# Household Production, Markets, and Separation[1]

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# Agenda

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- Syllabus
- Motivation: incomplete markets and household-producer separation
- Modeling separation
- Testing separation: Benjamin (1992)
- BREAK
- Testing separation: LaFave & Thomas (2016)
- Incomplete markets
- Market failures and technology adoption: Jones et al (2022)

# Introductions

- ▶ Name
- ▶ Where you're from

# Syllabus

Link

?

# Principles of Microeconomics

Consumers solve

$$\max_x \quad u(x) \quad \text{s.t.} \quad px \leq W$$

$$\text{FOC: } u'(x) = \lambda p$$

# Principles of Microeconomics

Consumers solve

$$\max_x \quad u(x) \quad \text{s.t.} \quad px \le W$$
$$\text{FOC: } u'(x) = \lambda p$$

Making labor supply endogenous:

$$\max_x \quad u(c, l) \quad \text{s.t.} \quad pc \le (L - l) * w$$
$$\text{FOCs: } u'(c) = \lambda p, \qquad u'(l) = \lambda w$$

# Principles of Microeconomics

Producers solve

$$\max_{K,L} \quad pf(K,L) - wL - rK$$

FOCs: $pf_1 = r, \qquad pf_2 = w$

# The real world

▶ How does optimization differ in the real world?
▶ In this course: how do contextual factors in low-income countries affect firm decision-making?
▶ Today: incomplete markets and household-producers

# Motivation: Incomplete markets

- ▶ Incomplete markets: optimization not possible
  - ▶ No/constrained land market ⇒ cannot optimize land use
  - ▶ No/constrained labor market ⇒ cannot optimize labor supply
  - ▶ No/constrained credit market ⇒ cannot optimize either input
- ▶ Such issues are prevalent in rural and low-income areas
- ▶ Economic implications:
  - ▶ Different types of behaviors become rational, e.g., low adoption of profitable technologies
  - ▶ Lower productivity due to misallocation of resources and lack of investment
  - ▶ Shocks may affect both production and consumption in households that are also producers: entrepreneurs

# Motivation: Labor supply across activities

TABLE 5.1 • Participation in Labour Activities During the Past 7 days (% of persons >5 years old)

| | By Activity | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Agriculture | | Nonfarm Enterprise | | Wage | | Apprenticeship | | No Activity | |
| Region | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| **Post-planting (July–Aug)** | | | | | | | | | | |
| North Central | 61.4 | 48.2 | 10.4 | 17.7 | 6.7 | 5.1 | 1.9 | 2.4 | 28.6 | 33.8 |
| North East | 57.0 | 35.4 | 21.3 | 24.3 | 8.0 | 1.1 | 2.8 | 0.6 | 30.1 | 47.6 |
| North West | 53.2 | 17.3 | 24.9 | 33.3 | 5.4 | 1.2 | 1.1 | 1.2 | 34.8 | 54.5 |
| South East | 40.1 | 48.8 | 23.2 | 20.2 | 7.6 | 7.7 | 1.8 | 2.2 | 40.2 | 35.5 |
| South South | 40.6 | 42.9 | 23.1 | 26.0 | 8.9 | 6.3 | 3.5 | 2.3 | 37.9 | 36.1 |
| South West | 26.6 | 16.2 | 26.8 | 36.1 | 12.7 | 8.1 | 5.6 | 4.2 | 38.4 | 42.5 |
| Urban | 20.0 | 14.4 | 29.4 | 31.7 | 12.0 | 7.8 | 3.3 | 2.5 | 45.9 | 50.6 |
| Rural | 59.8 | 40.4 | 18.6 | 25.0 | 5.9 | 2.8 | 2.1 | 1.7 | 30.2 | 40.6 |
| NGA | 48.6 | 33.1 | 21.6 | 26.9 | 7.6 | 4.2 | 2.5 | 1.9 | 34.6 | 43.4 |
| **Post-harvest (Jan–Feb)** | | | | | | | | | | |
| North Central | 37.0 | 23.9 | 9.5 | 13.0 | 8.1 | 4.7 | 1.7 | 1.6 | 48.0 | 58.8 |
| North East | 23.8 | 14.7 | 15.1 | 11.8 | 6.4 | 1.6 | 3.7 | 2.2 | 57.3 | 71.8 |
| North West | 28.3 | 9.0 | 22.1 | 22.6 | 4.9 | 1.2 | 0.9 | 0.3 | 54.3 | 69.0 |
| South East | 20.2 | 27.9 | 18.7 | 16.8 | 8.7 | 7.5 | 3.0 | 2.8 | 53.8 | 51.0 |
| South South | 26.8 | 28.7 | 15.9 | 18.3 | 12.9 | 7.0 | 2.8 | 3.5 | 49.5 | 50.2 |
| South West | 21.5 | 12.2 | 20.3 | 30.5 | 16.2 | 7.8 | 4.3 | 2.6 | 43.9 | 50.7 |
| Urban | 11.1 | 7.0 | 24.0 | 25.8 | 13.5 | 7.5 | 2.9 | 2.2 | 53.8 | 59.6 |
| Rural | 33.4 | 22.4 | 14.8 | 16.1 | 6.6 | 3.0 | 2.2 | 1.8 | 51.1 | 60.9 |
| NGA | 27.1 | 18.1 | 17.4 | 18.8 | 8.5 | 4.2 | 2.4 | 1.9 | 51.9 | 60.6 |

Source: Nigerian National Bureau of Statistics, GHSP 2018-19 Survey Report

# Motivation: Household-Producers

- ► Many of the global poor are entrepreneurs
  - ► Smallholder farmers
  - ► Small business owners
- ► How is decision-making different for entrepreneurs?
- ► What is the effect of missing markets and other market failures?
- ► Today's question: how do market failures affect separation of consumption and production problems?

# Separation failures

- ▶ Suppose we have friction in one market or another
- ▶ The challenge - developed in Benjamin (1992) - is that then production and consumption decisions are linked
- ▶ Labor market failures: if you have to use your own labor to produce, then you consider both the marginal product and the demand for leisure
- ▶ Why does this matter?

# Extreme situation: Autarchic household producers

Households maximize

$$u_h = u(c, l; a)$$

and produce

$$q = F(L; A)$$

- $c$ is consumption
- $l$ is leisure
- $a$ are household characteristics which shift utility
- $A$ are household characteristics which shift production

# Autarchic household producer static problem

Suppose

- ▶ Total household labor availability $T(a) = L + l$
- ▶ $F(L; A)$ and $u(c, l)$ behave normally, no further restrictions
- ▶ Price of the production/consumption good normalized to 1
- ▶ Household has $y$ additional income and no savings
- ▶ Households consumes all income and production

Household-producer optimizes

$$\max_L \quad u(y + F(L; A), T(a) - L; a)$$

$$\text{FOC: } u_1 F_1 - u_2 = 0 \Rightarrow F_1 = \frac{u_2}{u_1}$$

# Autarchic household producer static problem

$$\max_L \quad u(y + F(L; A), T(a) - L; a)$$

$$\text{FOC: } u_1 F_1 - u_2 = 0 \Rightarrow F_1 = \frac{u_2}{u_1}$$

▶ Marginal utility of leisure determines labor allocation
  ▶ *Not* price of labor
▶ What would happen to business/farm production if households got (exogenously) richer?
▶ No separation

# What if there is a functioning labor market?

- Households allocate labor to their business/farm $(L^F)$, wage work $(L^O)$, and leisure $l$ with total time $T(a) = L^F + L^O + l$
- Households have exogenous income $y$
- Households can hire $L^H$ units of labor
- Same wage $w$ of hired labor and wage work

Household-producer optimizes

$$\max_{L^H, L^O, L^F} \quad u(c, l; a)$$
$$\text{s.t. } c = F(L^F + L^H; A) - wL^H + wL^O + y$$
$$\text{and } l + L^F + L^O = T(a)$$

# Solving the problem

$$\max_{L^H, L^O, L^F} \quad u(F(L^F + L^H; A) - wL^H + wL^O + y, T - L^F - L^O)$$

FOCs:

$$
\begin{aligned}
L^O: & \quad u_1 w - u_2 = 0 \\
L^F: & \quad u_1 F' - u_2 = 0 \\
L^H: & \quad u_1(F' - w) = 0
\end{aligned}
$$

# Implications of optimization

FOCs:

$$L^O: \quad u_1 w - u_2 = 0$$
$$L^F: \quad u_1 F' - u_2 = 0$$
$$L^H: \quad u_1(F' - w) = 0$$
$$\Rightarrow F' = w, \quad \frac{u_2}{u_1} = w$$

- ▶ What does this imply for labor supply decisions?
  - ▶ Recall $F(L^F + L^H; A)$ is the business production function, $w$ is the wage

# Implications of optimization

FOCs:

$$L^O: \quad u_1 w - u_2 = 0$$
$$L^F: \quad u_1 F' - u_2 = 0$$
$$L^H: \quad u_1(F' - w) = 0$$
$$\Rightarrow F' = w, \quad \frac{u_2}{u_1} = w$$

▶ What does this imply for labor supply decisions?
  ▶ Recall $F(L^F + L^H; A)$ is the business production function, $w$ is the wage
▶ Employ labor until the marginal product equals the wage
▶ $\Rightarrow$ With a labor market, household-producers maximize profits, regardless of their characteristics/preferences $a$
▶ $\frac{u_2}{u_1} = w$: Production decisions only enter household labor-leisure decision through the budget constraint

## Evaluating household consumption and leisure decisions

Let the net value of production

$$\rho(w; A) \equiv F(L; A) - wL^H - wL^F$$

- ▶ We just saw that with separation, household-producers will first maximize $\rho(w; A)$
- ▶ Call this maximized function $\pi(w; A)$

Now let the total value of utility consumption

$$M \equiv c + wl = y + \rho(w; A) + wT(a)$$

Simplify the household problem

$$\max_{c, L^H, L^O, L^F, l} u(c, l; a)$$

$$\max_l u(y + \pi(w; A) + wT(a) - wl, l; a)$$

- ▶ Under separation, households only choose the optimal $l$

# Illustrating separation in production decision <span style="color:#3fa9f5">Constraint</span>

- ▶ Total household labor supply $L^S = L^F + L^O$
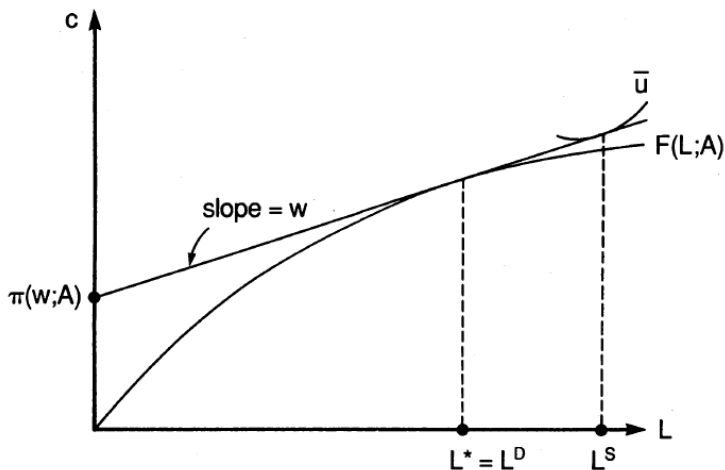- ▶ Total production labor $L^D = L^F + L^H$



FIGURE 1.—Separation.

# Summarizing role of labor markets in separation

▶ Without a labor market
  ▶ Production decisions depend on trade-offs between consumption and leisure
  ▶ These will be different for different household-producers $\Rightarrow$ production will depend on household characteristics
▶ With a labor market
  ▶ Production decisions will equate marginal costs and benefits
  ▶ These maximize profits on land and do not depend on household characteristics
  ▶ **Separation** result: profit maximization is *separable* from utility maximization

# How to more reasonably model labor markets?

Benjamin (1992) considers several possible frictions

1. Constraint on how much labor can be hired in ($L^H$) - can lead to marginal product of $L^F >$ wage rate
2. Constraint on how much labor can be sold ($L^O$) - can lead to marginal product of $L^F <$ wage rate
3. Wedges in wages between labor hired and labor sold
   - Ex: farmer preferences for working on their farms, family and hired labor not perfect substitutes in production

Let's focus on the second one: $L^O \leq H$ where $H$ is the max hours HH members may work outside of home

# Excess off-farm labor supply ($L^O = H$)

Household-farm's optimal labor supply

$$L^{D*}(w, A) \equiv (L^{F*} + L^{H*})|w, A$$
$$L^S(w, M; a) = T(a) - l(w, y + \pi(w; A) + wT(a); a)$$

If the constraint binds and $L^O = H$, we have

$$T(a) - l^* > L^{D*} + L^O = L^{D*}(w, A) + H$$

In this case, households will apply more household labor to their farm than seems optimal given wages:
$L^D = L^F + L^H > L^{D*}(w, A)$

# Shadow wage

- For any $L^D$, Define the shadow wage $w^*$ as the wage where *it would be optimal* to work that much on your farm
- Thus, if the farm expands to absorb extra labor supply we have $L^D > L^{D*}(w; A), w^* < w$
- We can then defined optimized profits if the wage was the shadow wage

$$\pi(w^*; A) = \max_L^D F(L^D, A) - w^* L^D = F(L^{D*}; A) - w^* L^{D*}(w^*, A)$$

$$\frac{\partial \pi}{\partial w^*} = F_1 \frac{\partial L^{D*}}{\partial w^*} - [L^{D*} + w^* \frac{\partial L^*}{\partial w^*}] = -L^{D*}$$

# Interpreting the algebra

$$\pi(w^*; A) = \max_L^D F(L^D, A) - w^* L^D = F(L^{D*}; A) - w^* L^{D*}(w^*, A)$$

$$\frac{\partial \pi}{\partial w^*} = F_1 \frac{\partial L^{D*}}{\partial w^*} - [L^{D*} + w^* \frac{\partial L^*}{\partial w^*}] = -L^{D*}$$

$$\Rightarrow \frac{\partial L^{D*}}{\partial a} = -\pi_{11}(w^*; A) \frac{\partial w^*}{\partial a}$$

- In other words, the change in on-farm labor demand $L^D$ when household characteristics $(a)$ change is equivalent to
    - The change in the shadow wage with $a$
    - Multiplied by the curvature of the profit function ($>0$ by the envelope theorem)
- The constraint creates a separation failure
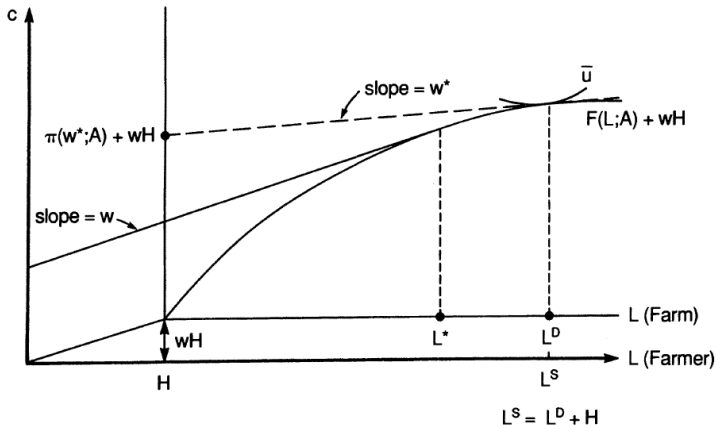- Without the constraint, $w^* = w$ and $\partial L^D / \partial a = 0$

FIGURE 2.—Case 1 constraint $H$ on off-farm labor supply.

# Benjamin empirical strategy to test for separation failure

Model suggests

$$log(L_i^D) = \alpha + \beta log(w_i^*) + \gamma log(A_i) \tag{1}$$

$$log(L_i^D) = \alpha + \beta \sum_{j=1}^{G} \delta_j a_{ij} + \gamma log(A_i) + u_i \tag{2}$$

▶ If there is separation, $\delta_j = 0$

▶ Specific test: consider as household characteristics counts of household members by age and sex

  ▶ Household size and composition should not affect farm labor allocation unless there is a violation of the separation hypothesis

▶ Concerns?

## TABLE II
### LABOR USE ON RICE FARMS

| Labor Type: | Percent Use[a] | Person Days[b] | Percent Hire[c] | Average Hired Person Days[d] | Average Family Person Days | Labor Days per Hectare[e] | Average Daily Wage[f] |
|---|---|---|---|---|---|---|---|
| Plowing | 49 | 4.1 | 37 | 3.1 | 1.0 | 8.5 | 900 |
| Hoeing | 99 | 20.6 | 73 | 13.6 | 7.0 | 46.6 | 475 |
| Planting | 99 | 20.9 | 86 | 18.1 | 2.9 | 43.0 | 270 |
| Weeding | 96 | 23.7 | 68 | 17.3 | 6.4 | 45.0 | 293 |
| Harvesting | 100 | 29.4 | 79 | 23.5 | 6.0 | 64.8 | 625 |
| Other Labor | 52 | 5.7 | 27 | 2.5 | 3.2 | 13.7 | 622 |
| Total Labor | 100 | 104.5 | 95 | 78.2 | 26.3 | 221.7 | |

[a] Percent Use is the percentage of farmers who report employing that type of labor.
[b] Person Days is the average annual person days of labor per farm for that task.
[c] Percent Hire is the percentage of farmers who hire some of their labor for that task.
[d] Average Hired/Family Person Days are average annual person days of each type of labor used.
[e] Labor per Hectare is the annual average person days of labor per hectare of rice land harvested.
[f] Average Wage is the average daily wage for that task (in Rp.).

# Separation?

TABLE V

IMPLIED DEMOGRAPHIC ELASTICITIES FROM TABLE IV
(Standard Errors in Parentheses)

| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | Elasticity of Labor Demand with respect to additional Household Members: | | | | | | |
| Type of member: | | | | | | | |
| Prime age male | 0.012 | 0.028 | 0.010 | 0.027 | 0.032 | 0.007 | 0.010 |
| | (0.024) | (0.025) | (0.018) | (0.024) | (0.026) | (0.031) | (0.030) |
| Prime age female | −0.016 | 0.013 | −0.004 | 0.022 | 0.027 | 0.005 | 0.006 |
| | (0.025) | (0.027) | (0.019) | (0.025) | (0.028) | (0.003) | (0.032) |
| Elderly male | 0.008 | 0.017 | 0.013 | 0.010 | 0.017 | 0.012 | 0.013 |
| | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) | (0.006) | (0.007) |
| Elderly female | 0.001 | 0.010 | 0.006 | 0.003 | 0.008 | 0.003 | 0.004 |
| | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) | (0.006) | (0.006) |
| Child ( < 15 yrs) | 0.038 | 0.011 | | −0.007 | 0.012 | 0.005 | 0.006 |
| | (0.018) | (0.017) | | (0.016) | (0.018) | (0.020) | (0.021) |

Specifications: (1) Parsimonious OLS. (2) OLS with full set of control variables. (3) OLS with full set of control variables, but children under 15 yrs. excluded from household size. (4) Within cluster estimation. (5) 2SLS for correction of measurement error of wage. (6) 2SLS for correction for potential simultaneity of wage. (7) 2SLS for correction for potential simultaneity of wage and adjustment of area harvested.

# Separation?

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| Elderly female | 0.001 | 0.010 | 0.006 | 0.003 | 0.008 | 0.003 | 0.004 |
| | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) | (0.006) | (0.006) |
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| | (0.018) | (0.017) | | (0.016) | (0.018) | (0.020) | (0.021) |

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"Together, the evidence is not consistent with surplus labor or constraints on farm labor supply."

# BREAK

- ▶ Benjamin (1992) result influential, but some concerns about data and econometrics
- ▶ LaFave & Thomas (2016) update original test with better panel data from Indonesia
    - ▶ Larger sample (≈4000 HHs),
    - ▶ 11 waves ⇒ can introduce farm fixed effects
    - ▶ Have power to identify household composition off changes in age profile of members ⇒ avoid endogenous composition concerns
    - ▶ Can address wages as determinant of labor supply: use community × time FEs (also picks up other input and output prices)

| 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) |

# LaFave and Thomas empirical strategy

Regression specification

$$\ln L_{hjt} = \alpha + \beta N_{hjt} + \delta X_{hjt} + \mu_h + \eta_{jt} + \varepsilon_{hjt}$$

- ▶ $L_{hjt}$ total person days used on farm $h$ in period $t$
- ▶ $N_{hjt}$ household demographics ($H_0 : \beta = 0$)
- ▶ $X_{hjt}$ other farm and hosehold characteristics
- ▶ $\mu_h$ farm FE
- ▶ $\eta_{jt}$ community $\times$ time FEs

# Results

| Household Demographic Composition | A. Pooled Cross-Sections | | B. Includ... | |
|---|---|---|---|---|
| | N. Household Members | Household Size and Shares | N. Household Members | Variation From Aging Only |
| | (1) | (2) | (3) | (4) |
| *Number of males in farm HH* | | | | |
| 0 to 14 years | 0.02 | – | −0.001 | – |
| | (0.01) | | (0.016) | |
| 15 to 19 | 0.11 | 0.40 | 0.09 | 0.09 |
| | (0.02) | (0.08) | (0.02) | (0.05) |
| 20 to 34 | 0.17 | 0.59 | 0.13 | 0.15 |
| | (0.01) | (0.07) | (0.02) | (0.11) |
| 35 to 49 | 0.23 | 0.65 | 0.16 | 0.15 |
| | (0.02) | (0.09) | (0.03) | (0.12) |
| 50 to 64 | 0.32 | 0.76 | 0.22 | 0.24 |
| | (0.03) | (0.09) | (0.03) | (0.12) |
| 65 and older | 0.21 | 0.45 | 0.20 | 0.24 |
| | (0.03) | (0.10) | (0.04) | (0.14) |

| Household Demographic Composition | A. Pooled Cross-Sections | | B. Includi... | |
|---|---|---|---|---|
| | N. Household Members | Household Size and Shares | N. Household Members | Variation From Aging Only |
| | (1) | (2) | (3) | (4) |
| *Number of females in farm HH* | | | | |
| 0 to 14 years | −0.02 | −0.15 | −0.04 | – |
| | (0.01) | (0.07) | (0.02) | |
| 15 to 19 | 0.02 | 0.10 | −0.01 | 0.02 |
| | (0.02) | (0.08) | (0.02) | (0.05) |
| 20 to 34 | 0.04 | 0.12 | 0.06 | 0.23 |
| | (0.02) | (0.09) | (0.02) | (0.10) |
| 35 to 49 | 0.09 | 0.30 | 0.16 | 0.33 |
| | (0.02) | (0.09) | (0.03) | (0.11) |
| 50 to 64 | 0.10 | 0.27 | 0.13 | 0.35 |
| | (0.02) | (0.09) | (0.03) | (0.12) |
| 65 and older | −0.05 | −0.10 | 0.05 | 0.26 |
| | (0.02) | (0.09) | (0.03) | (0.13) |
| Log household size | | 0.34 | | |
| | | (0.03) | | |

# Joint tests of $H_0 : \beta = 0$

| Household Demographic Composition | A. Pooled Cross-Sections | | | B. Includir |
|---|---|---|---|---|
| | N. Household Members | Household Size and Shares | N. Household Members | Variation From Aging Only |
| | (1) | (2) | (3) | (4) |
| *Tests for joint significance of demographic composition* | | | | |
| All groups | 37.27 | 33.65 | 13.13 | 2.53 |
|   *p*-value | 0.00 | 0.00 | 0.00 | 0.005 |
| Males | 49.88 | 21.67 | 18.27 | 1.90 |
|   *p*-value | 0.00 | 0.00 | 0.00 | 0.09 |
| Females | 10.58 | 10.99 | 7.70 | 2.78 |
|   *p*-value | 0.00 | 0.00 | 0.00 | 0.02 |
| Prime age adults | 45.13 | 14.55 | 22.52 | 2.18 |
|   *p*-value | 0.00 | 0.00 | 0.00 | 0.04 |
| C-test—1 and 2 period lags ($\chi^2$) | | | | |
|   *p*-value | | | | |
| Observations | 38,189 | 38,189 | 38,189 | 11,594 |
| N. Households | 4,452 | 4,452 | 4,452 | 1,584 |

# Separation?

- ► Sound rejection of separation in every test, $\beta_0$
  - ► Households with more members supply more household farm labor
- ► Test of monitoring mechanism
  - ► Hypothesis: HH members easier to monitor, more valuable
  - ► Find similar effects for labor to harvest (easy to monitor) and other operations
- ► Tests of heterogeneity across HHs
  - ► No differences by education of household head
  - ► Effects of household composition are smaller for HHs with more resources (higher expenditure)
  - ► No effects in top 15% of HHs in per capita expenditure

# What if households are not unitary?

- Udry (1996) asks: can HHs allocate their own resources efficiently?
- Separation may fail if HHs do not respond to labor markets as joint decision-makers
- Benjamin assumes a *unitary* HH with central decision-maker making labor and consumption decisions for all HH members
  - Efficient (if not necessarily equal) if consumption and production decisions are separate
- Udry observes that efficient aggregate production requires efficient production of crops across plots
- Separation test: are production inputs distributed efficiently across different HH plots?
  - Context: HH plots in Burkina Faso managed by particular HH members

Empirical test of separation

$$Q_{htc} = \beta X_{htci} + \gamma G_{htci} + \lambda_{htc} + \varepsilon_{htci}$$

- ▶ Plot $i$, crop $c$, HH $h$, time $t$
- ▶ Up to plot characteristics $X$, gender of manager $G$ should be excludable from input/yield equations
- ▶ Have rich plot-level panel data

# Differences by gender of plot manager

TABLE 1

Mean Yield, Area, and Labor Inputs per Plot by Gender of Cultivator
($N = 4,655$)

| | Crop Output per Hectare (1,000 FCFA)* | Area (Hectare) | Male Labor (Hours/ Hectare) | Female Labor (Hours/ Hectare) | Nonfamily Labor (Hours/ Hectare) | Child Labor (Hours/ Hectare) | Manure Weight (kg/ Hectare) |
|---|---|---|---|---|---|---|---|
| Men's plots | 79.9 | .740 | 593 | 248 | 106 | 104 | 2,993 |
| | (186) | (1.19) | (1,065) | (501) | (407) | (325) | (11,155) |
| Women's plots | 105.4 | .100 | 128 | 859 | 46 | 53 | 764 |
| | (286) | (.16) | (324) | (1,106) | (185) | (164) | (5,237) |
| $T$-statistic | $-3.27$ | 29.03 | 22.16 | $-21.31$ | 6.89 | 7.08 | 7.68 |
| $H_0$: $\mu_m = \mu_w$ | | | | | | | |

▶ Significant differences in yield by gender across multiple specifications
▶ Suggests effects driven by lower inputs to women, even controlling for plot characteristics
  ▶ Fertilizer allocated much more to men, despite well-established declining marginal product
▶ Doesn't answer what causes the inefficiency
  ▶ Potential factors: labor and financial market failures

# Incomplete markets

- Benjamin (1992) example of separation failures focuses on frictions in the labor market
- Could still restore separation with incomplete labor markets but functional land markets:
  - Redistribute land (through rental or sales) to larger HHs to equalize shadow wages across farms
- Separation failures typically require incompleteness in *more than one market*
  - LaFave and Thomas fail to reject separation for richest HHs
  - Other markets (e.g., credit, insurance) may be more complete for them

# Other market failures: incomplete financial markets

Suppose that:

- Production is risky, with $\theta$ a mean 1 TFP shock, meaning ag income $y = \theta F(L)$
- Households are risk averse, u' is convex
- Incomplete insurance market (non-existant)
- Incomplete credit market (non-existant)
- HHs inelastically supply labor endowment $T$, with $L$ to the farm and $T - L$ to the market for wage $w$
- Labor market resolves before $\theta$ is known

Can this generate a separation failure?

# Financial markets and separation failures?

Farm household solves

$$\max_{L} \quad E_\theta[u(c)]$$
$$\text{s.t. } c = wT + \theta F(L) - wL$$
$$\text{FOC: } E[u'(c)(\theta F'(L) - w)] = 0$$

What does this imply?

# Financial markets and separation failures?

Farm household solves

$$\max_{L} \quad E_\theta[u(c)]$$
$$\text{s.t. } c = wT + \theta F(L) - wL$$
$$\text{FOC: } E[u'(c)(\theta F'(L) - w)] = 0$$

Separation fails! $L$ will be a function of preferences (risk aversion)

▶ Can show that failure of insurance market (resolve uncertainty about $\theta$ generates underinvestment in labor relative to complete markets setting

# So what?

- ▶ Need better applied theory, dynamic models
    - ▶ LaFave and Thomas: "Developing empirically tractable models of farm households when markets are incomplete remains an important challenge."
    - ▶ Creates challenges for studying and supporting farm HHs
- ▶ How to identify market failures?
    - ▶ LaFave and Thomas: "It is not possible with a portmanteau test for complete markets to identify the sources of market failure."
    - ▶ Diagnosing specific market failures is especially hard given one market might substitute for another
- ▶ What are the impacts of non-separation?
    - ▶ Implications for factor misallocation?
    - ▶ Implications for technology adoption?

# Misallocation

- ▶ Large literature showing misallocation in developing countries
- ▶ Silver (2004): Novel method to separately identify financial and input market distortions using panel data from Thailand
- ▶ Estimates aggregate productivity effects of eliminating misallocation from these distortions



Figure 2: Counterfactual TFP gains from reallocation



Figure 3: Gains from partial reductions of $\tau$ and $\Lambda$
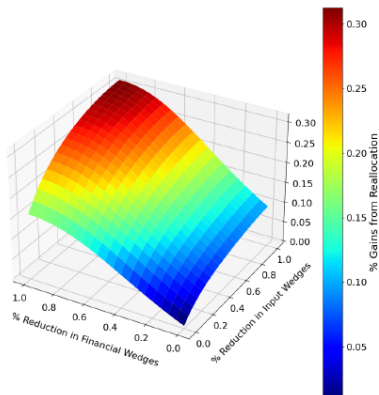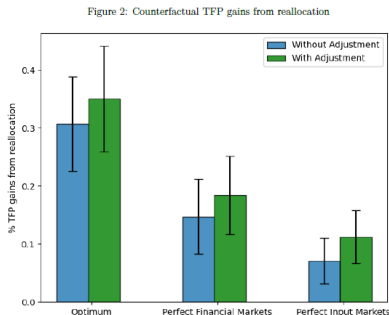
# Other implications: inefficient technology adoption?

Land and labor or capital market distortions together may lead to inefficient allocations of land and labor

- ▶ If efficient households and separation holds ⇒ optimal decisions *on every plot*, AND productive decisions uncorrelated across plots, conditional on productivity
    - ▶ Saw this fail in Udry (1996)
- ▶ Separation failures may induce within-HH dependencies across plots
- ▶ May further lead to distortions in technology adoption

Jones et al (2022) explore the case of adoption of irrigation, typically for cash crops, in Rwanda

# Context: Rwanda Jones et al study

2 agricultural seasons: rainy and dry

- ▶ Rainy season: produce staple crops – maize and beans; irrigation not very useful
- ▶ Dry season: too short for staple crop cycle, can produce horticulture (eggplant, tomatoes,...) only with irrigation
- ▶ Alternative: year-round perennial banana plants, activity does not require irrigation

Rwandan government irrigation projects to ⇑ agricultural productivity

- ▶ Irrigation channels cut on hillside from water source
- ▶ Command Area (CA): all plots downhill from channel
    - ▶ No pumping infrastructure: uphill plots cannot benefit
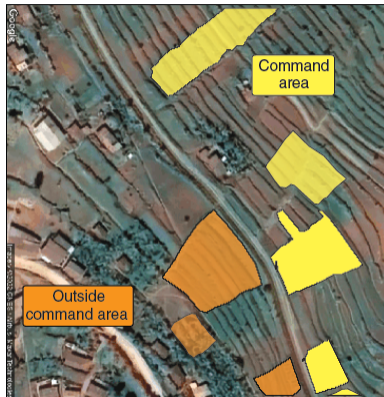- ▶ ≈40% adoption of irrigation in CA
- ▶ Jones et al: is this too low?

# Irrigation in Rwanda

Empirical approach: Regression discontinuity above and below channel

Panel A. Plots inside and outside command area
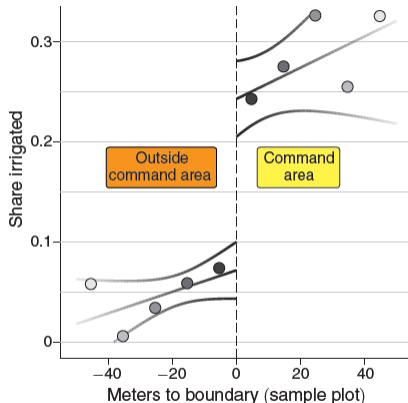
Panel B. Sharp increase in irrigation at boundary



Figure 2. Estimating the Impact of Irrigation Exploiting Spatial Discontinuity in Access

# Part 1: Impacts of irrigation in dry season

- ▶ Substantial increase in irrigation, though far from universal
- ▶ Increase in horticulture, decrease in banana
- ▶ Increase in HH and hired labor (mainly for irrigation, upkeep)
- ▶ Increase in yields and sales
- ▶ Hard to calculate profits under separation failures
  - ▶ What is the relevant wage for HH labor?
  - ▶ Profits often negative if HH labor valued at market wage
  - ▶ Recall from Benjamin (1992): under excess labor supply, shadow wage of HH *lower* than market wage

# Part 2: Cross-plot spillovers

Under efficient HHs/separation $\Rightarrow$ optimal decisions *on each plot*
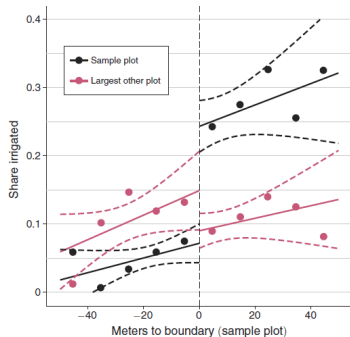


FIGURE 4. SEPARATION FAILS, AS ACCESS TO IRRIGATION ON THE SAMPLE PLOT CAUSES
SUBSTITUTION OF IRRIGATION USE AWAY FROM THE LARGEST OTHER PLOT

▶ Black is RD sample, Pink is largest other plot for HHs in
  discontinuity sample
▶ Substantial substitution across plots $\Rightarrow$ inefficiency

# Part 3: Cause of separation failure?

▶ Results consistent with separation failure. HH labor pulled off of largest other plot and diverted to sample plot.
  ▶ Potential inefficiencies in land markets: reallocation could increase adoption/yields.
  ▶ Back of the envelope exercise shows that having only 1 plot in the CA (rather than 2) would increase adoption by 5.5pp
▶ For separation failure, a second market also needs to fail. 3 possibilities:
  ▶ Incompleteness in insurance market: irrigated crops may be riskier
  ▶ Incompleteness in credit markets: may lack access to credit for input purchases
  ▶ Incompleteness in labor market: excess labor supply

# Part 3: How to identify market failures?

- ▶ Idea: Different market failures have different profile of heterogeneous treatment effects with wealth and HH labor endowment on largest other plot (LOP)
- ▶ Incompleteness in financial markets (insurance, credit)
  - ▶ Wealthier households should be less responsive.
  - ▶ Larger households should be less responsive (larger incomes).
- ▶ Incompleteness in labor market: excess labor supply
  - ▶ Relationship with wealth unsigned. If poor households have more elastic on-farm labor supply, poorer households should look less responsive.
  - ▶ Larger households should look less responsive (also assuming larger households are more elastic).

# Part 3: Market failure tests

TABLE 9—LARGER AND POORER HOUSEHOLDS DO NOT SUBSTITUTE AWAY
FROM LARGEST OTHER PLOT IN RESPONSE TO SAMPLE PLOT SHOCK

| | LOP, dry season, discontinuity sample | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cultivated (1) | Irrigated (2) | Horticulture (3) | Banana (4) | HH labor/ha (5) | Input exp./ha (6) | Hired labor exp./ha (7) |
| *SFE (spatial FE, specification (5))* | | | | | | | |
| SP CA | −0.183 | −0.117 | −0.130 | −0.058 | −83.6 | −9.3 | −4.8 |
| | (0.099) | (0.051) | (0.046) | (0.084) | (39.9) | (4.2) | (3.2) |
| | [0.065] | [0.021] | [0.005] | [0.489] | [0.036] | [0.026] | [0.138] |
| SP CA × No. of HH | 0.038 | 0.016 | 0.018 | 0.025 | 10.0 | 0.6 | 0.9 |
| members | (0.015) | (0.008) | (0.008) | (0.015) | (4.7) | (0.5) | (0.4) |
| | [0.010] | [0.049] | [0.016] | [0.088] | [0.032] | [0.269] | [0.019] |
| SP CA × asset index | −0.038 | −0.037 | −0.030 | −0.009 | −22.6 | −4.0 | −0.5 |
| | (0.032) | (0.018) | (0.020) | (0.027) | (12.3) | (1.6) | (1.4) |
| | [0.232] | [0.044] | [0.139] | [0.737] | [0.067] | [0.016] | [0.734] |
| Joint *F*-stat [*p*] | 3.0 | 2.4 | 2.7 | 2.3 | 2.0 | 2.5 | 2.0 |
| | [0.031] | [0.069] | [0.045] | [0.072] | [0.110] | [0.055] | [0.115] |
| Average effect | 0.002 | −0.041 | −0.042 | 0.067 | −36.2 | −6.6 | −0.1 |
| Observations | 2,104 | 2,104 | 2,104 | 2,104 | 2,091 | 2,094 | 2,094 |
| Clusters | 165 | 165 | 165 | 165 | 165 | 165 | 165 |
| Control mean | 0.368 | 0.114 | 0.107 | 0.201 | 68.1 | 5.4 | 3.7 |

▶ Labor endowment attenuates reallocation from LOP
▶ HH wealth aggrevates reallocation
▶ "Strong evidence for the existence of labor market failures that generate separation failures, which in turn cause inefficient adoption of irrigation"

# Jones et al 2022 Takeaways

▶ Quasi-experimental evidence consistent with separation failures
▶ Positive technology shock on one plot draws resources away from others
▶ So having 2 suitable plots for adoption leads to less per-plot adoption than having only 1 suitable plot
  ▶ Incomplete land markets prevent land reallocation
  ▶ Incomplete labor markets prevent labor reallocation
▶ ⇒ Market failures can lead on net to under-adoption of new, otherwise profitable technologies
▶ More adoption makes original investment more justifiable, sustainable

# Conclusions

▶ Incomplete markets common in many developing contexts

▶ These lead to separation failures for household-producers and misallocation of resources both within and across producers
  ▶ Policy implication: resource are not allocated productively across society $\Rightarrow$ too many low-productivity producers, most productive producers constrained in growth

▶ Market frictions also cause inefficient adoption of profitable technologies
  ▶ Policy implication: Providing technologies may not be sustainable due to below-optimal adoption