Barriers to Technology Adoption: What We Know from Micro Empirics

TA Session

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STEG Macro Development Course

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Goal for this TA section

- Overview of model of agriculture technology adoption (Magruder 2018)
- Review emerging evidence on intermediation in agriculture: a few examples
- How can micro and macro build off each other : example from Bergquist and Dinerstein, 2020

A model of agricultural technology adoption

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- Ex ante: farmer expects a choice of inputs x will produce $E_{s,t}[f_{s,t}(x)]$

A model of agricultural technology adoption

Farmers maximize:

$$u(c^0) + \beta \sum_{s,t \in S \times T} \pi_s \pi_t u(c^1_{s,t})$$

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- Input x, transformed into production via $f_{s,t}(x)$
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A model of agricultural technology adoption

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Four constraints:

1. $c^0 = Y - x - a$
2. $c^1_s = f_{s,t}(x) + Ra$
3. $x >= 0$
4. $a >= \bar{a}$

A model of agricultural technology adoption

Assumptions:

- Perfect info ($\pi_t \in \{0, 1\} \forall t$) (will relax this in a moment)
- Inada conditions: $f_s'(x) > 0, f_s''(x) < 0, \lim_{x \to 0} f_s'(x) = \infty$

First order conditions:

$$u'(c^0) = \beta \sum_{s, \in S} \pi_s f_s'(x) u'(c_s^1)$$

and

$$u'(c^0) = \beta RE[u'(c_s^1)] + \lambda_a$$

Implications

1. Credit constraints reduce input usage
   - Take the derivative of the FOC on x with respect to $\bar{a}$
   - If credit constraints bind ($a = \bar{a}$), then optimal input use is increasing in the amount of available credit ($\frac{\partial x^*}{\partial \bar{a}} < 0$)

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2. Risk reduces input usage
   - If there were perfect insurance ($c_s^1 = c^{1I}$), then the two FOCs imply:

$$\beta R + \frac{\lambda_a^I}{u'(c^{1I})} = \beta E[f'(x)]$$

   - But without perfect insurance:

$$\beta R + \frac{\lambda_a^I}{E[u'(c_s^1)]} = \beta \left\{ E[f'(x)] + \frac{cov(f'(x), u'(c_s^1))}{E[u'(c_s^1)]} \right\}$$

   - When farmers are not credit constrained, $\lambda_a = 0$. Because $cov(f'(x), u'(c_s^1)) < 0$, this implies that risk reduces inputs used (x)

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3. Can model information failures like more risk

Reminder: Low adoption and market inefficiencies

- Low adoption of some technologies because they are not profitable
- Others would be adopted in world with perfect markets, but are not adopted because of one or more "market inefficiencies"
- Market inefficiencies (Jack, 2011 - ATAI)
  - Input and output market inefficiencies: Problems with infrastructure and with supply chains, compounded by weak contracting environments, make it more costly for farmers to access input and output markets and access the benefit from technology adoption
  - Informational inefficiencies: If an individual does not know that a technology exists or about its benefits

Role of intermediaries

- We often think about input suppliers (or producers) and farmers (consumers); but existence of a range of intermediaries in between that could affect adoption
- Intermediaries could affect:
  - Market Price, e.g., transport costs, market structure, ...
  - Availability, e.g., economies of scale, delivery, ...
  - Diffusion of information
  - Matching suppliers and farmers
  - Contracts
  - A range of other possibilities
- Small and emerging literature looking at the role of intermediaries

Market structure for intermediaries - Bergquist and Dinerstein, 2020

- Low farmer revenues and high consumer food prices - maybe driven by imperfect competition among intermediaries
- Context and Sample: maize traders in Kenya
- Perfect competition versus Collusion
- Experiments (RCTs) to look at
  - Cost pass-through
  - Shape of demand
  - Effect of entry on market prices

Market structure for intermediaries - Bergquist and Dinerstein, 2020

- Traders pass through only 22% of costs reductions/subsidies to customers and capture high markups
- Traders are not competing: cannot reject a perfectly collusive model, can rule out Cournot competition
- Traders form agreements about prices and act as single profit-maximizing monopolist in the market
- Looking at new entry: if no prior connections in the market, small impact on price but if prior connections, collusion
- Looking at incumbent traders: median trader keeps 12 % of revenues as profit, largest traders earn highest markups (in aggregate traders capture 82% total surplus, consumers 18 %)
- Switching to Cournot competition: large effects on consumer surplus (triple) and deadweight loss would fall

Information Diffusion - Emerick et al, 2021

- Context and Sample: Rice dealers in India
- Can private input suppliers solve the information frictions experienced by farmers that lead to low adoption?
- Private dealers versus public-sector extension agents
- RCTs and "Secret Shopper" experiments
  - RCT : information about new seed variety given to private dealers in random subset of areas
  - "Secret Shopper" experiments: surveyors acting as farmers visit dealers and collect data on dealers' behavior

Information Diffusion - Emerick et al, 2021

- Areas where private dealers were targeted increased farmers' adoption of new variety by over 50%
- Private dealers target farmers who would benefit the most
- Private dealers proactively recommend new variety to farmers, spreading information and increasing adoption
- Possible mechanism: Private dealers motivated by reputation and business incentives

Contracts in trade - Startz, 2018

- Context and Sample: consumer goods traders in Nigeria, mostly importing internationally (buy goods and resell to home consumers)
- Focus on two types of frictions
  - Search: how do sellers find out availability of goods in far away places?
  - Contracts: how do sellers ensure they are actually delivered?
- Way traders can source: order remotely versus traveling to do business in person (despite high costs)
- Data collection: transaction-level panel data on what is traded (goods/quantities) and how (travel, payment terms)

Contracts in trade - Startz, 2018

- Not agriculture focused but very applicable
- Building a model of importing with search and contracting frictions; estimates model with collected data
- In absence of both search and contracting frictions: welfare would increase by 29 %
- Gains from eliminating search problem would be 15 % and from contracting 9 %
- Effect on market structure as well (size of firms)
- Policy implications: reduction in travel costs, financial services improving contracting, ...

Many other example

- Role of traders in formal and informal cross border trade (the focus of my work)
- Casaburi and Reed, 2016 in Sierra Leone (cocoa industry)
- ...

How can we relate macro concepts to micro data

- Using experimental evidence to calibrate structural model
- Allows to generate counterfactuals
- A good example: Bergquist and Dinerstein, 2020
  - Sample et setting: maize traders in Kenya
  - Goal: characterize market structure of intermediaries (maize traders in Kenya)

Overview of paper 1/2

- Model 1: Simple model of supply and demand (with some assumptions)
  - Cournot competition vs joint profit maximisation
  - Model of competition is a function of a few sufficient statistics / parameters: pass-through and curvature of demand
  - Using experiments to estimate those parameters
  - Characterize market structure
- Model 2: More general model
  - Similar idea to Model 1
  - Allows for within-market trader heterogeneity and non-constant marginal cost
  - Additional instruments to allow for traders choice in one market to depend on variation in other markets in which trader sells

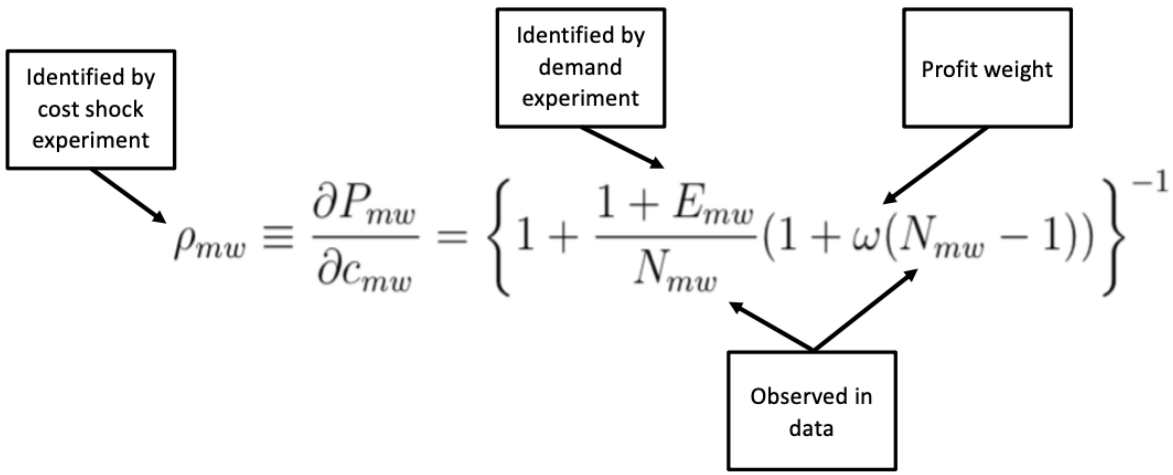
Overview of paper 2/2

- Model 3: Policy - Effect of Entry
  - Traders can enter a market when variable profits (depending on marginal cost and impact of entry on market competition) exceed fixed costs (net of subsidy)
  - Need one more parameter of entry - through experiment
- Estimate counterfactuals equilibria
  - Using estimated demand, quantity-setting, entry models
  - What would happen if traders engaged in Cournot competition

Focus on Simple Model

$$P_{mw} = c_{mw} - (1 + \omega(N_{mw} - 1)) \frac{\partial P_{mw}}{\partial Q_{mw}} \frac{Q_{mw}}{N_{mw}}$$

Panel B: **Simple model**



- ω key measure of market structure
- E the elasticity of the slope of the inverse demand

Pass through

- Experiment 1: Trader Cost Shock Experiment
- Exogenously reduce traders' marginal costs through subsidy per kg sold
- Observe pass through of this cost reduction to consumer price (22%)
- Need to do more as observed rate of pass through
  - Cournot competitive market structure with highly concave demand
  - Perfectly collusive market structure with moderately concave demand
  - Need to estimate demand curve (e.g., curvature of demand)

Curvature of demand

- Experiment 2: Demand Experiment
- Random price reductions
- Observe quantities purchased
- Estimate flexible demand function

Identifying model

Panel A: **Experiments**

Experiment	Exogenous Variation		Used to Identify
Cost Shock	• Marginal costs*	→	• Pass-through
	• Price	→	• Demand (quantity response)
	• Marginal costs in multimarket traders' other markets*	→	• MC slope
Demand	• Price*	→	• Demand (quantity response)
Entry	• Size of fixed payment to enter*	→	• Fixed costs of entry
	• Number new traders in market	→	• Effect of entry on competition

* = directly manipulated

- Use estimates from experiments
- Find perfectly collusive model - not competition amongst traders

Questions