labor days the household demanded. We take the log of the total labor days the household demanded.

Table 2 presents the household's average labor demand and source of farm labor in the first, last and all years of the panel. Overall, the labor demanded on the farm fell over time. We test the differences between the household's labor demand in 1970 and 2016 with Mann-Whitney tests. All differences discussed in this paragraph are significant at the 99% level. Total farm labor demand decreased between 1970/71 and 2015/16 from 134.9 person-days to 80.8 person-days. At the same time farm sizes did not fall by a statistically significant amount. So the fall in labor demand was not due to the effect of smaller farms requiring less labor. The person-days supplied to the farm from hired labor have decreased significantly: in 1970 the average number of labor days supplied by hired labor was 78 and it was 48 in 2015/16. The fall in hired labor is not as dramatic when we consider hired labor accounts for roughly half the total labor used on the farm in both the first and the last years, so hired labor has not changed in its importance relative to overall labor use. Permanent labor, labor supplied by a worker who is permanently employed rather than hired seasonally, is ten times higher in 2015/16 than it was in 1970/71. It was a negligible share of total farm labor in 1970/71 and 13% of total labor in 2015/16.

Male household members supplied less labor to the farm over time. In 1970/71 they supplied 45 person-days and in 2015/16 they supplied an average of ten person-days. Household labor accounted for a third of total labor in 1970/71 and it fell to account for 12% of total labor in 2015/16. household labor is supplied mostly by male household members. The days of farm labor supplied by female household members was a third of a day in 2015/16 and no days in 1970/71. Part of the reason female household members may have supplied so little labor by comparison to male household members in 1970/71 was that there was a statisti-

cally significant sex imbalance in 1970/71. Male household members far outnumbered female household members in all categories and the difference is statistically significant at the 99% level. By 2015/16 the sex imbalance is largely corrected and there is no statistical difference in the number of males and females in every age group besides the oldest age group and the 20 to 34 age group. Gender imbalances cannot explain why female household members supply so little labor in 2015/16. In 2015/16 female household members supply more labor to the farm than they did in 1970/71 but they supply far less than male household members, despite making up an almost equal share of the household. Farm work is clearly gendered in a way that goes beyond the number of male and female household members. Since female labor is not going to the farm it must be going to either domestic work or off-farm for a wage. We cannot say where exactly it is going because we do not have non-farm labor data.

Table 2: Summary Statistics of Labor Demand

	1970/71		2015/16		All years	
	Mean	St.dev	Mean	St.dev	Mean	St.dev
Person days of [...]						
Total labor demand	134.9	94.87	80.78	67.83	110.3	81.16
Harvesting	44.54	38.25	25.21	27.23	42.88	33.37
Land preperation	26.60	19.64	16.73	15.41	19.97	17.49
Weeding, Planting, Fertilizing	63.75	47.69	38.23	38.63	47.31	43.33
Family labor supplied by [..]						
Male household members	45.38	33.38	9.844	20.64	18.10	24.47
Female household members	0	0	1.432	6.967	0.357	3.314
Labor demand from [. . .]						
Hired	78.15	71.39	47.96	48.17	77.08	64.76
Permanent Worker	0.603	3.765	10.33	18.23	4.853	13.80
Labor Exchange	9.367	17.75	1.538	5.186	4.174	8.450

Note: Mean and standard deviation presented. Statistics are aggregated across the wet and dry season for 1970/71 and 2015/16. The wet season runs from May/June to October in 1970 and 2015 and the dry seasons runs from November to March/April of 1971 and 2016. Last two columns aggregate across all years and seasons.

4. Context

4.1 A Brief History of the Philippines and Land Reform

We test market completeness on data from rice farmers on Luzon island in the Philippines. Luzon is the largest Philippine island and has the largest population out of all the Philippine islands. Luzon is also home to the capital city, Manila. The Luzon area produces rice among other crops. Rice is an important staple crop in the Philippines and it is an important feature of the Philippine agricultural industry. In 2016, agriculture accounted for 10% of Philippine GDP and employed 23% of all employed Filipinos (World Bank (2021a); World Bank (2021b)).

Philippine agricultural tenure went through structural changes in the latter half of the 20^{th} century after Philippine land reform. Until the middle of the 20^{th} century agriculture was primarily practiced through sharecropping. In the sharecropping system, landlords financed a share of the tenant's costs of production and were repaid with a share of their tenant's output. The landlord had unilateral rights to remove a tenant from their property. Under Spanish rule, 1565 to 1898, landlords accumulated large agricultural estates called haciendas and practiced sharecropping. Sharecropping continued after Spanish rule ended and American rule began in 1898. The Philippines remained a colony of the United States until 1946, except for a period of two years when it was occupied by Japan during World War II. The Philippines gained independence from the US in 1946.

The independent Philippines was governed by an elected president and elected members of two houses of congress. Elections for the president and congress were held every four years and between 1946 and 1972 there were six peaceful transitions of presidential power. The streak of peaceful transitions ended when president Ferdinand Marcos declared martial law in 1972 and ruled the country as dictator until 1986. The Marcos dictatorship was marked by gross human rights abuses, state-sponsored political violence, massive corruption, and theft of state resources that personally enriched the president, his household, and

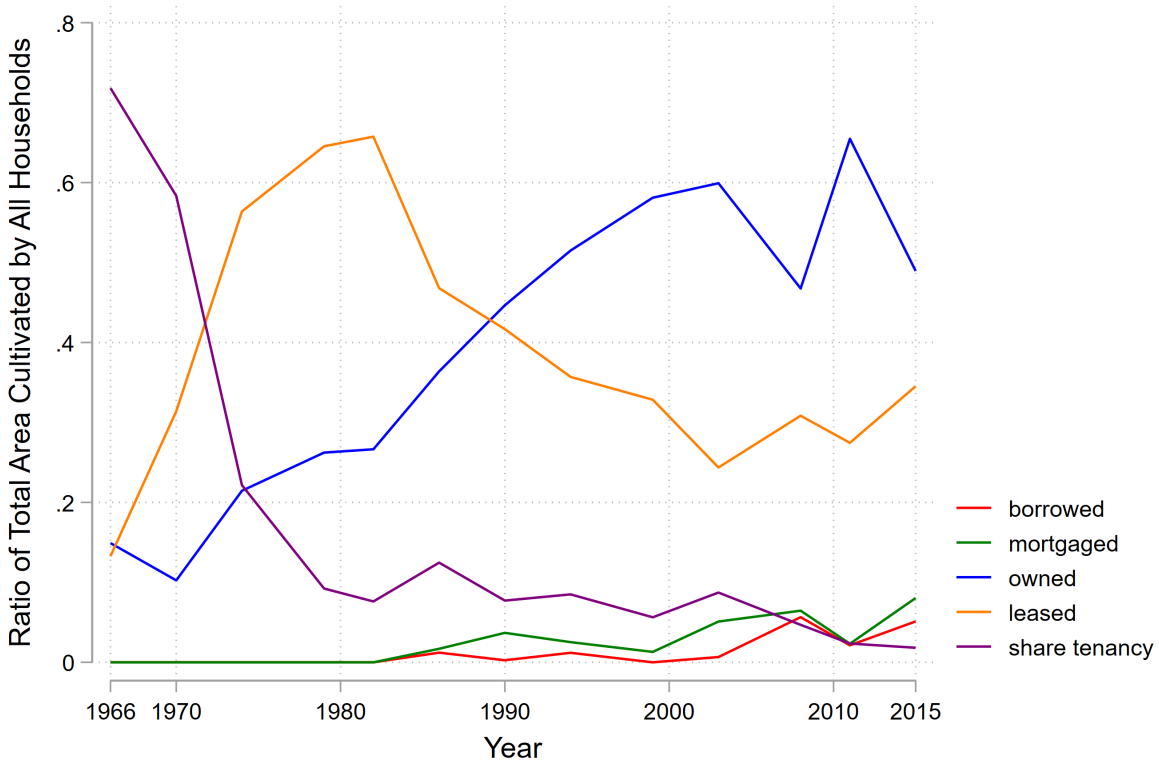
his cronies (Amnesty International (2018)). Marcos was forced from power in 1986 after intense pressure from the United States, the Philippine military, and the civilian population. Corazon Cojuangco Aquino was made president after Marcos' removal from power and her administration survived to the end of its term despite six coup attempts. Following Marcos' removal from power, the Philippines gradually returned to democratic elections and peaceful transitions of power between the outgoing and incoming administrations.

The time frame of this study, 1970 to 2016, coincides with the land reform period in Philippine history, 1963 to 2009. Between 1963 and 2016, small-scale agricultural household tenure changed from primarily landlords and sharecroppers to lease-holders and cultivator ownership. The 1963 Agricultural Reform Code sought to dismantle the sharecropping system and replace it with an owner-operated system.[3] The 1963 Agricultural Land Reform Code outlawed share-tenancy in rice and maize farming; replaced rice and maize share-tenancy with leasehold tenancy on rice and maize farms. Leasehold tenants paid a fixed rent on the land unlike share-tenants who paid their landlord a share of their output. Leasehold tenants also had a lease that guaranteed their right to cultivate their rental land. Share tenants cultivated the land at the sole pleasure of the landlord. The code also established an optional path for landless or land poor cultivators to purchase a restricted transfer title to their land. The restricted transfer title forbade the transfer of the property to anyone outside the government or the owner's family for a period of ten years after the final payment on the land purchase was made. The implementation of the code was slow at first but eventually affected most households in the panel. Figure 3 and Figure 4 plot the share of households under different land tenure arrangements throughout the sample years. In the Loop Survey, almost 70% of households were still sharecroppers in 1966. Share tenancy falls sharply over the next decade to 10% of the sample in 1980. Share tenancy never totally disappears. The dry season and the wet season follow similar trends over time.

Land reform started in earnest after 1971 when Marcos issued a presidential decree ac-

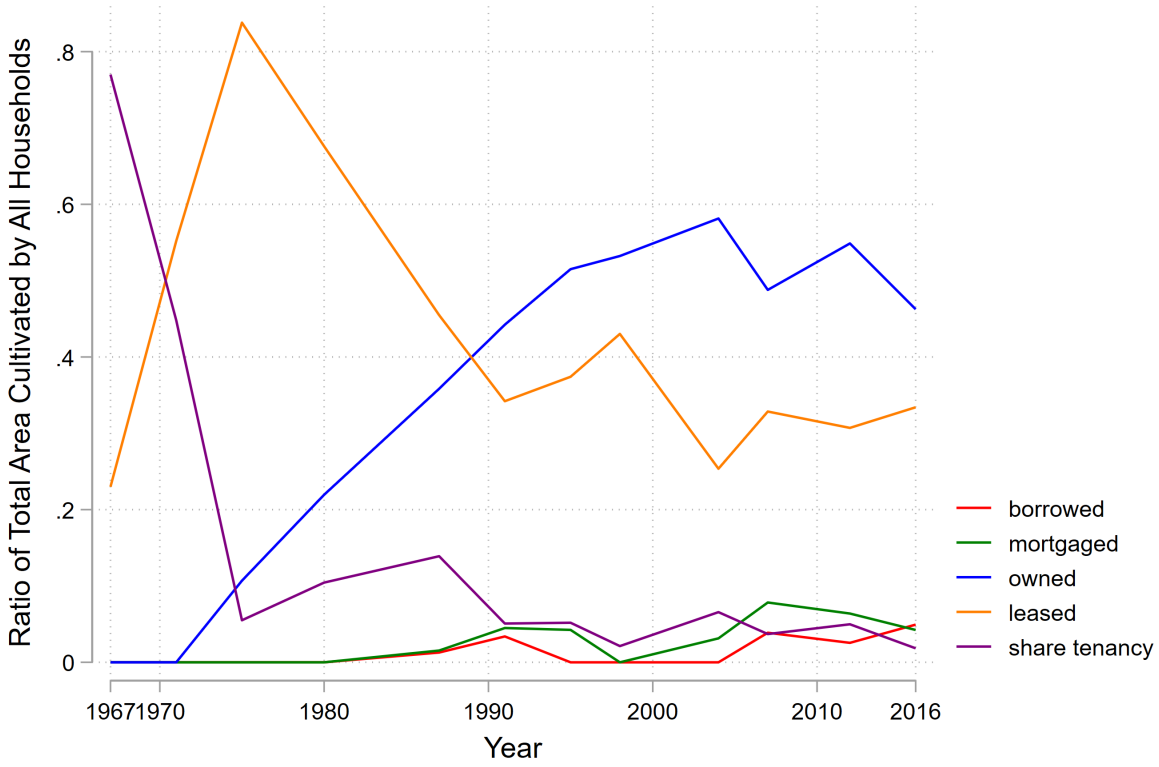
[3]Congress of the Philippines, Republic Act No. 3844, 1963, https://lawphil.net/statutes/repacts/ra1963/ra_3844_1963.html

Figure 3: Land Tenure Arrangements in Wet Season (1966 to 2015)



Note: Lines represent the area of land under different tenure arrangements over the total area of cultivated land. The sum of points in a year will not always add up to one because in the tenure of some plots was not always recorded. The wet season runs from May/June to October.

Figure 4: Land Tenure Arrangements in Dry Season (1967 to 2016)



Note: Lines represent the area of land under different tenure arrangements over the total area of cultivated land. The sum of points in a year will not always add up to one because the tenure of some plots was not always recorded. The dry season runs from November to March/April.

celerating land reform. The decree mandated all leaseholders on maize and rice farms enter into a 15 year amortization purchase of a 3-5 hectare plot from their landlord if they had not already done so and remaining sharecropping cultivators convert to leaseholders.[4] Households of the Loop Survey were predominantly beneficiaries of land reform. We can see in the data that following the decree, tenure in the Loop Survey shifts from sharecropping to lease holding. In 1978 and 1979, 10% of tenure arrangements are in sharecropping and 65% are in lease holding. Land ownership almost doubles compared to 1970 with 25% of households up from 12% (see Figure 3 and Figure 4). Land ownership increases to 50% in the mid-1980s, approximately fifteen years after Marcos' decree, and in a time frame that lines up with 15 year amortizations.

The next large pieces of land reform legislation were the 1988 Comprehensive Agrarian Reform Law (CARP) and the 2009 Comprehensive Agrarian Reform Law Extension with Reforms (CARPER). These laws expanded the types of agricultural land that were eligible for redistribution. CARP expanded who was eligible to be a beneficiary of land reform: leasers could enter into a twenty-five year amortization purchase for a land title that came with a ten year restriction of transfer.[5] CARP's main contribution to land reform was to expand the types of agriculture that were eligible for transfer. The Loop Survey households were already covered by the agricultural reform code and the presidential decree because those reforms targeted rice and maize and all of the households in the Loop Survey grow rice.

4.2 Land Reform's Effects on Small Farmer's Access to Credit

The land reform bills dismantled the traditional landlord credit. At the same time it restricted the transfer of titles. Title restrictions prevented farmers using titles as collateral for institutional loans. Prior to land reform, the role of landlords was to provide agricultural

[4]President of the Philippines, Presidential Decree No. 27, 1972, https://lawphil.net/statutes/presdecs/pd1972/pd_27_1972.html

[5]Congress of the Philippines, Republic Act No. 6657, 1988, https://www.lawphil.net/statutes/repacts/ra1988/ra_6657_1988.html

credit for tenant sharecroppers (Borras (2007)). In sharecropping, the landlord extended credit for some or all production activities and was entitled to a share of output as repayment of the loan. At the end of the season, the landlord typically claimed 50% of the output as repayment (Hayami and Kikuchi (2000)). Landlord credit was prominent enough to be regulated with legislation in the 1930s. An example being agricultural reform code of 1933 regulated the interest on landlord loans and the size of those loans (Murray (1972)).[6] In 1968 and 1969, landlords supplied 20 - 30% of loans to rice farmers (Sacay (1973)). That number understates the amount because Hayami and Kikuchi (2000) document landlords extending credit for 50% of costs associated with rice production. Some households continued in sharecropping arrangements despite its illegality and presumably, continued to have access to landlord credit. In the Loop Survey, sharecropping does not disappear completely, 5-15% of tenure arrangements are sharecropping between 1980 and 2003.

Under the land reform bills from 1963 to 2009 buyers who had finished making amortization payments were issued with land titles that came with ten year restrictions on transferring them to anyone outside the household or the government. [7] Restricted titles could also not be used to secure loans because in the case of default the title could not go to the creditor while the restriction was in place. The presidential decree of 1972 did not describe new rules for titles issued after its passage and therefore it did not upend the restricted title section of the 1963 reform code. Titles issued under CARP and CARPER were and are also subject to the ten year transfer restriction.[8] [9] The bottom line was: if a household had completed their amortization in 1971 they would not be able to offer their title as collateral to an institutional lender until 1981. A majority of households in the Loop Survey became owners of the land in the 1990s, see Figures 3 and 4. The number of households who owned the land

[6] Act No. 4054, 1933 https://laws.chanrobles.com/acts/7_acts.php?id=330

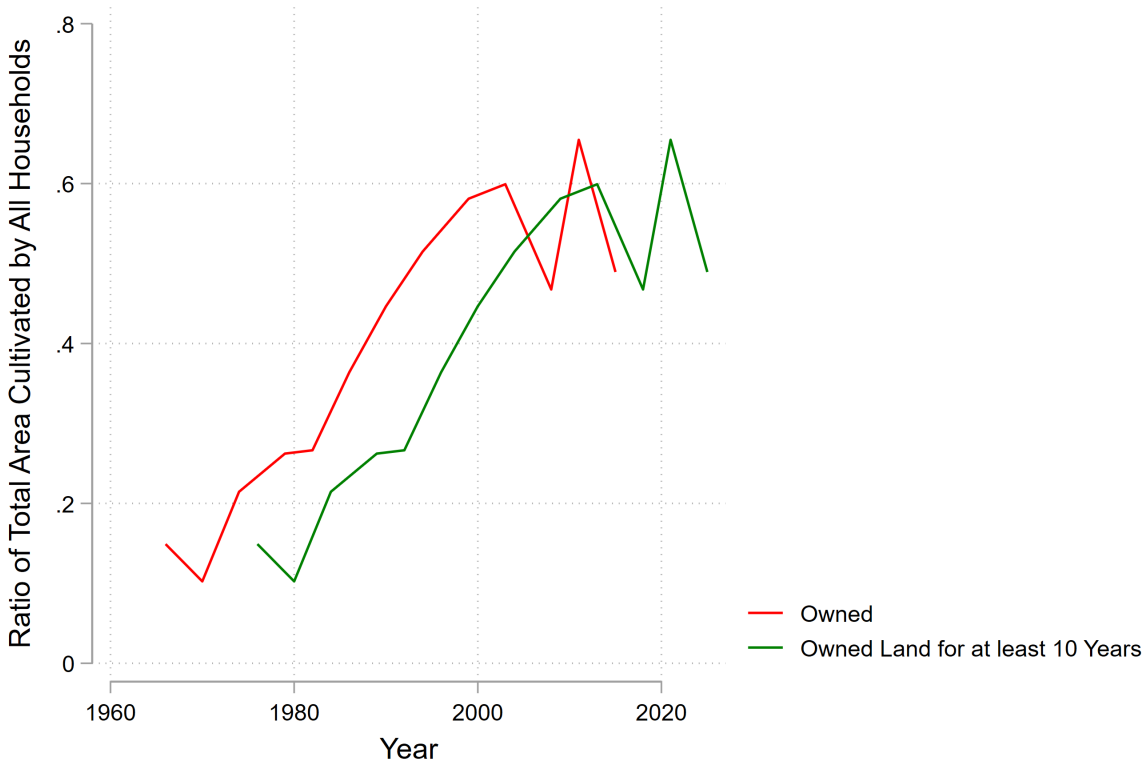
[7] Congress of the Philippines, Republic Act No. 3844, 1963, https://lawphil.net/statutes/repacts/ra1963/ra_3844_1963.html

[8] Congress of the Philippines, Republic Act No. 6657, 1988, https://www.lawphil.net/statutes/repacts/ra1988/ra_6657_1988.html

[9] Congress of the Philippines, Republic Act No. 9700, 2009, https://www.lawphil.net/statutes/repacts/ra2009/ra_9700_2009.html

longer than ten years in 1990 was less than half. Figure 5 plots the proportion of farmers who owned land for over ten years. This graph, rather than Figure 3 and Figure 4, gives an accurate representation of the number of households that could offer their title as collateral. Accounting for the restricted title clause the majority of owners were not able to offer land as collateral until the mid-2000s.

Figure 5: Ratio of Land Owned for at least 10 years: Wet Season



Note: Lines represent the area of land under different tenure arrangements over the total area of cultivated land. The wet season runs from May to November, the dry season runs from November to March/April.

Institutional agricultural lenders existed in the Philippines in the 1970s and they required collateral. A study by USAID in 1970 found that rural banks secured 80% of loans with real estate and the development bank of the Philippines had strict collateral requirements (Sacay (1973)). It is unclear how the other 20% of loans were secured.

The ten year restriction did not start counting down for beneficiaries until they had

completed amortization. Amortization could not start until the Land Authority had surveyed the land and entered into an agreement with the landlord for the price of purchase. If an agreement failed to be reached, the land authority would begin its own process of evaluating the value of the land. The Land Authority was slow to issue the documentation to eligible beneficiaries at every stage (Kerkvliet (1974); Fuwa (2000); Putzel (1992)). Administrative delays could increase the time a farmer had to wait before they could exercise their titles in an unrestricted manner. Evidence suggests that rice-producing areas such as the Central Luzon provinces received their lease-holder documentation in a timely manner (Otsuka (1991)). Many respondents in the Loop Survey considered themselves to be leaseholders and owners from as early as the 1970s. We do not know, though, if the Loop Survey households had the documentation to prove their tenure or claimed to by leaseholders while waiting for the documents to arrive.

Land reform beneficiary households could seek credit from institutional creditors by pledging a share of output as collateral, some institutional lenders might accept that. The process of collecting output collateral in the event of default is more expensive for the credit institution to administer, relative to alternatives, such as taking possession of land titles. Output collateral requires the credit institution to send representatives to the farm to accurately measure the output, and then pay to transport the output to market, and then sell the output. In order to be financially viable, the credit institution must charge a high rate of interest to finance the high transaction costs. Even farmers with titles had to pay a larger rate of interest than none agricultural or agri-industry borrowers. Surveys of financial institutions in the 1970s revealed the transaction cost as a percent of the loan was 5.5-7% for small-scale farmers compared to 1.8-2.5% for large-scale industry. To be financially viable the credit institutions must charge smallholder farms an interest between 10-14% (Saito and Villanueva (1981)). High-interest rates might explain why in the 1970s, small farmers, defined as those who tilled less than three hectares, received 1.6% of the total value of institutional credit granted (Sacay (1973)).

The government made agricultural, collateral-free credit for specific inputs available through various programs with limited success. Leaseholders could also access these loans. The primary government-funded, collateral-free, credit program of the 1970s and 1980s called "Masangana 99", gave loans only for the purchase of fertilizer and chemicals. It did not give loans to hire labor. "Masangana 99" did not reach many households overall; at its peak, it provided credit to 25% to 36% of all possible small farmers in the Philippines (Esguerra (1980); Kerkvliet (1990)).

Due to the constraints of institutional credit access, farmers largely sourced their loans from informal lenders. In the 1980s, farmer surveys on the source of their loans reported that 23% of their loans were from formal lenders. That ratio fell to 5% in the 1990s (Sacay (1973); Agabin et al. (1989); Llanto (1993); Akiyama and Larson (2004)). Moneylenders supplied informal seasonal production credit at high-interest rates. Interest rates ranged from 25% to 100% (Kerkvliet (1990); Rosegrant and Herdt (1981); Hayami and Kikuchi (2000)). Informal credit was available for consumption smoothing as well. A landlord would often extend credit to a farmer's household for food and living expenses if the harvest failed. A common way for a sharecropper to go into long-term debt to their landlord was after the landlord extended credit after a failed harvest. The farmer owed the landlord a debt for the production loan and the debt for the consumption loan.

Better-off household members were sources of agricultural production credit for farmers. Agabin et al. (1989) claim that 30% to 60% of loans were underpinned by social ties. Agabin et al. (1989) also notes that household loans were especially attractive loans because they were often low or no interest. Household members who worked for a wage outside of agriculture were able to provide liquidity to the farm. More educated household members were able to find stable jobs outside of agriculture and provide more liquidity to farming household members. Better-off households had the resources to educate their members to get off-farm wage employment.

Land sub-leasing was practiced to acquire credit but only to a limited degree because it

was illegal and violated a federal ban on sub-leasing. A sub-leasing loan was acquired by lending out cultivation rights for a loan then the lender used the land until the loan was repaid (Kerkvliet (1990)). This was a method of acquiring credit available to leasers as much as owners (Hayami and Kikuchi (2000)). Loans that reduce the farmer's access to land are not ideal for financing agriculture because they reduce the land the farmer can use for their own production.

Landlord credit was the main credit for sharecropper's production and consumption. After 1972, most households bought their land or became leaseholders and lost the option to use landlord credit. The landowners had to wait ten years from the date of their final payment on the land before they could use their title as collateral for an institutional loan. Until then, they had the same credit options as leaseholders. Their options were limited government credit or informal credit. Informal credit was not available equally. Remittance credit was only available to households with a member earning a wage. Land subleasing credit was illegal. Only money lenders were available to everyone for an exorbitant interest rate. The households facing the fewest constraints to credit were those households that had owned their land for at least ten years and could use institutional credit. There were constraints to all other types of households.

5. Empirical Model

Our empirical model follows LaFave and Thomas (2016). Their model is based on Benjamin (1992). We estimate the effect of demographic variables on the log of farm labor demand with a linear regression. The model tests for recursion by testing for the significance of demographic variables in the regression. The null hypothesis is that farm labor demand takes the same form as equation (9). Under the null, the demographic variables are statistically insignificant. Not rejecting the null implies that, at most, one market is incomplete, households are price takers, and household labor is perfectly substitutable for hired labor. Households are likely price takers because no farm operation in our sample appears

to be large enough to have market power to influence prices. If demographic variables are statistically significant, then farm labor demand resembles equation (19). The alternative hypothesis is that demographic variables have a statistically significant non-zero effect on labor demand.

Following LaFave and Thomas (2016), our model is:

$$lnL_{ict} = \alpha + \beta X_{ict} + \Omega N_{ict} + \delta_i + \gamma_{ct} + \epsilon_{ict}. \tag{20}$$

lnL_{ict} is the log of farm labor demand for household i in community c in time period t. The household demographics are N_{ict} and are represented by counts of household members in twelve gendered-age bins or the share of total household size made up by each gendered-age bin. Under the null hypothesis, Ω is zero. A set of control variables that are associated with household demographics and labor demand are included in X_{ict}. These include a household's expenditure percentile in the season, the gender of the head of the household, and the education of the head of the household. The controls may also vary with labor demand and the demographics of the household and including them accounts for potentially confounding variation between labor demand and household demographics. We are unlikely to capture all the confounding variation between lnL_{ict} and N_{ict} with controls. We include fixed effects to control for the confounding variables that the controls do not capture. We include a household fixed effect δ_i to control for unobservable, time-invariant household characteristics, such as farmer skill that potentially affect labor demand and household composition. For example, a more skilled farmer would be able to afford to rent more land that requires more labor. A skilled farmer would also be able to afford to support a larger household. Farmer skill varies with both labor demand and household characteristics. If we leave out fixed effects and farmer skill is correlated with N_{ict}, then the effect of farmer skill on labor demand will go into the error ϵ_{ict}. Then, N_{ict} is correlated with ϵ_{ict} violating a condition of an unbiased Ω. In such a long panel it is hard to say exactly what a household fixed effect measures. We include household fixed effects because unobservable household characteristics such as

farmer skill may vary slow enough over 40 years to still be considered fixed. For farmers who move locations, household fixed effects refer to any time-invariant unobserved variables that move with the farmer such as farmer skill. Community-time fixed effects γ_{ct} are included and absorb any variation affecting labor demand and household characteristics at the local level that vary with time. For example, seasonal differences between the wet season and dry season as well as local prices of inputs and outputs are captured by γ_{ct}. Standard errors are clustered at the household level, as observations of the same household are likely related to one another even if they are in different time periods.

We use joint F-tests to test for the significance of the male demographic variables, the female demographic variables, all demographic variables, and prime-age adult demographic variables. Prime-age adult demographic variables are both male and female age bins from 15 to 49 years. The null hypothesis is that all demographic variables are no zero and the household's decisions are recursive.

We test if the end of the restricted titles leads to market completeness by testing for recursion separately for households with different title restrictions. The standard recursion test does not diagnose which market is incomplete if we reject recursion. But certain outcomes of the recursion test may imply that at least one market changed states. The credit market in the Philippines is a likely market to become complete after restricted title expires. Recall land reform removed farmer's access to landlord credit, a traditional source of credit, and instituted a restricted ownership title that could not be used as collateral until the restriction expired. The restriction took ten years to expire from the date of fully paying off the purchase of the land. After the restriction expired landowning households could access formal sources of credit. The contextual evidence produces a timeline during when the credit market is incomplete and when it is complete. If that timeline matches the timeline when the recursion test tells us that a market switched states, then we can say that it is likely that one of the markets that switched states is the credit market. If we do not observe a switch in the recursive conclusion for households with an unrestricted title, then we cannot

say anything more than markets are complete or incomplete.

We pick 1994 to divide our data into two periods that we will test for recursion. In 1994 at least 50% of households had a land ownership title for at least ten years, see Figure 5, and therefore their transfer restriction had expired in 1994. After 1994 there are enough households with a restriction expired title to form a set of observations to run a recursion test on. Recursion is tested on those households between 1970 and 1991 and between 1994 to 2016. That assumption suggests that between 1970 and 2016 there were no new markets. That is a difficult case to argue because technology has changed over that time. However the green revolution changed farming markets the most because inputs changed to new seeds, fertilizer, and pesticide and the green revolution took place in the Philippines before and towards the beginning of the sample. By the time our sample starts most farmers are already using the markets associated with those new technologies. So it is possible that the number of important markets did not change.

If credit markets do switch states because of expired restrictions, then the credit market will only switch for households with an expired restriction. We do not expect credit markets to change completeness between 1970 to 1991 and 1994 to 2016 for households who do not have an unrestricted title. We, therefore, include a control test on households who did not possess an unrestricted title in 1994. It will be stronger evidence that credit markets become complete if we observe the test on the households without the restriction switching from rejecting recursion to not rejecting recursion and we observe the test on households with restriction remaining the same. The implication is that nothing changed for the second group of households after 1994.

The households without title are not a perfect control because the households with unrestricted title in 1994 are different from the households without an unrestricted title in 1994. Households with an unrestricted land title in 1994 were better off than households without an unrestricted land title. Owning an unrestricted title required making regular payments towards purchasing the land. That is a sign that the household is able to afford those pay-

ments and do so in a timely manner. These households fully paid off their land in 1984, only thirteen years after the passage of the presidential land reform decree mandating all sharecroppers in rice begin buying the land with a ten year amortization. These households purchased the land in ten to fourteen years. The results of Mann-Whitney tests are in Table 3 and Table 4. They show that households with an expired restriction are different in many way to households without an expired restriction title. It is possible that we observe a switch and it is not because of the restriction expiring but rather something else. For instance, the households with the restriction expired title are richer than the other households so their kids are better educated, and then they supply more credit back to the household. Or informal lenders see the act of paying off the amortization as a good sign that the household is a reliable debtor. All of these would mean that the credit market is less constrained for households with an expired title already. Therefore the credit market might be complete in both periods. But we have chosen the two periods we run the tests on to coincide with a particular expiration of title restrictions and any advantage in accessing credit from the expiration of the title will start after 1994. There is no reason to believe the other benefits would not be present throughout the dataset and if those are driving market completeness, then credit markets would not switch for restriction expired households around that time.

Table 3: Statistical Differences in Means of Key Variables Between Households With and Without an Expired Title restriction in 1994: Data from before 1994

	P-Value	Obs. Without Unrestricted Title	Obs. With Unrestricted Title
M: 0 to 14	0.02**	608	349
M:15 to 19	0.006***	608	349
M:20 to 34	0.232	608	349
M:35 to 49	0.391	608	349
M:50 to 64	0.015**	608	349
M: 65 and older	0.083*	608	349
F: 0 to 14	0.045**	608	349
F:15 to 19	0.038**	608	349
F:20 to 34	0.386	608	349
F:35 to 49	0.005***	608	349
F:50 to 64	0.779	608	349
F:65 and older	0.193	608	349
Ln Household Size	0.000***	608	349
Ln Labor Demand	0.758	534	308
Total Area of Land Cultivated	0.886	607	349
Age of Male Household Head	0.321	593	349
Education of Male Household Head	0.000***	593	347
Age of Female Household Head	0.898	489	257
Education of Female Household Head	0.166	489	255

Note: Comparing the means of key variables with Mann-Whitney tests. Households are split into groups according to whether they possessed an expired restriction title in 1994. The comparison is on data before 1994. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

Table 4: Statistical Differences in Means of Key Variables Between Households With and Without an Expired Title restriction in 1994: Data from after 1994

	P-Value	Obs. Without Unrestricted Title	Obs. With Unrestricted Title
M:0 to 14	0.331	681	412
M:15 to 19	0.696	681	412
M:20 to 34	0.046**	681	412
M:35 to 49	0.366	681	412
M:50 to 64	0.041**	681	412
M: 65 and older	0.081*	681	412
F:0 to 14	0.712	681	412
F:15 to 19	0.032**	681	412
F:20 to 34	0.43	681	412
F:35 to 49	0.464	681	412
F:50 to 64	0.286	681	412
F:65 and older	0.754	681	412
Ln of Household size	0.049**	681	412
Ln of Farm Labor demand	0.063*	587	350
Farm size (ha)	0.14	681	412
Male Household Head Age	0.002***	593	351
Male Household Head Education	0.000***	593	351
Female Household Head Age	0.001***	625	372
Female Household Head Education	0.000***	625	372

Note: Comparing the means of key variables with Mann-Whitney tests. Households are split into groups according to whether they possessed an expired restriction title in 1994. The comparison is on data after 1994. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

6. Results

6.1 Main Results

Table 5 presents the results of several estimations of Equation (20). The results display the effects of household demographic characteristics on the log of the household's demand for farm labor during a season. At the bottom of the table are joint F-tests of the demographic variables. The F-test's null hypothesis is that markets are complete and demographic variables do not effect the log of household's demand for farm labor. Table 5 is comparable to Table II in LaFave and Thomas (2016).

Columns (1) and (2) in Table 5 present the results from regressions that exclude household fixed effects but keep community-time fixed effects. Columns (1) and (2) treat the data as if it were cross-sectional. Excluding household fixed effects may lead to biased estimates of the coefficients. The omitted variables will result in an overestimate of the variance-covariance matrix of the demographic variables and reduce the size of the t-statistic, reducing the likelihood of rejecting the null hypothesis that the effect of the demographic variables is equal to zero.

In column (1), the household's demographic endowment is represented by counts of the number of household members in each of the 12 sex-age bins. The result is we reject the null hypothesis at the 95% level for the effect of all demographic variables on labor demand. We also reject the null at the 90% for a joint F-test of all the variables that count the number of females in the household, the p-value for that test is close to non-rejection because it is 0.1. We cannot reject the null hypothesis that a household's male demographics and working-age demographics have a statistically null effect on farm labor demand. The recursion test identifies the existence of incomplete markets if any of the household demographics have a statistically significant effect on farm labor demand. Despite the failure to reject the null hypothesis for a subset of demographic variables the rejection of the null hypothesis for some demographics is enough evidence to reject recursion. Markets are not complete. Our

Table 5: Labor Demand (Log of Person Days Per Season) And Household Composition

	Pooled Cross-Section		Household Fixed Effects
	(1)	(2)	(3)
M: 0 to 14 years	0.003		0.012
	(0.018)		(0.019)
M: 15 to 19 years	0.049 ∗ ∗	0.176	0.064 ∗ ∗∗
	(0.024)	(0.178)	(0.024)
M: 20 to 34 years	0.003	0.021	0.019
	(0.028)	(0.189)	(0.025)
M: 35 to 49 years	0.022	0.340	−0.098∗
	(0.041)	(0.264)	(0.055)
M: 50 to 64 years	0.067	0.497	−0.097
	(0.065)	(0.368)	(0.078)
M: 65 and older	0.002	0.206	0.006
	(0.076)	(0.446)	(0.067)
F: 0 to 14 years	0.017	0.100	−0.039∗
	(0.019)	(0.149)	(0.023)
F: 15 to 19 years	0.034	0.128	−0.019
	(0.034)	(0.289)	(0.030)
F: 20 to 34 years	0.033	0.297	0.023
	(0.022)	(0.242)	(0.025)
F: 35 to 49 years	−0.041	−0.011	−0.026
	(0.051)	(0.357)	(0.047)
F: 50 to 64 years	0.071	0.623	0.065
	(0.094)	(0.528)	(0.075)
F: 65 and older	0.181	0.939	0.113
	(0.119)	(0.634)	(0.075)
log of household size		0.192 ∗ ∗∗	
		(0.062)	
Tests for joint significance of demographic composition			
All groups	2.265	2.013	3.188
p-value	0.012	0.028	0.001
Males	1.016	0.805	2.726
p-value	0.418	0.548	0.016
Females	1.818	1.447	1.494
p-value	0.100	0.202	0.187
Prime-age adults	1.305	0.751	4.199
p-value	0.260	0.610	0.001
N. observations	918	918	900

Note: Table replicates LaFave and Thomas (2016). Columns 1 and 3 measure demographic variables as counts of household members in the category. Column 2 measures household demographics as a share of household size in each age-sex category relative to share of household made up of males aged 0-14 years. Standard errors are in parentheses. Results of hypothesis testing with joint F-tests are presented at the bottom of the table. Prime-age adults are aged between 15-49. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

findings are similar to LaFave and Thomas (2016) who reject recursion in the context of rural Indonesia.

The second column displays the estimates of demographic variables that have been reformulated to be the share of the total household size in each age category. We follow LaFave and Thomas (2016) and exclude the share of males aged 0 to 14 to avoid a perfect linear combination in the demographic variables. The remaining demographic variables measure the effect of increasing the share of the household in an age-gender category relative to the share of the household who are males aged 0 to 14. The specification of demographics in column (2) appears in Benjamin (1992). The log of household size is added in column (2) and together with the reformulated demographic variables these variables control for the scale of household size. We reject the null hypothesis at the 95% for all the demographic variables together. We reject the null hypothesis overall. The size of the household has a statistically significant effect on a household's demand for farm labor. LaFave and Thomas (2016) reject recursion in their estimate which formulates household demographics are shares.

The size of the household is significant for labor demand. The average household size across the whole panel is 6 members and an additional member to the average household represents a 17% increase in household size. If a 1% increase in household size is associated with a 0.19% increase in demand for farm labor, then an additional member to the average household is associated with a 3.42% increase in labor demand or a 2.8 day increase in labor demand with respect to the average farm labor demand. Households with more members demand more labor than households with fewer members. If two households had identical production technologies, faced the same output prices, the larger household would demand more labor than the smaller household. Under recursion, those two households should demand the same amount of labor because their production technologies are the same. In the presence of complete markets, the household's farm labor demand function would take the form of equation (9) and the labor it demanded would not depend on the characteristics of the household.

Column (3) is the specification of equation (20) that includes household fixed effects, community-time fixed effects, and measures household demographics by counting the number of household members in each age-gender bin. We find that household composition is significant for labor demand. A household's farm labor demand is significantly associated with the number of household members aged 15-19. An additional male in the household aged 15-19 is associated with a 6.4% increase in labor demand. Contextualizing this: the mean total seasonal farm labor demand for all years is 81 days, and so, if a 15 to 19 year old male joins a household with average farm labor demand, then that household will demand an additional 5.2 days of farm labor.

All the F-tests reject the null for all groups of demographic variables, male demographic variables, and prime-age demographic variables; household demographics have a significant and non-zero effect on farm labor demand. We reject recursion in favor of the alternative hypothesis.

We reject recursion more confidently in column (3) than in columns (1) and (2) because the p-values of the joint F-tests of demographic variables in column (3) are mostly lower than the corresponding tests in columns (1) and (2). Columns (1) and (3) are specified identically except that column (3) includes household fixed effects. The regressions with only community-time fixed effects omit household fixed effects that capture unobserved variables at the household level that affect labor demand and household demographics.

6.2 Identifying a Switch in Credit Market Completeness

Table 6 presents results of our recursion test to identify a market that switches from being incomplete to be complete. Columns (1) and (2) display the results of recursion tests on the households without an unrestricted land title in 1994 in two periods: 1970 to 1991 and 1994 to 2016. Columns (3) and (4) display the results of recursion tests on the subset of households with an unrestricted land title in 1994 in two periods: 1970 to 1991 and 1994 to 2016. Evidence that a market switches states of completeness requires rejecting recursion in

Table 6: Split regressions between land owners and non-landowners over time

	Households Without Unrestricted Title in 1994		Households With Unrestricted Title in 1994	
	1970-1991	1994-2016	1970-1991	1994-2016
	(1)	(2)	(3)	(4)
M: 0 to 14 years	−0.024	0.111	−0.001	−0.322
	(0.039)	(0.068)	(0.060)	(0.205)
M: 15 to 19 years	−0.062	0.113*	0.183***	−0.190
	(0.053)	(0.060)	(0.059)	(0.251)
M: 20 to 34 years	0.022	0.012	0.020	−0.370
	(0.045)	(0.054)	(0.066)	(0.306)
M: 35 to 49 years	−0.135	−0.073	−0.126	−0.069
	(0.102)	(0.113)	(0.130)	(0.389)
M: 50 to 64 years	−0.257**	0.114	−0.281	−0.527
	(0.115)	(0.187)	(0.242)	(0.422)
M: 65 and older	−0.148	0.084	−0.534	−0.286
	(0.117)	(0.201)	(0.387)	(0.530)
F: 0 to 14 years	−0.008	0.010	0.034	−0.155
	(0.039)	(0.065)	(0.102)	(0.199)
F: 15 to 19 years	−0.051	−0.025	−0.075	0.451
	(0.063)	(0.085)	(0.088)	(0.318)
F: 20 to 34 years	0.031	−0.041	0.123	0.017
	(0.058)	(0.053)	(0.102)	(0.209)
F: 35 to 49 years	−0.009	−0.231**	−0.097	−0.087
	(0.070)	(0.102)	(0.169)	(0.230)
F: 50 to 64 years	0.249***	−0.561***	−0.562**	0.159
	(0.088)	(0.172)	(0.220)	(0.214)
F: 65 and older	0.239**	−0.439**	−0.488**	0.282
	(0.103)	(0.217)	(0.217)	(0.460)
All groups	9.286	5.474	18.729	184.749
p-value	0.000	0.000	0.000	0.000
Males	2.145	1.721	1.833	2.725
p-value	0.061	0.136	0.133	0.042
Females	3.155	2.394	15.272	3.815
p-value	0.009	0.042	0.000	0.011
Prime-age adults	2.811	3.541	6.501	3.659
p-value	0.018	0.005	0.000	0.013
N	241.000	286.000	101.000	91.000

Note: The split occurs after 50% of the land is owned for at least ten years. Column 1 is estimated on data from 1970 to 1991. Column 2 is estimated on all data from 1994 to 2016. All columns are estimated with the full specification from 20. Standard errors are clustered at the household level and are reported parentheses. The demographic variables in both columns are counts of the number of household members. F tests are presented at the bottom of the table. Prime-age adults are 15-49 years old.(* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

the first period and not rejecting recursion in the subsequent period. There is no evidence that the credit market became complete because we reject recursion in all four tests. There is also no evidence credit markets did not switch states.

For households without an unrestricted title in 1994, columns (1) and (2), we reject recursion. F-tests of demographic variables in both time periods are statistically significant at the 99% level. In column (1), for the period between 1970 and 1991, we reject the null hypothesis for males, females, and prime-age adults. Females, all groups in general, and prime-age adults have a statistically significant effect on labor demand at the 99% level. Male demographics are statistically significant at the 90% level. In the later period, column (2), male demographics are statistically insignificant for the labor demand; however, other demographics are statistically significant. For female demographics in the later period, we reject the null hypothesis with less confidence than we did in the earlier period. Nonetheless, female demographics are still statistically significant at the 95% confidence level as opposed to the 99% confidence level. That is not due to a drop in power because the test in column (2) has more observations than the test in column (1). We expect credit markets to not have changed over time for these households. Formal credit did not become available to these households in either period.

For households with unrestricted title in 1994, columns (3) and (4), we do not observe a switch in market completeness. We reject the null hypothesis in both periods. In column (3), the F-tests are highly significant for all demographic variables, female variables, and prime-age adult variables. In column (4), the F-tests for all demographic variables are still highly significant. Male variables, female variables, and prime-age adults variables are significant at the 95% level. These were the households that we had the best chance to observe a switch in market completeness as these households were allowed to use their title for collateral in the second period.

Our result is inconclusive about the state of the credit markets after the end of title restrictions. A more direct test is if the end of title restrictions increased the use of credit to

finance production expenditure. We would expect that households with unrestricted titles are able to borrow more than households without unrestricted titles. We do not have data on the size of loans households took out but we do have data on the value of loan repayments made in a season. We approximate loan size with the value of repayments made each season as a ratio over total expenditure.

Table 7: Repayments to Creditors as a Share of Total Expenditure

	(1)
Total Size of Cultivated Land (ha)	−0.001∗
	(0.001)
Household has at Least One Irrigated Plot	−0.000
	(0.006)
Possessed Unrestricted Title in 1994	−0.004
	(0.005)
Possessed Unrestricted Title in 1994 × After 1991	0.000
	(0.006)
Constant	0.017∗∗∗
	(0.004)
Observations	1269

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 displays the results of a linear regression with community-time fixed effects measuring the effects of ending title restriction on the size of the share of loan repayments to total farm expenditure. The regression clusters standard errors at the household level. The independent variables are farm size in hectares, having an irrigated plot, a community-time fixed effect, being a household that will possess an unrestricted title in 1994, and the previous variable interacted with a dummy variable for any date on or after 1994. The last variable compares the repayments on loans as a share of total expenditure between households that could use their title to get institutional loans and households that could not use a title to get institutional loans. Most households that do own an unrestricted title in 1994 do not have access to institutional loans before 1994. Repayments to creditors are a proxy for credit

access but it is far from a perfect measure of credit access. It definitely represents credit access in the past. A household can receive a loan in one season and never receive another loan again but continue to be making repayments on the first and only loan it received. Those households have a non-zero value for the value of loan repayments as a share of total expenditure in periods when the debt was outstanding but debt for that season was not taken out.

We find that the only significant variable is land size that is significant at the 90% level. Other variables were insignificant, including the main variable of interest. We find that households with institutional credit are not financing a larger share of expenses with credit. Compared to themselves before 1994 and after 1994, households with an unrestricted title in 1994 do not spend more on loan repayments relative to total expenses. Households without an unrestricted title in 1994 do not pay more in loan repayments relative to total expenses. We see two possible explanations for the results: first, it could be that there are different interest rates between formal and informal credit. Repayments include the principle and the interest and there exists a combination of principal amounts and interest rates such that the repayment would be the same between a small loan with high interest and a large loan with low interest. Under this scenario, households with institutional credit are taking out larger loans with lower interest and making the same seasonal repayments as households with smaller loans with higher interest. Or second, it could mean that households with collateral are not using institutional credit even when it becomes available. Households with collateral are still making repayments on loans meaning that they are using credit. Since they are using credit and are not using institutional credit or landlord credit they must be using informal credit. Households would not adopt new credit when the transaction costs of switching to new credit are high. Switching to formal credit when it becomes available requires transaction costs to learn how formal credit works. And switching to formal credit carries a perceived risk that it might not work because it is new, unlike informal credit, which is already being used. Even if it has flaws it is familiar.

7. Conclusion

We tested market completeness with the recursion test from Benjamin (1992) and LaFave and Thomas (2016) on a panel of rice producing farmers in Central Luzon, Philippines. We find that markets are incomplete. Even the better-off farmers with an unrestricted land ownership title still lack at least two important markets. The rice farmers of Central Luzon do not face complete markets.

Our findings that markets are incomplete are in line with what is found in LaFave and Thomas (2016). We do not have empirical evidence that any particular market is incomplete. We initially suspected that the lack of landlord credit and institutional credit were leading to an incomplete credit market. That is less clear because we saw evidence that informal credit was still being accessed even when those other sources of credit were unavailable. When institutional credit became available to certain households those households were not spending differently on loan repayments relative to households without access to formal credit. If informal credit markets are available and are being used, then it throws into doubt that the lack of access to institutional credit has resulted in an incomplete credit market. Future research with precise data on credit is necessary to address the many areas of uncertainty about credit use.

Appendix

Online-Only Appendix to "Testing for the Appearance of Market Completeness Over Time in the Philippines"

We estimate the main empirical model with data that only comes from seasons where both demographic and production data was collected. The test is intended to compare if the results change when we match demographic data to seasons where demographic data was not collected. We find that the results and significance does not change significantly when we match the demographic data and when we do not match the demographic data.

Table A1: Main Specification on Demographic Data Exactly Matching Production Data

Table A1
Labor Demand (Log of Person Days Per Season) And Household Composition

	A. Pooled Cross-Section		B. Including Farm Household Fixed Effects
Household Demographic Composition	N. Household Members	Household Size and Shares	N. Household Members
	(1)	(2)	(3)
Number of Males in farm HH			
0 to 14 years	0.02	-	0.03
	(0.03)		(0.03)
15 to 19	0.07	0.02	0.10
	(0.04)	(0.30)	(0.04)
20 to 34	-0.00	-0.19	0.02
	(0.04)	(0.32)	(0.04)
35 to 49	0.04	0.35	-0.13
	(0.08)	(0.51)	(0.08)
50 to 64	0.10	0.36	-0.17
	(0.12)	(0.63)	(0.11)
65 and older	-0.07	-0.33	-0.06
	(0.11)	(0.67)	(0.10)

(Continues)

Table A1 - Continued
Labor Demand (Log of Person Days Per Season) And Household Composition

	A. Pooled Cross-Section		B. Including Farm Household Fixed Effects
Household Demographic Composition	N. Household Members	Household Size and Shares	N. Household Members
	(1)	(2)	(3)
Number of females in farm HH			
0 to 14 years	0.03	0.02	-0.01
	(0.03)	(0.28)	(0.04)
15 to 19	0.05	-0.06	-0.00
	(0.05)	(0.40)	(0.04)
20 to 34	0.11	0.60	0.10
	(0.04)	(0.33)	(0.04)
35 to 49	0.04	0.51	-0.01
	(0.08)	(0.56)	(0.07)
50 to 64	0.14	0.97	0.06
	(0.16)	(0.83)	(0.11)
65 and older	0.26	1.33	0.12
	(0.20)	(1.05)	(0.14)
Log hh size		0.36	
		(0.12)	

(Continues)

Table A1 - Continued

	A. Pooled Cross-Section		B. Including Farm Household Fixed Effects
Household Demographic Composition	N. Household Members	Household Size and Shares	N. Household Members
	(1)	(2)	(3)
Tests for joint significance of demographic composition			
All groups	1.73	1.314	2.400
p-value	0.0676	0.218	0.00896
Males	0.722	0.619	1.981
p-value	0.633	0.685	0.0752
Females	2.197	1.070	1.949
p-value	0.0472	0.384	0.0800
Prime age adults	2.178	1.092	4.109
p-value	0.0491	0.371	0.000988
N. observations	597	597	567
Number of households	131	131	102

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