# 14.771: Land Markets

Ben Olken

# Overview

- What we're going to cover
  - Why might the allocation of land matter? Moral hazard and sharecropping
  - Why do secure property rights over land matter? Implications for investment decisions
  - This implies a tension between static efficiency (reallocation) and dynamic efficiency (property rights).

# Marhsallian model of Sharecropping

- Sharecropping – where laborers pay owners a share of the output – is ubiquitous
- Yet economists have long recognized that it may be inefficient (e.g., Smith, Marshall)?
- Why?
- Consider a very simple model

## Marhsallian model of Sharecropping

- Suppose output is $F(I)$, concave. Tenant chooses about of input to use, $I$, and pays cost per unit of input, $c$. Could be own labor.
- Owner receives a share, $\alpha$, of output.
- Tenant solves

$$\max_I (1-\alpha)F(I) - cI$$

- FOC is

$$F'(I) = c\frac{1}{(1-\alpha)}$$

- Since $F$ is concave, tenant will use less input than would be optimal.
- Note a crucial assumption is that landlord gets a share of *output*, not *profits*. If it was profits then tenant would solve

$$\max_I (1-\alpha)\left(F(I) - cI\right)$$

  and input use would not depend on $\alpha$.

# Sharecropping and moral hazard

## Stiglitz 1974: Incentives and Risk Sharing

- The solution to the Marshallian problem is a rental contract – tenant rents land from landlord for fixed rent $r$, and keeps all output
- Tenant then solves

$$\max_{I} F(I) - cI - r$$

  which gives first-best input choice $F'(I) = c$.
- So why not do this?
- Stiglitz provides one answer: trade-off between incentives and risk-sharing
- Overview of model:
  - Farming is risky – output is uncertain (e.g., pests, weather, etc).
  - Risk averse agents prefer to be insured against this risk
  - But if inputs (e.g., effort) is not contractible
  - Sharecropping contract trades off risk and incentives

# Model

- Simple two-state version.
- Cultivation effort is denoted by $e$
- Farmer chooses $e$, but landlord cannot observe $e$
- Effort is costly to tenant, with cost $\frac{1}{2}ce^2$
- Output:
  - with probability $e$: Output is $H$
  - with probability $1 - e$: Output is 0
- The farmer and landlord write a contract which specifies a payment to the farmer
  - a payment $h$ if output is $H$
  - a payment $l$ if the output is 0

# Model

- What is the first-best?
- First best solves

$$max_e eH - \frac{1}{2}ce^2$$

- So first best is

$$e = \frac{H}{c}$$

# Model

- Can landlord implement first-best?
- Landlord solves

$$max_{h,l} e(H-h) + (1-e)(-l)$$

subject to farmer's IC constraint:

$$e = \underset{e}{\text{argmax}}\, eh + (1-e)l - \frac{1}{2}ce^2$$

and farmer's IR constraint:

$$eh + (1-e)l - \frac{1}{2}ce^2 >= \underline{w}$$

where $\underline{w}$ is farmer's outside option

# Model

- Begin by solving for farmer's solution taking contract as given (IC): given $h$ and $l$, what is optimal effort?
- Farmer solves
$$\max_e eh + (1-e)l - \frac{1}{2}ce^2$$
- This yields
$$e^* = \frac{h-l}{c}$$

# Solution

- To implement the first best, landlord needs to set $h - l = H$. This will be rental contract with rent $R$ and farmer keeps output.
- Why? Need worker to face socially optimal return to effort. Note that since $e^* = \frac{h-l}{c}$, setting $h - l = H$ yields $e^* = \frac{H}{c}$.
- IR constraint pins down $R$ so that farmer obtains $\underline{w}$ in expectation
- Recall farmer's utility is

$$eH - R - \frac{1}{2}ce^2$$

  evaluated at $e = \frac{H}{c}$
- So farmer's utility is

$$\frac{H^2}{2c} - R$$

- Landlord sets

$$R = \frac{H^2}{2c} - \underline{w}$$

  so that farmer obtains outside option.

# Solution

- So final contract is
  - $h = \underline{w} - \frac{H^2}{2c} + H$
  - $l = \underline{w} - \frac{H^2}{2c}$
- So farmer on net receives $\underline{w}$ but exerts optimal effort.
- This contract has two issues
  - Farmer now bears all the *risk*.
  - With positive probability farmer earns $\underline{w} - \frac{H^2}{2c} < 0$. What if farmer can't pay? This is a *limited liability* problem.
- Let's explore both.

## Introducing risk-aversion

- What if the farmer is risk-averse?
- Assume landlord still risk-neutral but farmer has utility $u(c)$, with $u$ concave.
- Now, farmer's utility is to solve

$$max_e eu(h) + (1-e)u(l) - \frac{1}{2}ce^2$$

- If landlord implemented the optimal contract from before, farmer's utility would be strictly less than $u(\underline{w})$.
- Why?
- Because concavity implies $eu(h) + (1-e)u(l) < u(eh + (1-e)l) = u(\underline{w})$
- So landlord will have to compensate farmer somehow
- Should landlord reduce $h - l$ to do so, or do it all on the $R$ dimension?

# Risk-aversion

- Answer: landlord will reduce $h - l$ a bit
- Risk-averse agent prefers a certainty equivalent to uncertainty, so holding $e$ constant cheaper in expectation for landlord to reduce $h - l$ than to increase $R$
- Starting from first-best $e$ reducing $e$ causes second-order loss of productive efficiency but first-order gain in risk-smoothing
- But, landlord will not go all the way to $h = l$ because then $e = 0$
- This is the argument given for sharecropping given by Stiglitz (1974): landlords and peasants *prefer* to engage in sharecropping to share risk, even if it lowers production due to moral hazard
- Stiglitz (1974) shows that with non-contractible effort, with risk-neutral agents there is no sharecropping (full rental contract), but with risk-averse agents there is sharecropping
- Example on the pset.

# Limited liability

- Let's go back to risk neutrality, and assume for the moment that outside option doesn't bind.
- But, let's impose *limited liability*. That is, you cannot impose $l < 0$.
- What happens to the optimal contract? Recall before we had
    - $h = \underline{w} - \frac{H^2}{2c} + H$
    - $l = \underline{w} - \frac{H^2}{2c}$
- This contract violates limited liability because $l < 0$
- So what happens to $l$? $l = 0$
- What is $h$? Recall $e^* = \frac{h-l}{c}$. So landlord solves

$$\max_h e(H-h) = \max_h \frac{h}{c}(H-h)$$

$$h = \frac{H}{2}$$

$$e = \frac{H}{2c}$$

# Outside options

- What happens if we add back in the constraint that farmer needs to earn at least $\underline{w}$?
- Farmers's utility under the contract:

$$\begin{aligned} & \frac{h}{c}h - \frac{1}{2}c(\frac{h}{c})^2 \\ = & \frac{1}{2}\frac{h^2}{c} = \frac{1}{8}\frac{H^2}{c} \end{aligned}$$

- If $\frac{1}{8}\frac{H^2}{c} \geq \underline{w}$, they can choose this contract. Note that the contract does not depend on $\underline{w}$. But also note: farmer gets information rents (i.e. receives more than $\underline{w}$).
- if $\frac{1}{8}\frac{H^2}{c} < \underline{w}$, landlord has to pick a contract which will give at least $\underline{w}$ to the farmer. Picks $h$ such that:

$$\frac{1}{2}\frac{h^2}{c} = \underline{w}$$

- Note that in this case increasing $\underline{w}$ increases effort.

## Contrasting the models

- In both models – risk-aversion and limited liability – sharecropping emerges, and effort is less than first best
- But models differ in terms of implications of a land reform
- Under risk-aversion, even with a land reform, share-cropping may re-emerge endogenously as a way of providing insurance.
- Under limited liability, no need to have share-cropping anymore.

# Evidence?

- Question: Does effort from a given farmer respond to incentives?
- How would you estimate this?
- One option would be to use farmers who farm multiple plots, some sharecropped and some owned
- Then you could estimate

$$y_i p = \alpha_i + OWNED_p + \epsilon_i p$$

where $\alpha_i$ is a person fixed effect and $y_i p$ is a measure of inputs used on the plot (land, fertilizer, etc)
- Good? Bad?

# Evidence?

- The problem with this approach is that ownership characteristics may be correlated with plot quality
- This is, indeed, the case:

TABLE 2

CHARACTERISTICS BY TENURE STATUS

| Village | Owned | | | Sharecropped | | | Fixed-Rent | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Plots | Average Plot Area (Acre) | Average Plot Value* | Number of Plots | Average Plot Area | Average Plot Value* | Number of Plots | Average Plot Area | Average Plot Value* |
| A | 1,249 (96.4)[†] | 1.91 | 21.20 | 8 (.5) | 1.53 | 13.75 | 38 (3.1) | 2.03 | 14.00 |
| B | 532 (84.1) | 1.55 | 42.15 | 66 (14.9) | 2.22 | 40.23 | 5 (1.0) | 1.90 | 40.00 |
| C | 1,516 (64.5) | 1.57 | 29.68 | 526 (35.5) | 2.49 | 24.86 | 3 (.0) | .20 | 21.33 |
| D | 1,472 (77.6) | 1.64 | 17.55 | 351 (22.1) | 1.96 | 13.43 | 2 (.3) | 4.00 | 10.00 |
| E | 1,133 (83.9) | 2.57 | 22.56 | 114 (12.3) | 3.73 | 18.94 | 37 (3.8) | 3.57 | 11.70 |
| F | 568 (92.2) | 3.51 | 15.05 | 57 (7.7) | 2.93 | 10.60 | 1 (.1) | 2.00 | 10.00 |
| G | 425 (67.1) | .71 | 39.30 | 138 (25.5) | .83 | 39.28 | 46 (7.4) | .72 | 35.20 |
| H | 916 (80.7) | 1.04 | 62.79 | 160 (16.1) | 1.19 | 60.70 | 26 (3.1) | 1.42 | 56.15 |
| All | 7,811 (80.9) | 1.81 | 29.20 | 1,420 (17.5) | 2.15 | 27.08 | 158 (1.6) | 1.77 | 27.45 |

# Evidence?

- Shaban (1987) tried to solve this by controlling for detailed plot characteristics.
- Does that help?
- Still finds evidence that owned plots get more inputs
- But ideally would like to have *plot* as well as person fixed effects, i.e. estimate

$$y_i p = \alpha_i + \alpha_p + OWNED_p + \epsilon_i p$$

- I can't find a paper that does this. Why might this be?
- Even if I could find such a paper, would you be satisfied?
- What might be a better way of testing moral hazard?

# Testing Moral Hazard Directly

## Burchardi et al 2019: Moral Hazard: Experimental Evidence from Tenancy Contracts

- Burchardi et al run a simple experiment:
- Work with tenant farmers in Uganda
- Randomize them to receive either 50% of output, 75% of output, or 50% of output plus exogenous cash transfer (fixed for half, risky for half)
- Why the third group?

# Results

## Output

TABLE II
EFFECTS ON OUTPUT

| | Output, $y$ | | Yield, $\frac{y}{m^2}$ | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| High $s$ (T1) | 56.28*** | 56.07*** | 0.074** | 0.073** |
| | (18.52) | (18.58) | (0.031) | (0.031) |
| | [0.004] | [0.004] | [0.024] | [0.027] |
| High $w$ (T2) | 5.36 | | −0.000 | |
| | (17.17) | | (0.030) | |
| | [0.765] | | [0.995] | |
| High $w$, safe (T2A) | | 18.29 | | 0.043 |
| | | (25.84) | | (0.048) |
| | | [0.543] | | [0.403] |
| High $w$, risky (T2B) | | −7.25 | | −0.043 |
| | | (15.82) | | (0.032) |
| | | [0.641] | | [0.206] |
| $H_0$: T1 = T2 | 0.023 | | 0.046 | |
| $H_0$: T1 = T2A | | 0.218 | | 0.590 |
| $H_0$: T1 = T2B | | 0.001 | | 0.002 |
| $H_0$: T2A = T2B | | 0.343 | | 0.120 |
| Mean outcome (C) | 95.13 | 95.13 | 0.174 | 0.174 |
| Observations | 473 | 473 | 473 | 473 |

- Note: randomized inference p-values in brackets. What is this?

# Results

## Capital input

TABLE III
EFFECTS ON CAPITAL INPUTS

| | Fertilizer (1) | Insecticide (2) | Tools (3) | Index (4) |
|---|---|---|---|---|
| *Panel A:* Extensive Margin | | | | |
| High $s$ (T1) | 0.094 | −0.010 | 0.086 | 0.201 |
| | (0.061) | (0.053) | (0.055) | (0.133) |
| | [0.176] | [0.860] | [0.123] | [0.162] |
| High $w$ (T2) | 0.027 | −0.064 | 0.007 | −0.049 |
| | (0.060) | (0.055) | (0.053) | (0.140) |
| | [0.690] | [0.261] | [0.901] | [0.739] |
| Within-Equation Test | | | | |
| $H_0$: T1 = T2 | 0.310 | 0.320 | 0.142 | 0.080 |
| Cross-Equations Test | | | | |
| $H_0$: T1 = 0 | | 0.283 | | — |
| $H_0$: T2 = 0 | | 0.594 | | — |
| $H_0$: T1 = T2 | | 0.375 | | — |
| Mean Outcome (C) | 0.277 | 0.276 | 0.500 | 0.000 |
| Observations | 432 | 423 | 432 | 423 |
| *Panel B:* Intensive Margin (US$) | | | | |
| High $s$ (T1) | 1.13* | 0.43 | 11.36** | 0.436*** |
| | (0.55) | (0.51) | (5.04) | (0.153) |
| | [0.056] | [0.416] | [0.039] | [0.008] |
| High $w$ (T2) | 0.59 | −0.50 | 1.59 | 0.029 |
| | (0.43) | (0.47) | (4.32) | (0.126) |
| | [0.205] | [0.282] | [0.727] | [0.808] |
| Within-Equation Test | | | | |
| $H_0$: T1 = T2 | 0.350 | 0.046 | 0.059 | 0.008 |
| Cross-Equations Test | | | | |
| $H_0$: T1 = 0 | | 0.039 | | — |
| $H_0$: T2 = 0 | | 0.274 | | — |
| $H_0$: T1 = T2 | | 0.044 | | — |
| Mean Outcome (C) | 0.96 | 1.81 | 37.81 | 0.000 |
| Observations | 419 | 413 | 427 | 402 |

# Results

## Labor input

TABLE IV

EFFECTS ON LABOR INPUTS

| | Own labor (hours/week) | Paid (days/season) | Unpaid | Index |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| High $s$ (T1) | 0.34 | – 0.05 | 8.02* | 0.20 |
| | (1.28) | (1.98) | (4.03) | (0.12) |
| | [0.781] | [0.982] | [0.065] | [0.157] |
| High $w$ (T2) | – 0.03 | 1.06 | 1.79 | 0.05 |
| | (1.22) | (2.08) | (3.31) | (0.12) |
| | [0.984] | [0.628] | [0.626] | [0.721] |
| Within-equation test | | | | |
| $H_0$: T1 = T2 | 0.783 | 0.550 | 0.173 | 0.280 |
| Cross-equations test | | | | |
| $H_0$: T1 = 0 | 0.277 | | | — |
| $H_0$: T2 = 0 | 0.909 | | | — |
| $H_0$: T1 = T2 | 0.575 | | | — |
| Mean outcome (C) | 17.13 | 4.28 | 12.54 | – 0.00 |
| Observations | 417 | 432 | 432 | 417 |

# Results

## Crop choice

TABLE V

EFFECTS ON CROP CHOICE

| | Maize (1) | Beans (2) | Peanuts (3) | Tomatoes (4) | Potatoes (5) |
|---|---|---|---|---|---|
| *Panel A:* Extensive margin | | | | | |
| High $s$ (T1) | 0.112** | 0.049 | 0.055 | 0.021*** | 0.012 |
| | (0.047) | (0.042) | (0.040) | (0.010) | (0.008) |
| | [0.025] | [0.253] | [0.212] | [0.008] | [0.201] |
| High $w$ (T2) | 0.090* | 0.032 | 0.049 | −0.001 | 0.002 |
| | (0.048) | (0.041) | (0.038) | (0.004) | (0.003) |
| | [0.084] | [0.447] | [0.239] | [0.805] | [0.686] |
| $H_0$: T1 = T2 | 0.652 | 0.720 | 0.899 | 0.013 | 0.217 |
| Mean outcome (C) | 0.620 | 0.300 | 0.327 | 0.000 | 0.000 |
| Observations | 479 | 479 | 479 | 479 | 479 |
| *Panel B:* Intensive margin: number of plants | | | | | |
| High $s$ (T1) | 159.82 | 4.53 | 330.43 | 41.02** | 3.40 |
| | (145.70) | (391.33) | (179.11) | (19.14) | (2.85) |
| | [0.295] | [0.994] | [0.128] | [0.020] | [0.318] |
| High $w$ (T2) | −66.01 | −85.58 | −39.70 | 1.48 | 0.67 |
| | (131.88) | (362.02) | (154.24) | (10.48) | (1.31) |
| | [0.635] | [0.841] | [0.818] | [0.912] | [0.841] |
| $H_0$: T1 = T2 | 0.147 | 0.760 | 0.094 | 0.013 | 0.205 |
| Mean outcome (C) | 861.96 | 867.83 | 577.09 | 0.00 | 0.00 |
| Observations | 479 | 479 | 479 | 479 | 479 |
| *Panel C:* Intensive margin: value of output | | | | | |
| High $s$ (T1) | 4.51 | 5.40 | 32.77*** | 7.67* | 0.27 |
| | (4.85) | (6.17) | (11.04) | (4.23) | (0.24) |
| | [0.384] | [0.389] | [0.003] | [0.051] | [0.447] |
| High $w$ (T2) | −2.43 | 1.78 | 4.72 | −0.25 | 0.05 |
| | (4.40) | (6.84) | (9.38) | (1.89) | (0.11) |
| | [0.591] | [0.820] | [0.655] | [0.917] | [0.814] |
| $H_0$: T1 = T2 | 0.152 | 0.613 | 0.065 | 0.074 | 0.318 |
| Mean outcome (C) | 28.43 | 15.78 | 22.44 | 0.00 | 0.00 |
| Observations | 479 | 479 | 479 | 479 | 479 |

- Note: beans are the non-risky crop; maize, peanuts, and tomatoes are riskier

# What is effort?

- The moral hazard model had $e$ as 'unobservable effort.'
- How do you interpret this in light of the results?
- In the paper they try to say: how much of the increase in output is driven by observables (land, non-owner labor, and capital)?Answer: about half.
- What else is going on? Crop choice (increased risk-taking). Explains the rest.
- So little 'unobservable effort.'Does that change the conclusions?