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FARMS, FAMILIES, AND MARKETS:
NEW EVIDENCE ON COMPLETENESS OF MARKETS IN AGRICULTURAL SETTINGS

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Farms, Families, and Markets: New Evidence on Completeness of Markets in Agricultural Settings
Daniel LaFave and Duncan Thomas
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ABSTRACT

The farm household model has played a central role in improving the understanding of small-scale agricultural households and non-farm enterprises. Under the assumptions that all current and future markets exist and that farmers treat all prices as given, the model simplifies households' simultaneous production and consumption decisions into a recursive form in which production can be treated as independent of preferences of household members. These assumptions, which are the foundation of a large literature in labor and development, have been tested and not rejected in several important studies, including, for example, Benjamin (1992). Using multiple waves of longitudinal survey data from Central Java, Indonesia, this paper tests a key prediction of the recursive model: demand for farm labor is unrelated to the demographic composition of the farm household. The prediction is unambiguously rejected. The rejection cannot be explained by contamination due to unobserved heterogeneity that is fixed at the farm level, local area shocks or farm-specific shocks that affect changes in household composition and farm labor demand. We conclude that the recursive form of the farm household model is not consistent with the data. Developing empirically tractable models of farm households when markets are incomplete remains an important challenge.

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1. Introduction

Small-scale, family-run enterprises form the backbone of many developing countries, and millions of households around the world produce goods and services both for their own consumption as well as for sale. These family farms and business enterprises operate in complex, interlinked markets for consumption, labor, credit, and output, and face considerable risk and uncertainty.

Modeling production and consumption decisions of family firms is a substantial challenge and many studies have relied on the neoclassical agricultural household model that integrates a family operated firm within a household utility maximization problem. The vast majority of empirical studies in this literature are founded, explicitly or implicitly, on a particularly simple form of the agricultural household model that assumes markets can be treated as if they are complete (Singh, Squire and Strauss, 1986). In a creative and extremely influential study, Benjamin (1992) tested and failed to reject an implication of the complete markets assumption using data from rural Indonesia. Following the same approach, we examine the implications of complete markets using recently collected data, also from rural Indonesia, and find that the assumption of complete markets is rejected both in models using cross-sectional data and models estimated with rich panel data that directly address potentially important sources of bias in the existing literature.

The result is important. There is a large and influential body of work that is predicated on the model with complete markets. This includes seminal work on nutrition and farm productivity, adoption of agricultural technology, labor supply choices, and responses to policy interventions (e.g. Yotopolous and Lau, 1974; Barnum and Squire, 1979; Strauss, 1982, 1986; Singh, Squire and Strauss, 1986).[1] Recent studies that have their origins in this model have made important contributions to the study of distributional impacts of agricultural productivity shocks, technology adoption, and the operation of labor markets (Jayachandran, 2006; Suri, 2011; Kaur, 2015; Mobarak and Rosenzweig, 2014), risk sharing (Townsend, 1994), the impact of microcredit (Kaboski and Townsend, 2011), understanding intra-household resource allocation (Udry, 1996), property rights (Field, 2007), and child labor and household production (Akresh and Edmonds, 2012). More broadly, the effects of policies depend critically on whether or not economic decision-makers behave as if markets are complete (Singh, Squire and Strauss, 1986; Dillon and Barrett, 2015).

Under the complete markets assumption, the agricultural household is assumed to behave as a price taker in all markets, and all farm production decisions can be treated as if the household operates a profit-maximizing firm. To wit, input choices depend only on the prices of inputs and

[1] Taylor and Adelman (2003) provide a review of the agricultural household literature. See also Strauss and Thomas (1995), Behrman (1999) and Schultz (2001).

characteristics of the farm. Production choices are made without reference to the preferences of household members and, therefore, to consumption allocations. The agricultural household can be modeled as if decisions are recursive in that production choices are made in the first stage, and, in the second stage, consumption choices are made taking into account income from farm profits. Consumption choices depend on production decisions but not vice-versa: the recursive form (or the model assuming separation) substantially simplifies empirical implementation of the model.

The assumptions that underlie the recursive model are not only very powerful, they are also very strong. It is assumed that the household behaves as if all current and futures markets exist, that all prices are treated as parametric by all agents in the economy, that there is no uninsurable uncertainty, and that household labor and hired workers are perfect substitutes in on- and off-farm work. These assumptions rule out, for example, the absence of markets for land, credit, insurance and labor, or monopoly power in these or input and output markets; all of these issues have been extensively discussed in the literature. The assumptions also rule out information asymmetries such as farmers knowing more about their land than hired workers or shirking by workers, as well as preferences for working on one's own farm or costs of working off one's farm.

However, it is important to underscore that if farm household behavior is consistent with the recursive model, it does not mean that complete markets actually exist. Rather, one interpretation of failing to reject separation is that households allocate resources in ways that make up for missing markets and, thereby, their choices can be modeled as if all markets exist. See, for example, Stiglitz (1974) for an articulation of how sharecropping serves such a purpose or the large literature describing how family and social networks substitute for credit and insurance markets (Rosenzweig and Stark, 1989, for example). As a result, it is not straightforward to identify underlying reasons why market completeness fails (see, for example, Beaman et al., 2015).

This research provides an empirical assessment of whether the recursive model is consistent with decision-making by farm households in rural Central Java, Indonesia, using new, longitudinal data specifically designed to address limitations in the existing literature. Indonesia is a good context for this research since key papers in this literature relied on data collected from rural households in Indonesia in the early 1980s and concluded that those households behave as if complete markets exist (Pitt and Rosenzweig, 1986; Benjamin, 1992). Using data collected two decades later, it is reasonable to suppose that markets have deepened and there are more inter-linkages across markets since the agricultural sector has undergone dramatic change over the last quarter century with the adoption of new technologies and diversification out of rice and into a broad array of cash crops. There is an active rural labor market, substantial migration between the rural and urban sector, and many rural dwellers are engaged in both agricultural and non-agricultural work (see, for example, Booth, 2002, for a discussion).

This paper makes three contributions. First, the key concern in the literature that has tested completeness of markets in agricultural household models is that results are contaminated by unobserved heterogeneity. Benjamin discusses the issue at length and notes that both household size and labor demand are likely correlated with unobserved characteristics such as farmer skills, entrepreneurship and wealth. Addressing this concern in studies that use cross-sectional data has been a challenge (see, for example, Lopez 1984, 1986; Jacoby, 1993; Grimard, 2000; Dillon and Barrett, 2015; and additional citations in Behrman, 1999). This paper uses panel data and includes farm fixed effects so that identification is based on changes in labor demand and changes in household size and composition. Udry (1999) uses panel data on Kenyan farmers with two successive cropping rounds, 6 months apart. However, as he notes, it is not clear there are sufficient changes in household composition that are plausibly exogenous during this short time frame. His modest sample (of 617 farmers) also raises concerns about power. Using four waves of panel data on 258 farm-households in China, Bowlus and Sicular (2003) report that of 442 person days of labor used per year on the average farm, 438 are provided by household members and only 4 are hired in indicating an absence of a local labor market where rejection of complete markets would not be surprising.

Our second contribution exploits the richness of our panel data collected in a setting of active markets, the length of the panel, and the size of our sample. We use 11 waves of data to isolate plausibly exogenous changes in household size and composition and establish our results are unlikely to be driven by unobserved heterogeneity including behavioral responses to shocks and migration into or out of the farm household. For example, with a large sample of over 4,000 households, we are able to restrict attention to changes in household composition driven only by aging of household members over the panel duration: in these models, recursion is rejected.

Third, careful attention is paid to measurement which is a serious concern in this literature. In particular, we provide evidence that our results are unlikely to be driven by measurement error in hired or family labor, whereas systematic measurement error likely underlies failures to reject complete markets in prior research.

It is not possible with a portmanteau test for complete markets to identify the sources of market failure; to some extent, this is an advantage given the fact that inter-linked markets are common in many rural economies. We explore one possible explanation for failure of recursion that has been widely discussed in the theoretical development literature: differential monitoring costs of hired relative to own labor which is inconsistent with the assumption of perfectly substitutable hired and own labor (Stiglitz, 1974). We find no evidence suggesting that rejections of recursion are explained by differential monitoring costs of own and hired workers.

The theoretical framework that guides the empirical work precedes a description of the data. We then present empirical tests of implications of recursion and draw our conclusions.

2. Theoretical Framework

This section presents a dynamic generalization of the neoclassical agricultural household model in Singh, Squire and Strauss (1986) to formalize intuition and establish the empirically testable implications of the model. The model incorporates production choices into an intertemporal utility maximization objective function with exogenous prices and complete markets.

Farm households simultaneously act as both producers and consumers making decisions regarding farm production, on one hand, and maximizing household utility on the other. For an infinitely lived household, the objective is to maximize the expected present discounted value of current and future utility choosing consumption, leisure, savings, farm labor, and other variable farm inputs in each time period:

$$\max E\left[\sum_{t=0}^{\infty} \beta^t u(x_{mt},\ x_{at},\ \ell_t;\ \ \mu_t,\ \varepsilon_t\right] \qquad [1]$$

where x_{mt} is a vector of market consumption goods, x_{at} is a vector of agricultural consumption goods (i.e. food, some of which may be grown by the household), and ℓ_t is a vector of household members' leisure. Preferences are captured by μ_t, which includes observed household characteristics such as household size and composition, and unobserved characteristics, ε_t. The utility function may be of general form as long as it is inter-temporally separable, quasi-concave, non-decreasing, and strictly increasing in at least one argument.

The household is constrained by the farm production technology, its time endowment, and an intertemporal budget constraint. The agricultural production function specifies the technology that links inputs to crop output, C_t, in period *t*:

$$C_t = C_t(L_t, V_t, A_t; \nu_t) \qquad [2]$$

where the period *t* is a complete crop cycle from land preparation through harvesting. The inputs include labor used on the farm that period, L_t, a vector of other variable inputs, V_t, such as seed and fertilizer, and fixed inputs, A_t, which in the study setting is effectively land.[2] Unobserved factors that affect output, such as supply shocks, are represented by ν_t. Rice is by far the dominant crop in the study area and while, for expositional simplicity, we assume a single output in the model, the empirical implementation allows multiple outputs on a farm.[3]

Total farm labor consists of the sum of family labor supplied to the farm, L_t^F, and outside labor hired onto the farm from the marketplace, L_t^H:

$$L_t = L_t^F + L_t^H \qquad [3]$$

Both family and hired labor are assumed to share a common shadow wage although allowing different productivities for family and hired labor does not change the main result. A household's endowment of labor, E_t^L, is divided between time spent working on the family farm, time in off-farm labor, L_t^O, and leisure:

$$E_t^L = L_t^F + L_t^O + \ell_t \qquad [4]$$

The intertemporal budget constraint describes the evolution of wealth over time. In the presence of credit markets or some other mechanism for inter-temporal smoothing, farmers can borrow resources in period *t* to be repaid with interest rate r_{t+1}; a parallel market exists for savings that earn the same interest rate. Let W_t be assets or wealth at the beginning of time period *t*, the budget constraint is:

$$W_{t+1} = (1+r_{t+1})[W_t + \{w_t(E_t^L - \ell_t)\} + \{p_{ct}C_t - w_t L_t - p_{vt}V_t - p_{at}A_t\} - \{p_{mt}x_{mt} + p_{ct}x_{ct}\}] \qquad [5]$$

Wealth in period *t+1* is equal to the interest earned on wealth in *t* plus net savings that period. Net savings in period *t* are the sum of net income from work (in the first pair of braces) and farm profits (in the second pair of braces), less expenditure (in the third pair of braces). Wealth is negative if a household is in debt. The household earns wage income from off-farm labor at the market wage, w_t, which, under the assumption of complete markets, is also the shadow wage for work on the farm.

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[2] In principle, the amount of land owned is a choice variable in the model. However, only 5% of household report a purchase or sale of land at any time during the survey period. Results will be presented that treat land as fixed as well as those that allow land to vary over time. Ethnographic evidence suggests land is typically inherited by the eldest son rather than divided amongst all siblings. Often the eldest may temporarily share the land with their younger siblings while retaining ownership, but when the younger siblings die, the entire plot is inherited by the heirs of the oldest son (White and Schweizer, 1998). Technology in the study area is not capital intensive. Farms have small capital stocks, primarily sickles to harvest rice, which are treated as variable inputs.

[3] The empirical application of the model is robust to alternative forms of the production function, including those allowing for intertemporal links in production where output is a function of current and past period inputs (e.g. Kochar, 1999). The empirical tests and results are also robust to production frameworks that explicitly include capital as an input and specify a transition process for capital over time. The form in equation [2] is maintained for expositional simplicity.

Thus, the imputed value of labor supply is $w_t(E_t^L - \ell_t)$. Net profits is the output C_t evaluated at the market price, p_{ct}, less the imputed value of labor demand (at the market price), $w_t L_t$, and the costs of variable and fixed inputs, $p_{vt}V_t$ and $p_{at}A_t$, respectively. The value of consumption, in the final pair of braces, is total spending on goods purchased in the market, $p_{mt}x_{mt}$, and the value of consumption of own production evaluated at the market price, $p_{ct}x_{ct}$.

Under the assumptions of this model, if markets are complete, consumption depends on current and expected future prices, wages and interest rates as well as current income while inter-temporal decisions follow the Euler equation. Importantly, in each period, demands for farm inputs are determined solely by their marginal products and prices in the production process and do not depend on consumption decisions. Thus, for example, solving for [3], total demand for labor on the farm in period *t*, L_t, which is the sum of hired and family labor, depends on the prices of crops and the prices of all inputs including the (shadow) wage:

$$L_t = L_t(p_{ct},\ p_{vt},\ p_{at},\ w_t) \qquad [6]$$

The key insight from this result is that demand for farm labor does not depend on observed or unobserved characteristics that only affect consumption choices of the farm household, μ_t and ε_t, respectively, in [1]. Concretely, demand for farm labor does not depend on the demographic composition of the household.

Herein lies the essential intuition of the recursion result: there is a separation between production and a household's preferences so that consumption and production choices can be treated as if they are made recursively in two stages. In the first stage, households maximize profits on their farms independent of preferences or any consumption side influences by choosing farm labor, variable inputs, and land. Utility is then maximized in the second stage, and consumption allocations are affected by production decisions only through farm profits.

This is a powerful result that renders the model of the farm-household substantially more tractable than a model in which production and consumption choices are inter-dependent. We focus on one direct implication of recursion tested by Benjamin (1992): since consumption choices (and factors that affect consumption) have no impact on production, the demographic composition of the farm household will have no direct impact on production choices. Intuitively, since farm labor can be supplied on and off the farm at the same (shadow) wage, which is also the wage of hired farm labor, excess demand for labor over and above that of household members can be purchased in the market, hiring people who are, by assumption, exchangeable with household members. Excess supply of family labor can be sold at the same wage in the market.

The model rules out many situations that have been discussed in the theoretical – and to some extent – empirical literature. There is no scope for differences in the productivity of farm household workers and hired labor because of, for example, farm-specific experience or differences in the propensity to shirk, or because of unobserved differences in productivity that are not rewarded in the market. The latter might include entrepreneurship, farm management skills or tastes for doing well on one's own farm. There are no costs of monitoring workers and no transaction costs (and commuting costs) that differ between own and hired workers or between on- and off- farm work. Labor is readily available at the prevailing wage at all times during the production process and there is no unemployment (or under-employment) in the local labor market. The model also rules out a host of sources of asymmetric information including a wedge between farm gate and consumption prices, local area monopolies, and within-household bargaining over labor supply, resource allocation or farm production. Impediments to transferring resources across time, such as lack of access to credit or insurance, are also ruled out.

3. Identification

Taking a linear approximation of the production function [2] specified in logarithms, demand for labor [6] by farm household *h* in community *j* at time *t* is:

$$\ln L_{hjt} = \alpha + \beta N_{hjt} + \delta X_{hjt} + \eta_h + \eta_{jt} + \xi_{hjt} \qquad [7]$$

where L_{hjt} is the total number of person days of labor used on the farm in period t and N_{hjt} is a vector of demographic characteristics of the farm household. Demographic composition may be related to other farm household characteristics, such as farmer experience and productivity, which are captured in the vector X_{hjt}. Household-farm fixed effects, η_h, absorb the effects of all time-invariant farm household characteristics, such as land size, for example. Community-specific effects, η_{jt}, one for each period *t,* absorb local area variation including, for example, time varying input and output prices.

In most of our specifications, household demographic composition is specified flexibly as the number of members, n^k_{hjt}, in each of 6 gender-specific age groups (0-14, 15-19, 20-34, 35-49, 50-64 and 65 and above):[4]

[4] To provide a direct comparison with Benjamin (1992), we also report estimates from a model where *N* is specified

$$N_{hjt} = \sum_{k=1}^{12} n_{hjt}^{k} \quad [8]$$

Under the null that farm household decisions are recursive, N_{hjt} will have no impact on labor demand and β will be zero. Credible identification of this effect has been a stumbling block in the literature. Most studies in the literature rely on cross-sectional data. Identification in those studies depends on the inclusion of farm-specific observed characteristics, X_{hjt}, to mitigate the impact of correlations between demographic composition and unobserved factors that affect labor demand. In practice, even with extensive controls, there are potentially unobserved farm-specific characteristics that affect labor demand and are correlated with household demographic composition. These include, for example, land owned, soil quality, plot fertility, farm specific knowledge, and managerial experience, many of which are difficult to measure and typically correlated with wealth and thus household composition (Benjamin, 1992; Udry, 1996, 1999; Dillon and Barrett, 2015). Exploiting panel data, our labor demand model includes farm fixed effects, η_h, which absorb all observed and unobserved farm-specific heterogeneity that is fixed over time and affects labor demand in a linear and additive way. Estimates of [7] should not be contaminated by these fixed sources of unobserved heterogeneity.

The model with household fixed effects is identified by changes in labor demand that are affected by changes in household size and composition that will arise from aging of household members, births and deaths, as well as migration into and out of the household. Demand for labor will vary with wages and prices that might arise from predictable changes (such as seasonality) as well as unpredictable shocks (from weather, pestilence, or technology, for example). These innovations may also contemporaneously affect household size or composition, if, for example, individuals migrate in response to productivity shocks. The vast majority of these unobserved innovations are likely to be spatially correlated and will be absorbed in our community-time specific fixed effects, η_{jt}. Under these assumptions, estimates of [7] can be given a causal interpretation.

These estimates will be contaminated, however, if there are household-specific unobserved innovations over time (such as farm-specific productivity shocks) that are correlated with both changes in household composition and changes in labor demand. This would arise, for example, if a productivity shock is accompanied by migration into or out of the farm household. To address this

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following Deaton, Ruiz-Castillo and Thomas (1989) as $N_{hjt} = \log(n_{hjt}) + \sum_{k=1}^{11} \frac{n_{hjt}^{k}}{n_{hjt}}$ where n is total household size and n^k is the number of household members in demographic group k. This specification separates scale and composition effects, whereas our specification directly estimates semi-elasticities of demand. None of our conclusions depend on the functional form of demographics in the model.

class of concerns, we investigate the robustness of our results to departures from the assumptions underlying our baseline model [7].

First, leveraging the five year span of the panel survey, we isolate the impact of demographic variation on labor demand due solely to aging by restricting attention to the 35 percent of households that had no change in household membership because of migration, births or deaths during the study period. In this case, identification is driven solely by aging of household members across demographic groups; this will arise, for example, when an 18 year old male ages out of the 15-19 age bracket into the 20-34 age bracket and we test whether there are concomitant changes in total farm labor demand. This is clearly a very stringent test. Its key advantage is that since aging is exogenous, changes in demographic composition of these farm households cannot be correlated with unobserved farm-specific shocks that affect labor demand because of behavioral responses to the shock. We also provide evidence that results of these analyses are not driven by selectivity of the sub-sample.

Second, using the entire sample, we delink contemporaneous changes in household composition and changes in labor demand by examining the impact of lags and leads of changes in household composition on labor demand and also use lagged composition as instruments for current composition. Third, we exploit the fact that we know about family members who are not co-resident and use family composition as instruments for household composition to set aside concerns regarding endogenous decisions about family living arrangements. Fourth, we also examine farm labor demand for specific tasks for which migration is less likely to be a concern.

It is likely that unobserved heterogeneity is correlated over time for a household and across space within a community. We have estimated variance-covariance matrices taking into account correlations at either level and inferences are not different. Estimates based on household-level correlations are reported in the tables.[5]

4. Data

The Work and Iron Status Evaluation (WISE), a large-scale longitudinal survey conducted in Central Java, Indonesia, is designed to collect the information on individuals, households and communities necessary to test implications of recursion in the agricultural househol model. After a listing survey in late 2001, a population-representative sample of households living in Purworejo kabupaten were interviewed every four months beginning in 2002 and continuing through 2005. A longer-term

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[5] In addition, variance-covariance matrices calculated using block-bootstraps with blocks defined at the household or community level do not change any inferences.

follow-up was conducted five years after the start of the survey in 2007. All waves of the survey are included in this study. Since the tests of recursion rely heavily on changes in household composition, it is imperative that selective attrition does not contaminate inferences. Attrition is extremely low in WISE: ninety-seven percent of farm households from the 2002 baseline were re-interviewed five years later in the 2007 wave (Thomas et al., 2011).

Accurate measurement of labor used on the farm, including both labor hired in and labor supplied by household members, is key for this research. WISE was designed with measurement concerns in mind; the following describes the collection of data on hired in labor, own farm labor, and assessments of the quality of these data.

In each survey wave, the WISE instrument collects extensive information on each household's farm business over the previous four months from the farm manager, usually the household head. This includes ownership and use of land, value of farm assets, crops grown, costs of all inputs including labor, crop output, and the quantity and value of sales. For each farm product, the farmer is asked about total non-household labor as well as labor in each of eight specific activities (caring for livestock; preparing land; planting; weeding; fertilizing; harvesting; drying and selling). For each specific activity, the farmer reports the number of individuals and the number of person days of paid labor and, separately, the number of individuals and number of person days of exchange labor. Total hired-in labor is the sum of person days of paid and exchange labor.[6]

Following survey research best practices, WISE collects information about each individual household member from him/herself. Specifically, each member age 15 and older completes an interview that covers a broad array of topics including a module that collects detailed information on work and earnings. The average individual interview takes about ninety minutes and is usually completed independent of the rest of the survey and, in particular, independent of the farm business module for everyone other than the farm manager. In the work and earnings module, each household member, including the farmer, reports his/her own labor activities as the number of hours worked per week and the number of weeks per month for each of the last four months along with information about earnings and the type and location of work. Household-farm work is defined in each month as work in the agricultural sector where the individual is self-employed on their own farm or as a worker on the household farm. Labor supplied on the farm by each household member

[6] In a separate section, collected near the end of the farm business module, the farmer is asked to estimate total costs for nine different types of expenses, including cash payments for hired labor, and in-kind payments for labor. (Interviewers are instructed to not reconcile these reports with the rest of the farm business module.) The quality of the hired labor reports can be assessed by comparing the costs reported on a per day basis (number of hired person days X cost per day) for each activity (from the farm inputs module) with total labor costs over the past four months (from the farm costs module). The gap is small: at the median, the costs module report is 4% higher than the inputs module.

is the sum over the prior four months of the product of the number of weeks and the number of hours per week worked on the farm. Total household own farm labor is the sum of farm hours over all members in the household who work on the farm. This is converted to person days in order to be comparable with hired in labor assuming a 9.5 hour work day.[7]

Accurately measuring labor supply in informal markets is a substantial challenge in any survey setting (e.g. Bardasi et al., 2011 and Beegle et al., 2012). WISE includes a number of internal validations to ensure data quality. In the farm business module the farmer reports the name of the household members who worked on the farm for each product and the specific tasks they performed. Putting aside the farmer's own reports of labor supply, we have cross-validated the two sources of information and the correspondence is extremely close: of over 40,000 instances of a household member reporting that he/she worked on the farm in the individual labor module, the farmer reports the member worked on the farm 94% of the time in the farm business module. The 6% that are not consistent are excluded from the measure of total own farm labor provided by household members in the analyses.[8]

While there is little incentive for a household member to systematically overstate total hours of work, or hours of work on the household's farm, the work and earnings module collected data on time allocation in a separate module to assure time use of respondents is well measured. Specifically, a 24-hour time diary recorded all activities in 15 minute increments for the day preceding the interview, allowing individuals to multi-task. Cross-validation of the 24-hour recall with labor supply over the prior four months at the aggregate level provides a useful check on the quality of the data. For all household members other than the farmer, the average member worked 14.3 hours per week on the farm according to the work and income module, and 1.7 hours more per week in the 24 hour time allocation module. Farmers may over-state their work on their own farm and so they are examined separately. The average farmer reported 21.7 hours of work per week in the work and earnings module and 1.7 hours more in the 24 hour time allocation module. The correspondence of labor supply estimates from these two different sources is extremely high and there is little to suggest that farmers (or other household members) systematically overstate how much they work on the farm in the work and earnings module, our primary source for measures of own farm labor supply.

Comparability of measures of hired-in labor and own farm labor is important for the tests of

[7] This is based on the mean hours of work per day of the primary earner in a household in both the labor and time use modules. Any lower number of hours per person day (e.g. 8 or 9) increases the share of labor use on the farm attributed to household members relative to hired-in labor and strengthens the connection between household demographics and labor demand rejecting separation.

[8] The majority of inconsistencies are teenagers reporting they worked on the farm. These account for very little labor (0.04 person days per week) and whether or not they are excluded has no impact on the results presented below.

complete markets and can be directly assessed as WISE is representative of the population, and thus all farms, in the study area at baseline. Taking into account sampling weights, total labor hired in by sampled farms should be equivalent to total labor sold to other farms as reported by members of the sampled households. This match is extremely close: during the four months prior to the baseline survey, we estimate there were 69,743 person days of labor hired in to work in the study area and, drawing on the work and earnings module, household members worked 69,694 person days on farms in other households. Moreover, the seasonal patterns of reported hired-in farm labor and sold agricultural labor track very closely over the cropping cycle.

Table 1 presents summary statistics of the data pooled over the eleven waves of WISE. The sample consists of 4,452 farm households and over 38,000 household-wave observations. Every individual interviewed at baseline is eligible to be followed and interviewed throughout the study (to assure continued representativeness of the baseline population). When an individual moves out of a baseline WISE household and forms a new household, it becomes part of the WISE sample.

Panel A describes characteristics of the farms in the sample. Agriculture is the primary source of income in the study area, with wetland rice being grown by eighty-five percent of farm households. Rice is harvested three times per year and an increasing fraction of farmers have diversified into also producing oranges, groundnuts, and coconuts. The average farm household owns approximately half an acre of land and a modest capital stock.

Household composition is reported in panel B of the table. The average household has 3.83 members including one prime age (20-64) male and female. Variation in household composition is key for identification in our models with household fixed effects; the percentage of households that experience changes in composition is displayed in column 3. There is substantial variation over time with 59 percent of households having a change in the number of members as a result of birth, death, exit or entry. This understates the extent of change (if an entrant offsets an exit in a period): during the study period 78 percent of households experience at least one change in the number of household members in the age and gender groups in panel B.

The allocation of labor on the farm is reported in panel C. The average farm uses 72 person days of labor in each four-month season. Three-quarters of the labor (54 person days) is provided by household members, of which over three-quarters is supplied by male household members. Own farm labor accounts for about half the work of household members; approximately one quarter of their time is allocated to non-farm businesses and the rest to work for other private and public employers.

There is an active agricultural labor market. Workers are hired on to the farm by ninety percent of farm households and ninety-five percent of them are paid a daily wage; the rest are involved in exchange labor contracts in which the worker provides labor in exchange for labor on his/her own farm. Hired workers are engaged primarily in planting, weeding and harvesting with the daily wage for the latter at approximately Rp18,000, three times greater than the wage for planting or weeding.

5. Empirical results

Estimates of the demand for farm labor model are presented in Table 2 which displays each element of $ß_k$, the coefficients on household demographic composition in [7]. Results with all covariates are in Appendix Table A1. Under the null that the model is recursive, all of the demographic coefficients should be zero. Test statistics for joint significance are presented at the bottom of the table.

The first column reports estimates pooling all farm households and treating the sample as a cross-section which is comparable with the canonical empirical model in the literature. Household demographic composition is specified as the number of members in each gender-specific age group as in [8]: more males age 15 years and older and more females age 20 through 64 are significantly associated with greater total labor demand with estimated effects being greatest for males age 35 to 64 years. The significance of demographic composition is confirmed by the F tests for joint significance at the bottom of the table. Recursion is rejected.

The second column separates the effects of scale from composition by including the logarithm of total household size, which captures scale, and the share of members in each age and gender group relative to the excluded group, the number of males age 0 to 14 years old. This is the specification reported in Benjamin (1992). Household size and composition are both significantly associated with labor demand and switching a male under 15 years old for a male age 25 through 64 years has the biggest impact on labor demand. The two specifications can be directly compared by calculating elasticities of demand for labor for each demographic group: they are extremely close. For example, for males age 20 to 34 years, the elasticity is 0.051 in the first column and 0.053 in the second column. The standard error for both estimates is 0.004. We proceed with the specification in the first column which has a more direct interpretation.

Both of these sets of estimates are likely to be contaminated by time-invariant unobserved heterogeneity (such as the quantity or quality of farm land and farmer skills) that is correlated with both labor demand and household composition. To address this concern, farm household fixed effects are included in the model in the third column. Recursion is also rejected in this model. The F statistic for the joint significance of the demographic covariates is 13.13 (p-value < 0.005). Moreover, the estimated effects are both economically meaningful and of plausible magnitudes. For male adults age 20 to 55, for example, the estimated effects are between 0.13 and 0.22 which translate into between 10.1 and 17.8 additional person days of labor over the past four months estimated at the mean of labor demand.[9] The effects of males age 15-19 are positive and significant but much smaller in magnitude. The estimated effects of females in column 3 are smaller in magnitude than comparable age males although roughly the same in percentage terms taking into account differences in labor supply across genders. Effects are much smaller for older females, and female children are associated with reduced labor demand. The estimated effects are smaller for male adults in the model that includes fixed effects suggesting the cross-section estimates are contaminated by time-invariant unobserved heterogeneity.

The results do not depend on the precise specification of the gender and age-specific demographic groups. Recursion is rejected in the fixed effects model that includes only the number of males and females (which restricts the gender-specific demographic groups to have the same effect, a restriction that is rejected), as well as a model that includes only household size. While the exact age of the vast majority of household members is recorded in the survey, and there is very little evidence of age-heaping among respondents under 50 years old, older adults are less likely to know their birthdates and there is more heaping on ages that end in preferred digits (0 or 5). This is driven mostly by respondents whose reported age is 70 and older; they have no impact on the estimates since, in the empirical models, all of these respondents fall in the 65 and older demographic group through the entire study duration. Furthermore combining the 50-64 and $\geq$65 age groups assures that age misreporting among these members has no impact on the number of people counted in this broader age group. Recursion is rejected in the model with this specification (F of 14.38, p-value < 0.005).[10]

The fixed effect models in Table 2 do not include controls for (log) land owned as there are very few land transactions during the study period and, for the vast majority of farm households, the amount owned does not change and is absorbed by the fixed effect. For other households, it is possible that changes in owned land are correlated with changes in household size and labor demand. Whether or not land controls are included in the model has no impact on the results as shown in Appendix Table A2 which mirrors Table 2 but includes land controls (F of 12.84, p

[9] The estimates are smaller, 8.4 through 14.9 additional person days, when estimated at the median.
[10] An alternative strategy to assure the results are not contaminated by age stacking on preferred digits is to specify the gender-specific age brackets as 0-12, 13-17, 18-32, 33-47, 48-62 and $\geq$63 years. The F statistic for the joint significance of these demographic groups is 18.3 (for males), 6.1 (for females) and 12.4 (for all household members); all p-values are <0.005.

value<0.005 for the baseline model.) Rejection of recursion is also robust to excluding the final wave of the survey which was collected after a two year hiatus.[11]

Sources of variation in household composition and effects on labor demand

The fixed effects estimates are identified by changes in household size and composition that reflect births and death, migration into and out of the household, and aging of household members. To assure that unobserved heterogeneity such as farm-specific productivity shocks that are not shared with other farms in the community do not drive both changes in household composition and labor demand, column 4 reports estimates that close down all changes in household composition other than aging, which is exogenous, by restricting the sample to households that have no births, deaths or migration during the study. In this case, only aging of household members from one demographic group into the next identifies the impact of household composition.

By design this subsample has the same males and females in a household in every wave and so household size is fixed and thus absorbed into the household fixed effect. As a result, one age-specific demographic group must be dropped from the model and estimated effects are interpreted relative to that group (birth to 14 in the table). Recursion is rejected for these households. The conclusion is not sensitive to the definition of wider age groups, as aging variation predicts labor demand in models using wider age bands such as (birth to 14, 15-54, 55-64, and 65 and above), (birth to 14, 15-54, 55 and above), as well as (birth to 14 and 15 and above).

Furthermore, rejection of recursion is not driven by the selectivity of households that have no births, deaths or migration. An alternative approach, which uses all households in the survey, ignores births, deaths and migration by estimating the model with baseline household composition and aging every baseline member in accordance to the date of each survey wave while excluding entrants and exits. Recursion is rejected in this model based on the entire sample (F statistic of 3.62, p-value < 0.005). These are stringent tests and, therefore, powerful results.

An alternative approach to break the link between contemporaneous changes in household composition and labor demand that are possibly driven by the same time-varying, unobserved farm-specific shock is to relate current labor demand to household composition in the prior season. These estimates, which are purged of contamination due to contemporaneous movements of members into and out of the household, are reported in column 5 of Table 2. Prior season household composition predicts current labor demand and recursion is again rejected. It is possible that there

[11] Following Udry (1999), demographic composition also predicts total farm production in the model with and without farm fixed effects.

are costs of moving into and out of the household and so we examine the relationship between farm labor demand and household composition in the next season as well. There is no reason to expect future household composition to be driven by unanticipated productivity and labor demand shocks in the current period, so these estimates should not be contaminated by reverse causality. Column 6 establishes that future household composition – particularly the number of males – also predicts current labor demand.

This suggests an instrumental variables approach to address concerns about endogeneity of household composition. Controlling farm household and time-specific community-fixed effects, conditional on current household composition, composition in prior seasons should have no impact on labor demand. Column 7 reports fixed effects instrumental variables estimates using lagged household composition as instruments. Maintaining that composition lagged three waves (which is a year prior to the interview) is exogenous, we do not reject that composition lagged two and one waves are also exogenous. All of the first stage estimates are well determined (with F test statistics for the identifying covariates ranging between 22 and 73 with 9 of the 12 test statistics exceeding 45; see Appendix Table A3). Treating household composition as endogenous has no impact on our substantive finding: household composition significantly predicts farm labor demand in the fixed effects instrumental variables model.[12]

An alternative strategy makes use of information on the demographic composition of non-coresident family members to combat concerns of endogenous migration. WISE tracks migrants out of baseline households and collects information on non co-resident family members so that it is possible to create the total number of co-resident and non co-resident family members associated with each baseline household. Conditional on household composition, family composition does not belong in the model of labor demand and provides instruments that address concerns with endogenous living arrangements of family members that are related to household-specific shocks. Recursion is rejected in these models. (The F statistic on demographic composition is 3.09 and the p-value is 0.0002.)

Labor demand by farm task

[12] It is possible that the overidentification test for household composition from three, two and one wave prior to the survey lacks power. We have checked that IV estimates are not substantively different using only three and two wave lags in household composition as instruments. In all cases, the first stage estimates and overidentification tests indicate the instruments are valid, the joint test of all demographic groups rejects recursion, and individual coefficient estimates are similarly significant and slightly larger than the model including one season lags in the instruments. In addition, we have estimated the model replacing the instruments with lagged changes in household composition during the prior three waves; recursion is rejected with a p value of 0.044 for all demographic covariates and 0.002 for males.

Labor demand peaks during the harvest season and migration is also highest at that time while it is less likely to be a concern during other times in the cropping cycle. The last three columns of the table display the effects of houshold composition on demand for labor separately for land preparation and caring for livestock; weeding, planting and fertilizing; and, third, harvesting. This stratification has an additional advantage. Principal agent problems are inherent in the farmer-hired worker relationship in settings where monitoring is costly and have been shown to be important for land preparation and caring for livestock (Rosenzweig and Wolpin, 1993) and it is possible that the rejection of recursion is concentrated on these activities. In contrast, it is easier to monitor harvesting and, possibly weeding and planting.

It is clear from the last three columns of Table 2 that household composition predicts demand for labor for each of these activities. Monitoring costs and shocks to seasonal migration patterns do not explain rejection of recursion.

Heterogeneity across farm households

The evidence presented in Table 2 establishes that the behavior of the average farm household is not consistent with the existence of complete markets. It is, however, possible that a subset of households invest in financial capital, family or social networks, risk diversification or risk mitigation strategies that serve as substitutes for missing markets. For such households, behavior may be consistent with complete markets. For example, there is evidence suggesting that wealthier and better-educated households are better able to cope with unanticipated shocks (Townsend, 1994; Frankenberg, Smith and Thomas, 2003).

To investigate this issue, the sample of farm households has been stratified by measures of resource availability and the labor demand functions have been estimated separately for each sub-sample. Results are reported in Table 3. We begin with better educated farmers who not only are likely to have better access to resources but are also likely to be better informed about markets and more able to exploit new technologies and entrepreneurial opportunities. The first panel of Table 3 stratifies the sample into three groups by the education of the household head: 16% who did not complete primary school, 63% who did not complete secondary school and the 21% who completed at least secondary school. For all three groups, including the better-educated, household composition is a significant predictor of farm labor demand. The same conclusion emerges when the sample is stratified by a measure of the cognitive ability of the household head and when households are stratified by the level of education of the best-educated adult in the household.

It is possible that it is financial resources rather than education or cognitive ability that are key in assuring that incomplete markets do not distort behaviors. The second and third panels in the table stratify farm households based on average real per capita household expenditure over the entire survey period which we interpret as a measure of longer run resource availability or "permanent income." Results in columns 4 and 5 of the table stratify households at the median of permanent income. While recursion is rejected for both groups, the effects of household composition are smaller for households with more resources.

We have investigated this more fully across the entire per capita expenditure distribution and find that there is evidence that household composition is not a significant predictor of demand for farm labor when we isolate the top 15 percent of households. Columns 6 through 8 of Table 3 report these results, with the bottom 15 percent of households included to reflect a group of similar sample size. None of the individual coefficients are significant in Column 8, and the joint test fails to rejection separation (F of 0.76, p-value = 0.69). We are unable to dig more deeply into why this is the case. Per capita expenditure is likely correlated with cognitive skills, including knowledge and farming skill, non-cognitive traits, network connections, savings, access to credit and many other characteristics. We do not have the power to separate these effects. Moreover, there are legitimate concerns regarding the power of the test. The estimated coefficients on 35-49 year old males and females in the top group are very close in magnitude to the estimates for the middle-income group and none of the coefficients on the demographics groups are significantly different between the two groups. The failure to reject recursion in the top income group is arguably largely driven by the relatively large standard errors.

We have also explored whether household composition predicts labor demand for several other sub-samples. These include households with only one adult member (who is likely to need hired labor) relative to households with many adults (and unlikely to hire labor); households with large plots (whose demand for labor is greater) and those with small plots; and households that experienced a negative weather shock (and may need help at that time). In all of these cases, household composition is a significant predictor of farm labor demand for every sub-sample.

While there are active labor markets across the entire study area, there is heterogeneity in the level of development, nature of markets and, importantly, for this study, the extent to which labor is hired for farm work. Stratifying communities into quintiles of the extent to which labor is hired in the local economy, we find that recursion is rejected in every sub-sample including those communities where over a third of labor demand is hired.[13]

The only sub-sample for which there is any evidence that recursion is not rejected is those

[13] Rejections hold across communities based on the level of inequality in landholdings as well (Bowlus and Sicular, 2003).

farm households in the top 15 percent of the resource distribution. We conclude that there is only modest evidence that some households behave as if there are complete markets. For the vast majority of farm households in the study area, the assumption that complete markets exist is not consistent with observed household behavior.

Reconciliation with results in Benjamin (1992)

In contrast with our results, Benjamin (1992) implemented the same test using data on farm households in rural Java collected in 1980 and could not reject the complete markets hypothesis. It is useful to investigate the reasons for these different conclusions.

It is possible that local economies have become less efficient over time in rural Java. That seems very unlikely. There has been a sustained and substantial increase in the use of hired labor in the agricultural sector over the last forty years with the majority of farm households both purchasing labor for their own farms while household members work off the farm (Booth, 2002). Agricultural production has been transformed over the last quarter century with the adoption of high yielding varieties of rice and diversification into other cash crops (Pearson et al., 1991).

Our investigation suggests that a more likely explanation lies in differences in the data. Benjamin used a business module administered as part of the 1980 Survei Sosial Ekonomi Nasional (National Socioeconomic Survey, SUSENAS), a multi-purpose cross-sectional survey conducted in February of each year by Statistics Indonesia.[14] At that time, the centerpiece (or core) of the survey, which was repeated every year on a new sample, was a detailed consumption module that took up the vast majority of interview time along with a listing of household members and their activities.

The business module was administered to a 10 percent subsample of households and has been administered only once. Questions are asked of the household head about sources of household business income and, for agricultural businesses, information about land holdings, choice of technology, labor and other inputs, and harvest and sales. Farmers are also asked to recall the number of person days provided by unpaid workers and the number of person days provided by paid workers and their total wage bill over the last 12 months. These questions are asked about each of six tasks (e.g. planting, harvesting). Unpaid workers are assumed to be family workers. Benjamin (1992) estimates that the average farm household that produced rice in Java used 104.5 person days of labor in the prior year of which 78.2 person days were hired workers and 26.3 person days were contributed by household members.

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[14] Unfortunately, the micro-data from the Agricultural Supplement (Section IV) to the 1980 SUSENAS is no longer available from Statistics Indonesia and we have been unable to locate the data from any other source.

This estimate of household labor appears to be very low. First, it implies that one household member worked on the farm for one day in each fortnight of the previous year. This seems unlikely since the average farm household had 1.4 males and 1.4 females, rice was cropped three times a year at the time, and rice farming is the primary activity of the farm households examined in Benjamin.

Second, the activity module of the SUSENAS core provides a check on this estimate. For each household member age 10 and older, the household head reports whether the person worked and, if so, whether the person worked in a family business and the number of hours worked in the past week. Benjamin (1989) summarizes those data. For the same Javanese rice farmers, the household head reported that in the last week, male household members worked 28.5 hours, female household members worked 14.2 hours, and so the average household provided 42.7 hours of labor for the household businesses in the week before the survey. This is at least 4.5 person days in the last week and, if the previous week was not unusual, around 200 to 250 person days in the last year.

It is possible that households had many farm businesses and that only about one-tenth of their labor (26 person days) was allocated to rice farming. While other businesses likely account for some of the time, it is unlikely that they account for ninety percent of the time since rice farming is the primary activity of the households. It seems more likely that unpaid labor reported in the business module is a substantial under-estimate, possibly, in part, because of the substantial cognitive demands of recalling over the last 12 months the number of person days of household labor worked on the farm.

Third, Hart (1978) followed rice farmers in Central Java as part of an intensive ethnographic study. She estimates that the average household provided about 202 person days of labor on the family farm, which is much closer to the estimate from the SUSENAS core module than the estimate reported in the business module. (Hart did not enumerate hired labor.)

In contrast with the design of SUSENAS, in WISE each household member reports the amount of labor supplied on the farm over the last four months, and hired labor for the last four months is reported by the person who manages the farm. Farm labor demand is the sum of all these components. It amounts to nearly 220 person days aggregated over the last 12 months, of which one-quarter is hired and over 160 days of labor are provided by household members. This estimate is closer to Hart and the SUSENAS activity module; again the SUSENAS business module appears to be very low.

It is not straightforward to draw comparisons over time; average farm size has declined, technology has changed as high yield rice varieties have been adopted, household size has declined and labor productivity on and off the farm has changed. However, it is straightforward to adjust for a key change that likely captures much of the variation in labor intensity over time: the decline in farm sizes. According to Benjamin (1992), in the 1980 SUSENAS, the average farm uses 220 person days of labor per hectare of which less than one-quarter, 50 person days per hectare, was provided by household members. Hart estimates that rice farm household members worked 404 person days of labor per hectare of land cultivated in 1978. This is eight times the estimate in the SUSENAS business module. In WISE, it is estimated that farm household members work 490 person days per hectare on the farm which is very close to Hart's estimate. Total demand for labor per hectare in WISE is 660 person days per year. This suggests that labor intensity in rice cultivation has increased over time, which is plausible given the smaller farm sizes, shift to high yield varieties and increased use of other inputs.

It is also possible to compare sources of income across surveys. Statistics Indonesia has conducted an Agricultural Census every decade since 1983. Those data document that in 1983, 83% of total farm household income was earned from agricultural activities and the rest was from non-farm work (Rusastra, Lokollo, and Friyanto, 2009). It is difficult to reconcile this estimate with the 1980 SUSENAS estimate of only one-quarter of farm labor being provided by household members. The Agricultural Census also documents a secular decline in the share of household income from agriculture as more off farm opportunities have arisen. In 2003, 69.5% of the income of farm households was from farm work (Rusastra, Lokollo, and Friyanto, 2009). The estimate of the share of income from agriculture in farm households in WISE is very close: 71%.

The balance of evidence points to the 1980 SUSENAS data on farm work by household members being implausibly low. We have explored whether this is likely to lead to failing to reject recursion. The labor use data in WISE have been reweighted to match the first moment of household labor supply in Benjamin (1992) and we have replicated his specification of the demand for farm labor with farm fixed effects. None of the household demographics is individually significant nor are they jointly significant. Recursion cannot be rejected. However, this conclusion is reversed if the models do not include farm fixed effects or if the demographics are specified as the number of household members in gender and age groups as in [8].

We conclude, based on the evidence in WISE, that household behavior is not consistent with the existence of complete markets for the vast majority of households, with the possible exception of those at the top of the income distribution.

6. Conclusion

Family-run farms and microenterprises play an important role in low income settings and are thought to be key drivers of global growth. In order to understand labor markets, consumption and investment choices of these households, as well as formulate and evaluate policies, it is essential to model the opportunities and constraints farm households face. Using longitudinal survey data from Central Java, Indonesia, this research has rejected an implication of the model of a farm household under the assumption that markets are complete: the assumption that there is a separation between production and consumption decisions is not consistent with the data. Specifically, with complete markets, household demographic composition should not be related to the demand for farm labor. This implication is rejected even after taking into account time invariant unobserved heterogeneity at the farm level and time-varying shocks at the community level. Moreover, recursion is rejected in models that utilize changes in household composition that are driven exclusively by aging; in models that delink contemporaneous changes in household composition and demand for labor; in models that treat changes in household composition as endogenous; and in models that examine labor demand for separate farm tasks that vary in the extent to which monitoring costs and migration are likely to be salient.

These conclusions contrast with much of the prevailing wisdom and empirical practice in the literature. Understanding the nature and sources of market incompleteness in rural economies is likely to be a profitable enterprise.

References

Akresh, R. and E. V. Edmonds (2012): "Sibling Rivalry, Residential Rivalry, and Constraints on the Availability of Child Labor," Working Paper.

Bardasi, E., K. Beegle, A. Dillon, and P. Serneels (2011): "Do Labor Statistics Depend on How and to Whom the Questions are Asked? Results from a Survey Experiment in Tanzania," *World Bank Economic Review*, 25 (3), 418–447.

Barnum, H. and L. Squire (1979): "An Econometric Application of the Theory of the Farm Household," *Journal of Development Economics*, 6 (1), 79–102.

Beaman, L., D. Karlan, B. Thuysbaert, and C. Udry (2015): "Selection into Credit Markets: Evidence from Agriculture in Mali," Working Paper.

Beegle, K., C. Carletto, and K. Himelein (2012): "Reliability of Recall in Agricultural Data," *Journal of Development Economics*, 98 (1), 34–41.

Behrman, J. R. (1999): "Labor Markets in Developing Countries," in *Handbook of Labor Economics*, Vol. 3, ed. by O. Ashenfelter and D. Card, Amsterdam: North-Holland.

Benjamin, D. (1989): *An Econometric Analysis of Farm Labor Demand in Rural Java*, Doctoral dissertation, Princeton University.

Benjamin, D. (1992): "Household Composition, Labor Markets, and Labor Demand: Testing for Separation in Agricultural Household Models," *Econometrica,* 60 (2), 287–322.

Booth, A. (2002): "The changing role of non-farm activities in agricultural households in Indonesia: Some insights from the agricultural census," *Bulletin of Indonesian Economic Studies*, 38 (2), 179–200.

Bowlus, A. J. and T. Sicular (2003): "Moving Toward Markets? Labor Allocation in Rural China," *Journal of Development Economics*, 71 (2), 561–583.

Deaton, A., J. Ruiz-Castillo, and D. Thomas (1989): "The Influence of Household Composition on Household Expenditure Patterns: Theory and Spanish Evidence," *Journal of Political Economy*, 97 (1), 179-200.

Dillon, B. and C. B. Barrett (2015): "Agricultural Factor Markets in Sub-Saharan Africa: An Updated View with Formal Tests for Market Failure," Working Paper.

Frankenberg, E., J. Smith, and D. Thomas (2003): "Economic shocks, wealth, and welfare," *Journal of Human Resources*, 38 (2), 280-321.

Field, E. (2007): "Entitled to Work: Urban Property Rights and Labor Supply in Peru," *Quarterly Journal of Economics,* 122 (4), 1561–1602.

Grimard, F. (2000): "Rural Markets, Household Composition, and Rainfall in Côte d'Ivoire," *Review of Development Economics*, 4 (1), 70–86.

Hart, G. (1978): *Labor Allocation Strategies in Rural Javanese Households*, Doctoral dissertation, Cornell University.

Jacoby, H. (1993): "Shadow Wages and Peasant Family Labour Supply: An Econometric Application to the Peruvian Sierra," *The Review of Economic Studies*, 60 (4), 903–921.

Jayachandran, S. (2006): “Selling Labor Low: Wage Responses to Productivity Shocks in Developing Countries,” *Journal of Political Economy*, 114 (3), 538–575.

Kaboski, J. P. and R. M. Townsend (2011): “A structural evaluation of a large-scale quasi-experimental microfinance initiative,” *Econometrica*, 79 (5), 1357–1406.

Kaur, S. (2015): “Nominal Wage Rigidity in Village Labor Markets,” Working Paper.

Kochar, A. (1999): “Smoothing Consumption by Smoothing Income: Hours-of-work Responses to Idiosyncratic Agricultural Shocks in Rural India,” *Review of Economics and Statistics*, 81 (1), 50–61.

Lopez, R. (1984): “Estimating Labor Supply and Production Decisions of Self-Employed Farm Producers,” *European Economic Review*, 24 (1), 61–82.

Lopez, R. (1986): “Structural Models of the Farm Household that Allow for Interdependent Utility and Profit Maximization Decisions,” in *Agricultural Household Models: Extensions, Applications, and Policy*, ed. by I. Singh, L. Squire, and J. Strauss, Baltimore: Johns Hopkins University Press.

Mobarak, A. M. and M. Rosenzweig (2014): “Risk, insurance and wages in general equilibrium,” Working Paper.

Pearson, S., W. Falcon, P. Heytens, E. Monke, and R. Naylor (1991): *Rice Policy in Indonesia*, Ithaca: Cornell University Press.

Pitt, M. and M. Rosenzweig (1986): “Agricultural Prices, Food Consumption and the Health and Productivity of Indonesian Farmers,” in *Agricultural Household Models: Extensions, Applications, and Policy*, ed. by I. Singh, L. Squire, and J. Strauss, Baltimore: Johns Hopkins University Press.

Rosenzweig, M. and O. Stark (1989): “Consumption Smoothing, Migration and Marriage: Evidence from Rural India,” *Journal of Political Economy*, 97 (4), 905-26.

Rosenzweig, M. and K. Wolpin (1993): “Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income Countries: Investments in Bullocks in India,” *Journal of Political Economy*, 101 (2), 223-224.

Rusastra, I W., E. Lokollo, and S. Friyatno (2009): “Land and household economy: Analysis of agricultural census 1983-2003,” in *Proceeding of the National Seminar on Land and Household Economy 1970-2005: Changing road for poverty reduction,* ed. by I. W. Rusastra, S. Pasaribu, and Y. Yusdja, ICASEPS and UNESCAP-CAPSA.

Schultz, T. P. (2001): “Women’s Roles in the Agricultural Household: Bargaining and Human Capital Investments,” in *Handbook of Agricultural Economics*, Vol. 1, ed. by B. Gardner and G. Rausser, Amsterdam: North-Holland.

Singh, I., L. Squire, and J. Strauss, eds, (1986): *Agricultural Household Models: Extensions, Applications, and Policy*, Baltimore: Johns Hopkins University Press.

Stiglitz, J. (1974): “Incentives and Risk Sharing in Sharecropping,” *Review of Economic Studies*, 41 (2), 219-255.

Strauss, J. (1982): “Determinants of Food Consumption in Rural Sierra Leone: Application of the Quadratic Expenditure System to the Consumption-Leisure Component of a Household-Firm Model,” *Journal of Development Economics*, 11 (3), 327–353.

Strauss, J. (1986): "Does Better Nutrition Raise Farm Productivity?" *Journal of Political Economy*, 94 (2), 297–320.

Strauss, J. and D. Thomas (1995): "Human Resources: Empirical Modeling of Household and Family Decisions," in *Handbook of Development Economics*, Vol. 3, ed. by J. Behrman and T. N. Srinivasan, Amsterdam: North-Holland.

Suri, T. (2011): "Selection and Comparative Advantage in Technology Adoption," *Econometrica*, 79 (1), 159-209.

Taylor, J. E. and I. Adelman (2003): "Agricultural Household Models: Genesis, Evolution, and Extensions," *Review of Economics of the Household*, 1 (1), 33–58.

Thomas, D., E. Frankenberg, J. Friedman, J. Habicht, M. Hakimi, N. Ingwersen, Jaswadi, N. Jones, C. McKelvey, G. Pelto, B. Sikoki, T. Seeman, J. P. Smith, C. Sumantari, W. Suriastini, and S. Wilopo (2011): "Causal Effect of Health on Labor Market Outcomes: Experimental Evidence," Working Paper.

Townsend, R. M. (1994): "Risk and Insurance in Village India," *Econometrica*, 62 (3), 539–591.

Udry, C. (1996): "Gender, Agricultural Production and the Theory of the Household," *Journal of Political Economy*, 104 (5), 1010–1046.

Udry, C. (1999): "Efficiency and Market Structure: Testing for Profit Maximization in African Agriculture," in *Trade, Growth and Development: Essays in Honor of T.N. Srinivasan*, ed. by G. Ranis and L. K. Raut, Amsterdam: Elsevier Science.

White, D. and T. Schweizer (1998): "Kinship, Property and Stratification in Rural Java: A Network Analysis," in *Kinship, Networks, and Exchange*, ed. by D. White and T. Schweizer, Cambridge: Cambridge University Press.

Yotopolous, P. and L. Lau (1974): "On Modeling the Agricultural Sector in Developing Economies," *Journal of Development Economics*, 1 (2), 105–127.

Table 1. Summary Statistics

Panel A — Farm Characteristics

	Mean
	(1)
Rice Farm (%)	84.89
Own Land (%)	73.20
Size of Land Owned (m^2)	2,076.45
	(70.72)
Value of Farm Assets (Rp0,000)	236.29
	(4.50)
Value of Non-Farm Assets (Rp0,000)	433.85
	(5.23)
Age of [...]	
Male Household Head	54.44
	(0.07)
Female Head or Spouse	49.18
	(0.06)
Years of Education of [...]	
Male Household Head	6.06
	(0.02)
Female Head or Spouse	4.98
	(0.02)
N. Households	4,452
N. Household-wave Obs.	38,189

Panel B — Household Composition

	Mean	**Percent with a Change**
	(2)	(3)
Household Size	3.83	58.67
	(0.008)	
Number of Males Age [...]		
0 to 14 years	0.51	28.05
	(0.004)	
15 to 19	0.19	26.42
	(0.002)	
20 to 34	0.30	26.48
	(0.003)	
35 to 49	0.36	22.08
	(0.003)	
50 to 64	0.31	23.54
	(0.002)	
65 and older	0.30	15.61
	(0.002)	
Number of Females Age [...]		
0 to 14 years	0.47	25.38
	(0.004)	
15 to 19	0.14	23.43
	(0.002)	
20 to 34	0.27	25.81
	(0.002)	
35 to 49	0.41	23.29
	(0.003)	
50 to 64	0.34	24.78
	(0.002)	
65 and older	0.25	17.07
	(0.002)	
Any Change in Household Composition (%)		77.81

Panel C — Farm Labor in the Last 4 Months

	Mean
	(4)
Person Days of [...]	
Total Labor Demand	72.45
	(0.30)
Family Supplied Labor	54.38
	(0.22)
Hired Labor	18.07
	(0.19)
Family labor supplied by [...]	
Male Household Members	40.33
	(0.18)
Female Household Members	14.05
	(0.10)
Person Days Hired for [...]	
Planting	6.39
	(0.07)
Harvesting	4.86
	(0.07)
Weeding	4.10
	(0.08)
Other Farm Tasks	2.72
	(0.08)

Notes. Table reports means and standard errors in parentheses for variables of interest. The sample consists of households with farm businesses, approximately 75% of households in the survey. All labor measured as unconditional means of person days over the past 4 months, and assets as January 2002 Rp 10,000.

Table 2. Labor Demand (log of person days per season) and Household Composition

	A. Pooled Cross-Sections		B. Including Farm-Household Fixed Effects					C. Labor Demand by Farm Task		
Household demographic composition	N. Household Members (1)	Household Size and Shares (2)	N. Household Members (3)	Variation from Aging Only (4)	Prior Composition (5)	Next Period Composition (6)	1, 2, and 3 Period Lagged Composition as IVs (7)	Land Prep Livestock Dry/Sell/ Mill (8)	Weeding Planting Fertilizing (9)	Harvesting (10)
Number of males in farm HH										
0 to 14 years	0.02	-	-0.001	-	-0.03	0.03	0.01	-0.01	-0.01	-0.03
	(0.01)		(0.016)		(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
15 to 19	0.11	0.40	0.09	0.09	0.05	0.07	0.09	0.16	0.07	0.06
	(0.02)	(0.08)	(0.02)	(0.05)	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
20 to 34	0.17	0.59	0.13	0.15	0.09	0.05	0.21	0.14	0.09	0.12
	(0.01)	(0.07)	(0.02)	(0.11)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
35 to 49	0.23	0.65	0.16	0.15	0.09	0.01	0.20	0.17	0.12	0.19
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.08)	(0.05)	(0.03)	(0.04)
50 to 64	0.32	0.76	0.22	0.24	0.08	0.08	0.22	0.22	0.16	0.24
	(0.03)	(0.09)	(0.03)	(0.12)	(0.04)	(0.03)	(0.10)	(0.06)	(0.04)	(0.05)
65 and older	0.21	0.45	0.20	0.24	0.06	0.08	0.20	0.17	0.14	0.19
	(0.03)	(0.10)	(0.04)	(0.14)	(0.04)	(0.03)	(0.11)	(0.06)	(0.04)	(0.05)
Number of females in farm HH										
0 to 14 years	-0.02	-0.15	-0.04	-	-0.02	0.003	-0.02	-0.03	-0.05	-0.03
	(0.01)	(0.07)	(0.02)		(0.02)	(0.017)	(0.05)	(0.03)	(0.02)	(0.03)
15 to 19	0.02	0.10	-0.01	0.02	-0.002	-0.001	-0.01	0.01	-0.02	-0.02
	(0.02)	(0.08)	(0.02)	(0.05)	(0.018)	(0.018)	(0.04)	(0.03)	(0.02)	(0.03)
20 to 34	0.04	0.12	0.06	0.23	0.05	0.01	0.04	0.05	0.06	0.07
	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
35 to 49	0.09	0.30	0.16	0.33	0.12	0.04	0.23	0.07	0.13	0.11
	(0.02)	(0.09)	(0.03)	(0.11)	(0.03)	(0.03)	(0.08)	(0.05)	(0.03)	(0.04)
50 to 64	0.10	0.27	0.13	0.35	0.08	0.06	0.18	0.04	0.13	0.11
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.09)	(0.05)	(0.04)	(0.05)
65 and older	-0.05	-0.10	0.05	0.26	0.03	-0.01	0.05	-0.05	0.06	0.07
	(0.02)	(0.09)	(0.03)	(0.13)	(0.03)	(0.03)	(0.09)	(0.05)	(0.03)	(0.05)
Log Household Size		0.34								
		(0.03)								
Tests for joint significance of demographic composition										
All Groups	37.27	33.65	13.13	2.53	5.01	4.21	2.99	6.19	5.40	4.89
p-value	0.00	0.00	0.00	0.005	0.00	0.00	0.00	0.00	0.00	0.00
Males	49.88	21.67	18.27	1.90	6.08	5.79	3.63	9.71	6.80	6.63
p-value	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Females	10.58	10.99	7.70	2.78	3.45	1.95	1.86	1.31	3.84	1.82
p-value	0.00	0.00	0.00	0.02	0.00	0.07	0.08	0.25	0.00	0.09
Prime age adults	45.13	14.55	22.52	2.19	8.88	4.86	5.51	10.02	9.71	7.85
p-value	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
C-test - 1 and 2 Period Lags (χ^2)							15.19			
p-value							0.92			
Observations	38,189	38,189	38,189	11,594	33,737	33,737	25,739	27,387	33,166	24,353
N. Households	4,452	4,452	4,452	1,584	4,096	4,096	3,783	4,176	4,166	4,022

Notes. Standard errors in parentheses below coefficient estimates. All estimates of variance-covariances take into account clustering at the household level and allow arbitrary heteroskedasticity. Joint tests for the significance of demographic groups are F-statistics. The C-test is an overidentification test examining the exogeneity of 1 and 2 period lags conditional on the validity of the 3 period lags. All models control quintiles of farm and household (real) assets, age and education of the household head and spouse, month of interview indicators, and community-time fixed effects. Column 2 enters demographics as log(household size) and the share of 11 of the 12 demographic groups. Columns 3 through 10 include farm household fixed effects. As column 4 limits the sample to household with the same males and females across waves, changes in demographic composition do not change household size and are therefore interpreted relative to the omitted demographic group (age less than 15).

Table 3. Labor Demand for Stratified Samples

	Household Head's Years of Education			Position in Per Capita Expenditure Distribution				
	5 or Less	6 to 11	12 or More	Bottom 50%	Top 50%	Bottom 15%	Middle 70%	Top 15%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of males in farm HH								
0 to 14 years	0.03	-0.01	0.02	-0.01	0.01	-0.05	0.01	-0.03
	(0.04)	(0.02)	(0.04)	(0.02)	(0.03)	(0.04)	(0.02)	(0.06)
15 to 19	0.10	0.07	0.11	0.10	0.06	0.09	0.09	0.04
	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)	(0.05)	(0.02)	(0.05)
20 to 34	0.11	0.14	0.09	0.16	0.11	0.16	0.15	0.07
	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)	(0.04)	(0.02)	(0.06)
35 to 49	0.08	0.16	0.20	0.24	0.10	0.34	0.16	0.11
	(0.09)	(0.04)	(0.06)	(0.04)	(0.05)	(0.07)	(0.03)	(0.11)
50 to 64	0.11	0.22	0.31	0.29	0.15	0.33	0.21	0.14
	(0.10)	(0.04)	(0.07)	(0.05)	(0.05)	(0.09)	(0.04)	(0.10)
65 and older	0.22	0.20	0.21	0.27	0.11	0.30	0.21	0.03
	(0.12)	(0.04)	(0.08)	(0.05)	(0.05)	(0.10)	(0.04)	(0.11)
Number of females in farm HH								
0 to 14 years	-0.08	-0.06	0.04	-0.04	-0.03	-0.05	-0.03	-0.05
	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)	(0.05)	(0.02)	(0.06)
15 to 19	0.12	-0.02	-0.04	0.01	-0.04	-0.09	0.001	-0.03
	(0.05)	(0.02)	(0.04)	(0.02)	(0.02)	(0.05)	(0.02)	(0.05)
20 to 34	0.12	0.05	0.04	0.07	0.06	0.09	0.06	0.05
	(0.06)	(0.02)	(0.05)	(0.03)	(0.03)	(0.05)	(0.02)	(0.06)
35 to 49	0.24	0.13	0.26	0.17	0.14	0.18	0.16	0.15
	(0.08)	(0.03)	(0.06)	(0.03)	(0.04)	(0.06)	(0.03)	(0.09)
50 to 64	0.16	0.10	0.22	0.14	0.10	0.06	0.15	0.09
	(0.09)	(0.03)	(0.06)	(0.04)	(0.04)	(0.07)	(0.03)	(0.09)
65 and older	0.14	0.003	0.10	0.09	-0.003	0.05	0.06	0.06
	(0.10)	(0.03)	(0.06)	(0.04)	(0.04)	(0.07)	(0.03)	(0.08)
Joint test of demographic variables								
All Groups	2.50	9.12	4.52	10.15	4.17	4.19	10.55	0.76
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69
Mean person days of […]								
Hired Labor	10.59	16.83	28.29	11.19	25.02	7.91	16.94	33.89
Family Farm Labor	57.44	57.16	42.18	59.26	49.46	61.30	55.76	40.86
Observations	5,575	25,417	7,197	19,179	19,010	5,862	26,616	5,711
N. Households	695	2,820	937	2,226	2,226	780	2,942	730

Notes. Standard errors in parentheses below coefficient estimates. Table reports estimates of labor demand regressions for stratified samples. All estimates of variance-covariances take into account clustering at the household level and allow arbitrary heteroskedasticity. Joint tests for the significance of demographic groups are F-statistics. All models control quintiles of farm and household (real) assets, age and education of the household head and spouse, month of interview indicators, community-time fixed effects and farm household fixed effects.

Appendix Table A1. Labor Demand (log of person days per season) and Household Composition

	A. Pooled Cross-Sections		B. Including Farm-Household Fixed Effects					C. Labor Demand by Farm Task		
Household demographic composition	N. Household Members (1)	Household Size and Shares (2)	N. Household Members (3)	Variation from Aging Only (4)	Prior Composition (5)	Next Period Composition (6)	1, 2, and 3 Period Lagged Composition as IVs (7)	Land Prep Livestock Dry/Sell/ Mill (8)	Weeding Planting Fertilizing (9)	Harvesting (10)
Number of males in farm HH										
0 to 14 years	0.02	-	-0.001	-	-0.03	0.03	0.01	-0.01	-0.01	-0.03
	(0.01)		(0.016)		(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
15 to 19	0.11	0.40	0.09	0.09	0.05	0.07	0.09	0.16	0.07	0.06
	(0.02)	(0.08)	(0.02)	(0.05)	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
20 to 34	0.17	0.59	0.13	0.15	0.09	0.05	0.21	0.14	0.09	0.12
	(0.01)	(0.07)	(0.02)	(0.11)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
35 to 49	0.23	0.65	0.16	0.15	0.09	0.01	0.20	0.17	0.12	0.19
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.08)	(0.05)	(0.03)	(0.04)
50 to 64	0.32	0.76	0.22	0.24	0.08	0.08	0.22	0.22	0.16	0.24
	(0.03)	(0.09)	(0.03)	(0.12)	(0.04)	(0.03)	(0.10)	(0.06)	(0.04)	(0.05)
65 and older	0.21	0.45	0.20	0.24	0.06	0.08	0.20	0.17	0.14	0.19
	(0.03)	(0.10)	(0.04)	(0.14)	(0.04)	(0.03)	(0.11)	(0.06)	(0.04)	(0.05)
Number of females in farm HH										
0 to 14 years	-0.02	-0.15	-0.04	-	-0.02	0.003	-0.02	-0.03	-0.05	-0.03
	(0.01)	(0.07)	(0.02)		(0.02)	(0.017)	(0.05)	(0.03)	(0.02)	(0.03)
15 to 19	0.02	0.10	-0.01	0.02	-0.002	-0.001	-0.01	0.01	-0.02	-0.02
	(0.02)	(0.08)	(0.02)	(0.05)	(0.018)	(0.018)	(0.04)	(0.03)	(0.02)	(0.03)
20 to 34	0.04	0.12	0.06	0.23	0.05	0.01	0.04	0.05	0.06	0.07
	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
35 to 49	0.09	0.30	0.16	0.33	0.12	0.04	0.23	0.07	0.13	0.11
	(0.02)	(0.09)	(0.03)	(0.11)	(0.03)	(0.03)	(0.08)	(0.05)	(0.03)	(0.04)
50 to 64	0.10	0.27	0.13	0.35	0.08	0.06	0.18	0.04	0.13	0.11
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.09)	(0.05)	(0.04)	(0.05)
65 and older	-0.05	-0.10	0.05	0.26	0.03	-0.01	0.05	-0.05	0.06	0.07
	(0.02)	(0.09)	(0.03)	(0.13)	(0.03)	(0.03)	(0.09)	(0.05)	(0.03)	(0.05)
Log Household Size		0.34								
		(0.03)								
Quintiles of Farm Assets (quintile 1 omitted)										
Quintile 2	0.23	0.23	0.11	0.08	0.12	0.09	0.11	0.12	0.06	0.02
	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
Quintile 3	0.42	0.42	0.19	0.16	0.20	0.17	0.19	0.29	0.06	0.05
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
Quintile 4	0.62	0.62	0.24	0.22	0.26	0.21	0.24	0.41	0.08	0.09
	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintile 5	0.83	0.84	0.34	0.28	0.34	0.31	0.32	0.52	0.13	0.14
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintiles of Household Assets (quintile 1 omitted)										
Quintile 2	0.04	0.04	0.06	0.05	0.05	0.05	0.04	0.02	0.05	0.05
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Quintile 3	0.04	0.03	0.06	0.05	0.05	0.06	0.05	0.01	0.07	0.06
	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Quintile 4	0.06	0.05	0.10	0.09	0.08	0.10	0.07	0.06	0.08	0.10
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintile 5	-0.00	-0.01	0.10	0.11	0.09	0.10	0.07	0.05	0.09	0.09
	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)

Appendix Table A1 - *Continued*

	A. Pooled Cross-Sections		B. Including Farm-Household Fixed Effects					C. Labor Demand by Farm Task		
	N. Household Members	Household Size and Shares	N. Household Members	Variation from Aging Only	Prior Composition	Next Period Composition	1, 2, and 3 Period Lagged Composition as IVs	Land Prep Livestock Dry/Sell/ Mill	Weeding Planting Fertilizing	Harvesting
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Age, Education, Presence of HH Head and Spouse										
Primary Male's Age	-0.003	-0.001	-0.0005	-0.0004	-0.0001	0.002	-0.002	-0.002	0.003	-0.004
	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)
Primary Male's Education	-0.016	-0.015	-0.001	-0.006	-0.002	0.001	-0.003	0.001	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)
Primary Male Present	0.30	0.29	0.25	-0.09	0.40	0.31	0.27	0.31	0.15	0.16
	(0.03)	(0.04)	(0.05)	(0.19)	(0.05)	(0.06)	(0.09)	(0.08)	(0.06)	(0.07)
Primary Female's Age	0.002	0.003	0.001	0.007	0.002	0.002	0.003	0.002	-0.002	-0.0001
	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Primary Female's Education	-0.010	-0.011	0.003	0.001	0.003	0.003	0.004	-0.004	0.004	-0.003
	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)
Primary Female Present	0.18	0.19	0.08	-0.21	0.15	0.17	0.08	0.10	0.07	0.01
	(0.04)	(0.04)	(0.04)	(0.17)	(0.04)	(0.05)	(0.07)	(0.07)	(0.05)	(0.06)
Interview Month Indicators (January omitted)										
February	0.13	0.14	0.13	0.28	0.15	0.07	0.13	0.004	0.18	0.01
	(0.06)	(0.06)	(0.06)	(0.11)	(0.06)	(0.06)	(0.06)	(0.11)	(0.07)	(0.13)
March	0.23	0.22	0.24	0.54	0.21	0.19	0.17	0.05	0.36	0.16
	(0.08)	(0.08)	(0.07)	(0.14)	(0.08)	(0.08)	(0.09)	(0.13)	(0.09)	(0.16)
April	0.10	0.10	0.22	0.48	0.29	0.17	0.26	-0.02	0.31	0.25
	(0.10)	(0.10)	(0.09)	(0.16)	(0.12)	(0.10)	(0.11)	(0.15)	(0.11)	(0.18)
May	0.12	0.13	0.16	0.55	0.30	0.12	0.25	0.07	0.18	0.16
	(0.11)	(0.11)	(0.10)	(0.19)	(0.14)	(0.11)	(0.12)	(0.16)	(0.12)	(0.19)
June	0.16	0.17	0.14	0.49	0.27	0.07	0.18	0.16	0.04	0.23
	(0.12)	(0.12)	(0.11)	(0.20)	(0.14)	(0.12)	(0.13)	(0.17)	(0.13)	(0.19)
July	0.15	0.16	0.17	0.45	0.29	0.12	0.18	0.20	0.06	0.24
	(0.12)	(0.12)	(0.12)	(0.21)	(0.15)	(0.13)	(0.14)	(0.18)	(0.14)	(0.19)
August	0.21	0.22	0.15	0.60	0.27	0.16	0.004	0.23	0.04	0.29
	(0.13)	(0.13)	(0.13)	(0.22)	(0.15)	(0.14)	(0.15)	(0.18)	(0.15)	(0.19)
September	0.12	0.12	0.14	0.78	0.24	0.18	-0.04	0.21	-0.03	0.24
	(0.14)	(0.14)	(0.14)	(0.24)	(0.16)	(0.16)	(0.17)	(0.19)	(0.16)	(0.20)
October	0.02	0.04	0.09	0.80	0.18	0.15	-0.16	0.16	-0.31	0.38
	(0.16)	(0.16)	(0.15)	(0.26)	(0.18)	(0.17)	(0.18)	(0.18)	(0.17)	(0.21)
November	-0.09	-0.07	-0.13	0.72	-0.06	-0.10	-0.14	0.18	-0.38	0.04
	(0.23)	(0.23)	(0.20)	(0.45)	(0.23)	(0.21)	(0.26)	(0.23)	(0.27)	(0.28)
December	-0.14	-0.15	-0.08	-0.13	-0.07	-0.04	-0.05	-0.04	-0.22	0.09
	(0.07)	(0.07)	(0.06)	(0.13)	(0.06)	(0.06)	(0.07)	(0.10)	(0.10)	(0.14)
Tests for joint significance of demographic composition										
All Groups	37.27	33.65	13.13	2.53	5.01	4.21	2.99	6.19	5.40	4.89
p-value	0.00	0.00	0.00	0.005	0.00	0.00	0.00	0.00	0.00	0.00
Males	49.88	21.67	18.27	1.90	6.08	5.79	3.63	9.71	6.80	6.63
p-value	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Females	10.58	10.99	7.70	2.78	3.45	1.95	1.86	1.31	3.84	1.82
p-value	0.00	0.00	0.00	0.02	0.00	0.07	0.08	0.25	0.00	0.09
Prime age adults 15 to 49	45.13	14.55	22.52	2.19	8.88	4.86	5.51	10.02	9.71	7.85
p-value	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
C-test - 1 and 2 Period Lags (χ^2)							15.19			
p-value							0.92			
Observations	38,189	38,189	38,189	11,594	33,737	33,737	25,739	27,387	33,166	24,353
N. Households	4,452	4,452	4,452	1,584	4,096	4,096	3,783	4,176	4,166	4,022

Notes. Standard errors in parentheses below coefficient estimates. All estimates of variance-covariances take into account clustering at the household level and allow arbitrary heteroskedasticity. Joint tests for the significance of demographic groups are F-statistics. The C-test is an overidentification test examining the exogeneity of 1 and 2 period lags conditional on the validity of the 3 period lags. Column 2 enters demographics as log(household size) and the share of 11 of the 12 demographic groups. All columns include community-time fixed effects and columns 3 through 10 include farm household fixed effects.

Appendix Table A2. Labor Demand (log of person days per season) and Household Composition Including Land Controls

	A. Pooled Cross-Sections		B. Including Farm-Household Fixed Effects					C. Labor Demand by Farm Task		
Household demographic composition	N. Household Members	Household Size and Shares	N. Household Members	Variation from Aging Only	Prior Composition	Next Period Composition	1, 2, and 3 Period Lagged Composition as IVs	Land Prep Livestock Dry/Sell/ Mill	Weeding Planting Fertilizing	Harvesting
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Number of males in farm HH										
0 to 14 years	0.02	-	-0.0002	-	-0.03	0.03	0.01	-0.01	-0.01	-0.04
	(0.01)		(0.02)		(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
15 to 19	0.11	0.40	0.09	0.08	0.05	0.07	0.09	0.16	0.07	0.06
	(0.02)	(0.07)	(0.02)	(0.05)	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
20 to 34	0.17	0.56	0.13	0.16	0.09	0.05	0.21	0.14	0.09	0.12
	(0.01)	(0.07)	(0.02)	(0.11)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
35 to 49	0.21	0.57	0.16	0.15	0.09	0.01	0.20	0.17	0.12	0.19
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.08)	(0.05)	(0.03)	(0.04)
50 to 64	0.30	0.68	0.22	0.25	0.08	0.08	0.21	0.22	0.15	0.23
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.10)	(0.06)	(0.04)	(0.05)
65 and older	0.20	0.39	0.19	0.25	0.06	0.07	0.18	0.17	0.13	0.19
	(0.03)	(0.10)	(0.03)	(0.14)	(0.04)	(0.03)	(0.11)	(0.06)	(0.04)	(0.05)
Number of females in farm HH										
0 to 14 years	-0.01	-0.16	-0.04	-	-0.02	0.001	-0.02	-0.03	-0.05	-0.03
	(0.01)	(0.07)	(0.02)		(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
15 to 19	0.03	0.09	-0.01	0.02	-0.00	0.00004	-0.02	0.01	-0.02	-0.02
	(0.02)	(0.08)	(0.02)	(0.05)	(0.02)	(0.02)	(0.04)	(0.03)	(0.02)	(0.03)
20 to 34	0.03	0.05	0.06	0.22	0.05	0.01	0.04	0.05	0.06	0.07
	(0.02)	(0.09)	(0.02)	(0.10)	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.03)
35 to 49	0.08	0.24	0.15	0.32	0.12	0.04	0.22	0.07	0.13	0.11
	(0.02)	(0.09)	(0.03)	(0.11)	(0.03)	(0.03)	(0.08)	(0.05)	(0.03)	(0.04)
50 to 64	0.09	0.20	0.12	0.33	0.07	0.06	0.17	0.04	0.12	0.11
	(0.02)	(0.09)	(0.03)	(0.12)	(0.03)	(0.03)	(0.09)	(0.05)	(0.03)	(0.05)
65 and older	-0.06	-0.17	0.04	0.25	0.03	-0.01	0.04	-0.05	0.06	0.06
	(0.02)	(0.09)	(0.03)	(0.13)	(0.03)	(0.03)	(0.09)	(0.05)	(0.03)	(0.05)
Log Household Size		0.32								
		(0.03)								
Land Controls										
Own Land	0.09	0.09	0.08	0.08	0.09	0.08	0.10	0.01	0.07	0.08
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Land size (log)	0.08	0.08	0.03	0.04	0.03	0.03	0.04	-0.02	0.05	0.03
	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Share of land irrigated (%)	0.29	0.29	0.09	0.09	0.09	0.08	0.04	-0.07	0.02	-0.04
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintiles of Farm Assets (quintile 1 omitted)										
Quintile 2	0.22	0.22	0.10	0.08	0.12	0.09	0.10	0.12	0.06	0.02
	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
Quintile 3	0.41	0.41	0.19	0.16	0.20	0.17	0.19	0.29	0.06	0.05
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
Quintile 4	0.60	0.59	0.24	0.22	0.25	0.21	0.24	0.41	0.08	0.09
	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintile 5	0.79	0.80	0.33	0.27	0.34	0.30	0.32	0.52	0.12	0.14
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintiles of Household Assets (quintile 1 omitted)										
Quintile 2	0.03	0.02	0.06	0.05	0.05	0.05	0.04	0.01	0.05	0.05
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Quintile 3	0.01	0.01	0.06	0.05	0.05	0.06	0.05	0.01	0.07	0.06
	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Quintile 4	0.02	0.01	0.09	0.09	0.08	0.09	0.07	0.06	0.08	0.10
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
Quintile 5	-0.06	-0.07	0.09	0.11	0.09	0.09	0.07	0.06	0.08	0.08
	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)

Appendix Table A2 - *Continued*

	A. Pooled Cross-Sections		B. Including Farm-Household Fixed Effects					C. Labor Demand by Farm Task		
	N. Household Members	Household Size and Shares	N. Household Members	Variation from Aging Only	Prior Composition	Next Period Composition	1, 2, and 3 Period Lagged Composition as IVs	Land Prep Livestock Dry/Sell/ Mill	Weeding Planting Fertilizing	Harvesting
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Age, Education, Presence of HH Head and Spouse										
Primary Male's Age	-0.004	-0.002	-0.0004	-0.0003	-0.00006	0.002	-0.002	-0.002	0.003	-0.004
	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)
Primary Male's Education	-0.02	-0.02	-0.001	-0.01	-0.002	0.001	-0.003	0.001	0.0009	0.002
	(0.00)	(0.00)	(0.003)	(0.01)	(0.002)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)
Primary Male Present	0.31	0.30	0.25	-0.07	0.40	0.31	0.28	0.31	0.15	0.16
	(0.03)	(0.03)	(0.05)	(0.18)	(0.05)	(0.06)	(0.09)	(0.08)	(0.06)	(0.07)
Primary Female's Age	0.002	0.003	0.001	0.007	0.002	0.002	0.003	0.002	-0.002	-0.00009
	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Primary Female's Education	-0.011	-0.012	0.002	0.0004	0.002	0.003	0.003	-0.004	0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)
Primary Female Present	0.18	0.19	0.08	-0.21	0.15	0.17	0.08	0.10	0.07	0.01
	(0.03)	(0.04)	(0.04)	(0.16)	(0.04)	(0.05)	(0.07)	(0.07)	(0.05)	(0.06)
Interview Month Indicators (January omitted)										
February	0.12	0.12	0.13	0.28	0.15	0.07	0.13	0.01	0.19	0.01
	(0.06)	(0.06)	(0.06)	(0.11)	(0.06)	(0.06)	(0.06)	(0.11)	(0.07)	(0.13)
March	0.22	0.22	0.24	0.54	0.21	0.19	0.18	0.06	0.36	0.16
	(0.08)	(0.08)	(0.07)	(0.14)	(0.08)	(0.08)	(0.09)	(0.13)	(0.09)	(0.16)
April	0.10	0.10	0.22	0.48	0.30	0.18	0.27	-0.02	0.32	0.25
	(0.10)	(0.10)	(0.09)	(0.16)	(0.12)	(0.10)	(0.11)	(0.15)	(0.11)	(0.18)
May	0.13	0.14	0.17	0.56	0.31	0.12	0.26	0.06	0.19	0.15
	(0.11)	(0.11)	(0.10)	(0.19)	(0.14)	(0.11)	(0.12)	(0.16)	(0.12)	(0.19)
June	0.16	0.18	0.15	0.50	0.28	0.08	0.19	0.16	0.05	0.23
	(0.12)	(0.12)	(0.11)	(0.20)	(0.14)	(0.12)	(0.13)	(0.17)	(0.13)	(0.19)
July	0.15	0.17	0.18	0.47	0.30	0.14	0.19	0.19	0.07	0.24
	(0.12)	(0.12)	(0.12)	(0.21)	(0.15)	(0.13)	(0.14)	(0.18)	(0.14)	(0.19)
August	0.23	0.24	0.16	0.61	0.28	0.17	0.01	0.22	0.04	0.29
	(0.13)	(0.13)	(0.13)	(0.22)	(0.15)	(0.14)	(0.15)	(0.18)	(0.15)	(0.19)
September	0.17	0.17	0.15	0.78	0.25	0.19	-0.03	0.20	-0.03	0.24
	(0.14)	(0.14)	(0.14)	(0.24)	(0.16)	(0.16)	(0.17)	(0.19)	(0.16)	(0.20)
October	0.07	0.08	0.10	0.80	0.19	0.16	-0.15	0.16	-0.31	0.38
	(0.16)	(0.16)	(0.15)	(0.25)	(0.18)	(0.17)	(0.18)	(0.18)	(0.17)	(0.21)
November	-0.01	0.01	-0.11	0.73	-0.04	-0.08	-0.15	0.18	-0.37	0.04
	(0.22)	(0.22)	(0.19)	(0.44)	(0.23)	(0.21)	(0.25)	(0.23)	(0.28)	(0.27)
December	-0.14	-0.15	-0.07	-0.14	-0.06	-0.04	-0.05	-0.04	-0.21	0.09
	(0.07)	(0.07)	(0.06)	(0.13)	(0.06)	(0.06)	(0.07)	(0.10)	(0.10)	(0.14)
Tests for joint significance of demographic composition										
All Groups	38.05	34.07	12.84	2.49	4.83	4.09	2.92	6.19	5.31	4.82
p-value	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Males	51.52	20.13	17.95	1.91	5.95	5.67	3.51	9.69	6.61	6.56
p-value	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Females	10.40	10.85	7.44	2.77	3.28	1.86	1.86	1.33	3.83	1.77
p-value	0.00	0.00	0.00	0.02	0.00	0.08	0.08	0.24	0.00	0.10
Prime age adults 15 to 49	45.56	14.00	22.08	2.15	8.51	4.86	5.33	10.01	9.63	7.82
p-value	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
C-test - 1 and 2 Period Lags (χ^2)							14.56			
p-value							0.93			
Observations	38,189	38,189	38,189	11,594	33,737	33,737	25,739	27,387	33,166	24,353
N. Households	4,452	4,452	4,452	1,584	4,096	4,096	3,783	4,176	4,166	4,022

Notes. Standard errors in parentheses below coefficient estimates. All estimates of variance-covariances take into account clustering at the household level and allow arbitrary heteroskedasticity. Joint tests for the significance of demographic groups are F-statistics. The C-test is an overidentification test examining the exogeneity of 1 and 2 period lags conditional on the validity of the 3 period lags. Column 2 enters demographics as log(household size) and the share of 11 of the 12 demographic groups. All columns include community-time fixed effects and columns 3 through 10 include farm household fixed effects.

Appendix Table A3

Labor Demand Regressions - First Stage Results

1, 2, and 3 Period Lagged Household Composition as IVs

	Dependent Variable											
	Number of males [...]						Number of females [...]					
	Birth to 14 years	**15 to 19**	**20 to 34**	**35 to 49**	**50 to 64**	**65 and older**	**Birth to 14 years**	**15 to 19**	**20 to 34**	**35 to 49**	**50 to 64**	**65 and older**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Joint Test of all IVs												
F-statistic	73.43	52.77	45.12	53.59	46.21	26.18	56.69	47.45	49.81	52.51	39.22	22.13
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	25,739	25,739	25,739	25,739	25,739	25,739	25,739	25,739	25,739	25,739	25,739	25,739
N. Households	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783

Notes. Table reports joint F tests of IVs from the 1st stage of labor demand regressions using 1, 2, and 3 period lagged household composition as instruments for the number of household members in the demographic group in each column. Along with community-time and farm household fixed effects, additional controls include quintiles of farm and household (real) assets, age and education of the household head and spouse, and the month of interview. All estimates of variance-covariances take into account clustering at the household level and allow arbitrary heteroskedasticity.