14.771 Development Economics: Microeconomic issues and Policy Models

Fall 2008

14.771: Technology Lecture 2

Ben Olken

November 2008

Outline

- More on technology adoption:
  - Some pitfalls of learning: herd behavior
  - Savings and other constraints on technology adoption
- How technology can affect markets
- Other issues in technology
  - Appropriate technology
  - International technology transfer

Banerjee (1992)

- "A Simple Model of Herd Behavior" – we'll look at the very simple version
- Suppose there are two options, A and B. In the paper, they are restaurants, could also be ways of using a technology, investments, or whatever.
- One option is better than the other. If you choose the good restaurant you get return y; if bad restaurant you get return 0.
- Common priors over which is better. Suppose prior probability A is better is α.
- Each person receives a signal about which is better. Signal is correct with probability β.
- People move in sequence. You observe people's choices, but not their private signal.

Equilibrium in the Simple Model

- What happens?
- Person 1 follows signal.
- Person 2:
  - Observes their own signal, person 1's choice, and the common prior
  - Chooses whichever option has higher posterior probability
- Herd behavior:
  - Suppose person 1's signal matches the prior, and person 2 gets the opposite signal
  - Since both signals are of the same quality, person 2 has no information except the prior.
  - So person 2 ignores the private signal and chooses the option with higher prior.
  - By induction so will everyone else
- So everyone can end up on the wrong outcome!

Sources of inefficiency

- Why?
  - The key thing is that information can be lost – people's choices are not sufficient statistic for all the information that has been revealed.
- How would we prevent inefficient herding?
- How would model differ if:
  - Everyone moved at the same time
  - There were multiple discrete choices
  - There were a continuum of possible choices
    - Answer: depends on loss function. If quadratic loss like F&R, you don't get inefficiency, because your choice is a sufficient statistic for all previous information. If discrete gain from getting the right answer, you can continue to get inefficiency
- Key point: critical to learning is the precise nature of information revelation. Learning from others can be good, but the key is to ensure you don't get trapped in the wrong outcome.

Credit and hyberbolic discounting

- Duflo, Kremer and Robinson (2006), maize in Kenya
- Interviews with farmers suggested that one reason only 10%-17% of farmers in demonstration plots took up fertilizer themselves was "they didn't have the money"
- Could normal credit constraints be the problem?
- Given that farmers have cash right after the last harvest, seems like normal credit constraints may not be the problem – may be that they are not good at saving money for harvest

Present-biased preferences

- Traditional preferences

$$u(c_t) = \sum_{k=t}^{T} \delta^{k-t} v(c_k)$$

- Present-biased preferences (also called "hyberbolic discounting", see Loewenstein/Prelec, Laibson, Rabin and others) capture they idea that individuals may discount the entire future more than they discount any future period relative to the previous one

$$u(c_t) = v(c_t) + \beta \sum_{k=t+1}^{T} \delta^{k-t} v(c_k)$$

  $\beta < 1$ implies 'present-bias'
- Key implication: with $\beta < 1$, people prefer 100 dollars today to 110 in a month, but would prefer 110 in two months to 100 in one month. Such preferences would violate normal (exponential) discounting

Present-biased preferences

- These preferences are not time-consistent. Today I would like to start a saving plan tomorrow, but tomorrow I would like to put it off until a day later.
- Two ways of thinking about these preferences: naiive and sophisticated. Sophisticated people are aware of these preferences; naiive people are not.
- Sophisticated people have a demand for commitment: today I would like to place restraints on my future self.

Model of fertilizer adoption

- Consider a 3-period model
  - Period 1, inherit income from previous harvest
  - Period 2, plant. Chose to use fertilizer on share γ of land. Receive no income.
  - Period 3, receive income from next harvest

$$y_3 = \gamma y_H + (1 - \gamma) y_L$$

- Can purchase fertilizer in period 1 or 2, with small utility cost that is paid in the period when it is purchased. (hassle)
- Utility function in period 1

$$u(c_1) + \beta (u(c_2) + u(c_3)) + F * D_1 + \beta F * D_2$$

where D_j is 1 if fertilizer purchased in period j and F is utility cost

Model of fertilizer adoption

- What will a naiive farmer do?
- What will a sophisticated farmer do?

Empirical tests

- Randomize farmers into the following treatments:
  - Farmer is visited by agent at harvest and offered option to buy fertilizer then. Take it or leave it.
  - Farmer is visited by agent before harvest, and asked when person should return to sell him fertilizer. When returns it is as above.
  - Control
- Also examined subsidizing price of fertilizer by 50%

Results

Results

- Program is taken up by 30%-40% of farmers and increases adoption by 10%-12%
- Effect of visiting early is comparable to 50% reduction in price – quite substantial effect
- When farmers are given ex-ante choice of when to come back, many choose to have the person come back right after harvest: suggests some amount of sophistication is present. Total effect is similar to main program: suggests not just impulse buy
- Bottom line: these savings / procrastination stories may be important, and magnitude is as large as a 50% reduction in price

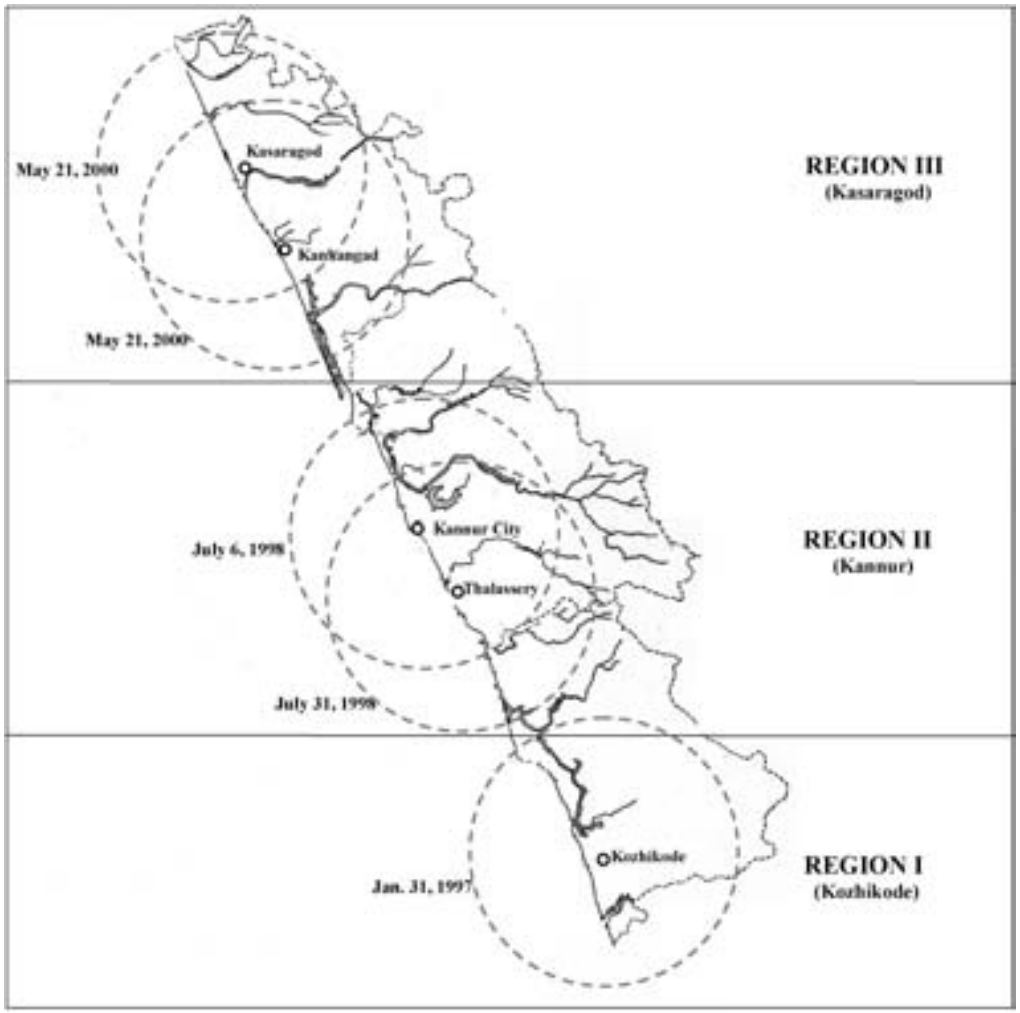
Other issues

- So far everything we've discussed has been about technology adoption.
- Switching gears.... Three more topics in brief.
  - High tech and development: does it matter?
  - Appropriate technology for developing countries
  - International technology transfer

Jensen (2008)

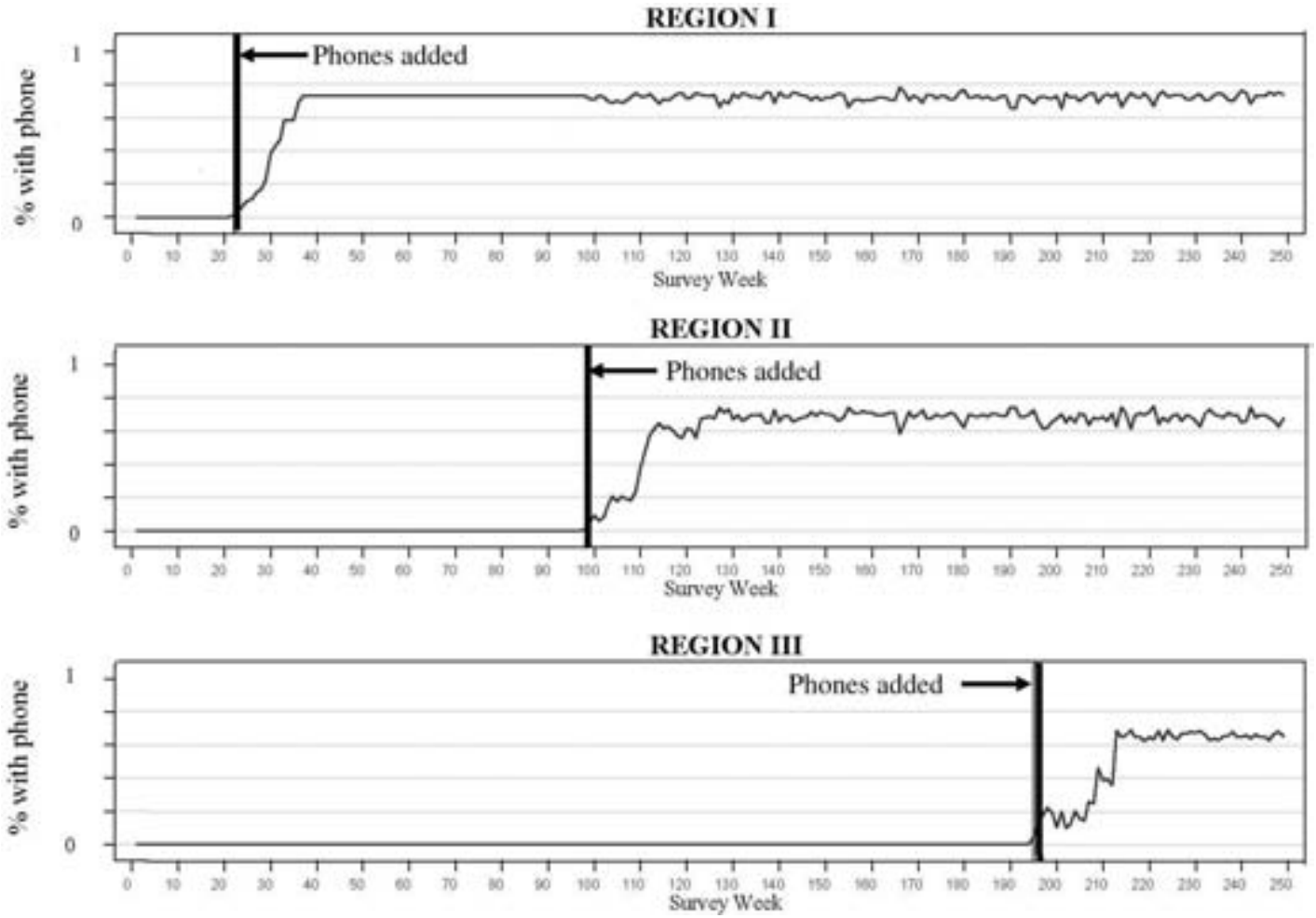
- Setting:
  - Fisherman in Kerala, India
  - Fish markets are located every 15km or so up and down the coast of Kerala
  - Travel time means each fisherman only has time to bring catch to one market
  - No storage – fish caught that day must be sold that day
- Experiment:
  - Introduction of cell phones along the Kerala coast in three phases
  - Cell phones mean that fisherman can call/SMS ahead while still at sea to determine which market to go to
- Question:
  - How does cell phone technology change market efficiency?
  - Key outcomes: price variation and wastage

Setting

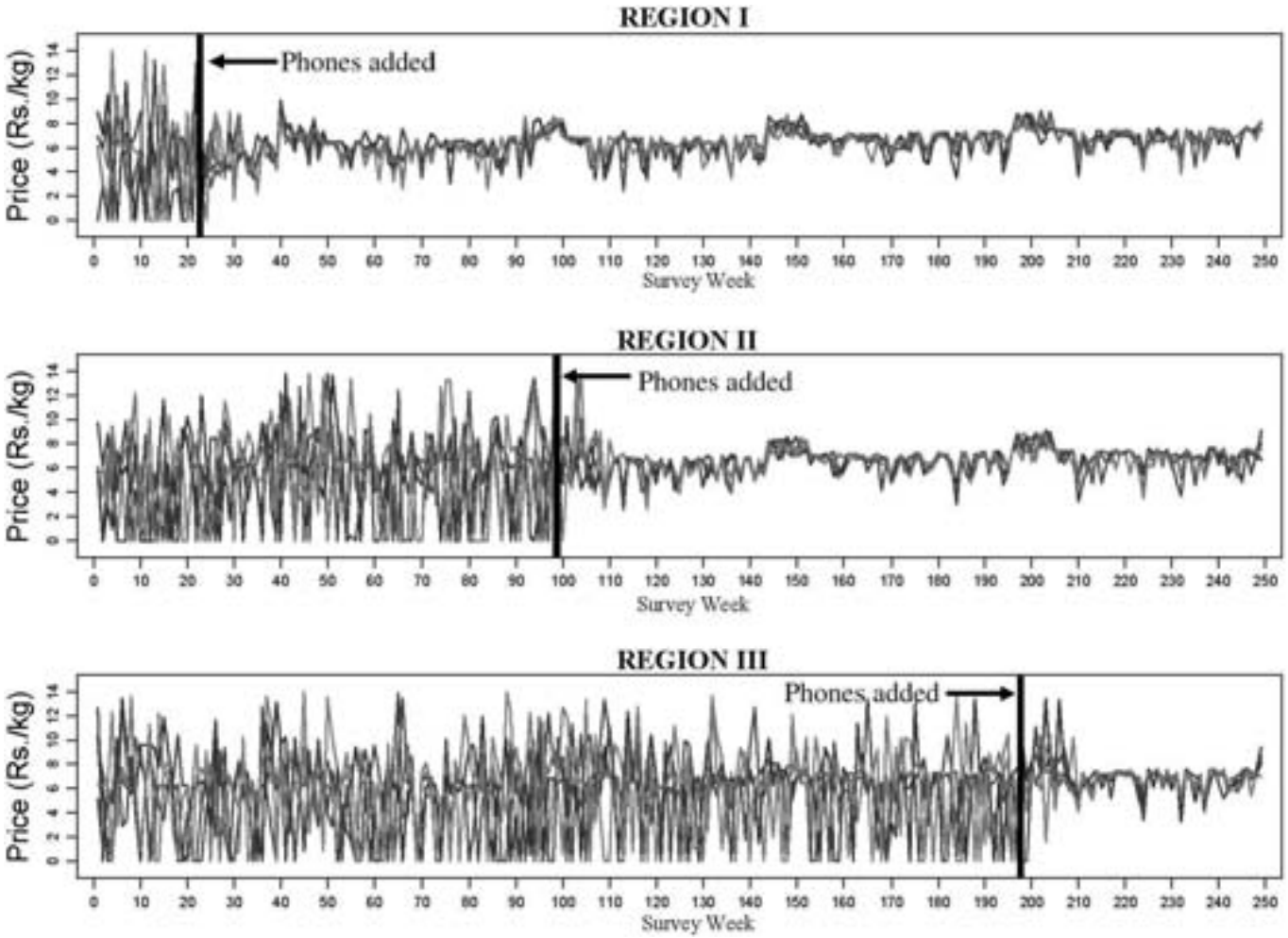


Courtesy of MIT Press. Used with permission.

Technology adoption



Results



Results

TABLE III
PRICE DISPERSION AND WASTE IN KERALA SARDINE MARKETS

	Period 0 (pre-phone)	Period 1 (region I adds phones)	Period 2 (region II adds phones)	Period 3 (region III adds phones)
Max–min spread (Rs/kg)				
Region I	7.60	1.86	1.32	1.22
	(0.50)	(0.22)	(0.10)	(0.44)
Region II	8.19	7.30	1.79	1.57
	(0.44)	(0.29)	(0.19)	(0.16)
Region III	8.24	7.27	7.60	2.56
	(0.47)	(0.27)	(0.25)	(0.34)
Coefficient of variation (percent)				
Region I	.68	.14	.08	.07
	(0.07)	(0.01)	(0.01)	(0.01)
Region II	.62	.55	.12	.08
	(0.04)	(0.04)	(0.01)	(0.01)
Region III	.69	.57	.54	.14
	(0.09)	(0.04)	(0.03)	(0.02)
Waste (percent)				
Region I	0.08	0.00	0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)
Region II	0.05	0.04	0.00	0.00
	(0.01)	(0.01)	(0.00)	(0.00)
Region III	0.07	0.06	0.06	0.00
	(0.01)	(0.01)	(0.01)	(0.00)

High tech and development

- Jensen is a 'possibility result': shows an important example of how technology really can matter for poor people
- How much does it matter? Where else might it matter?
  - Political economy:
    - Freedom of information
    - Online procurement (Banerjee, Olken, and Pande in progress)
  - Monitoring:
    - Attendance of teachers, nurses, etc is a huge problem.
    - Cameras (Duflo, Hanna, and Ryan 2008)
    - Fingerprint readers in Indian schools
    - Compliance with drug regimes (e.g., using cell phones to monitor TB compliance)
  - Computer assisted learning
    - Banerjee et al (2007)

Appropriate technology

- Technology is not one-size-fits all
- Rather, technology is usually specific solutions to specific problems
- These problems are likely to differ in developing / developed countries.
  - Relative price of capital / labor is very different. So whether technology should augment capital or augment labor should be different. (Basu and Weil 1998)
  - Skill levels are different. So whether technology should augment high-skill labor or low-skill labor should also be different. (Acemoglu and Zilibotti 2001)
- Since technology is developed in proportion to market size, this usually means that technology is developed in rich countries and exported to poor countries, where it is suboptimal.
- Empirics of appropriate technology: best work calculates firm level overall productivity in different countries, and examines how patterns differ by high and low skill (Acemoglu and Zilibotti). But would be nice to show something even more direct.

Example: garbage collection

- In US:

Example: garbage collection

- In Indonesia:

International technology adoption

- As discussed already, most technologies are developed in rich countries
- How do they get to poor countries?
- One view is that firm linkages are important – e.g, foreign direct investment, joint ventures etc.
- Empirics: once again, most empirical work investigates this by looking at changes in firm level productivity. Would be nice to see something more direct actually showing technology transfer.

Aitken and Harisson (1999)

- Examine whether FDI changes the productivity of manufacturing firms in Venezuela.
  - Also examine spillovers: once technology is transferred to a particular firm through FDI, what happens to other firms
- Fixed effects regression:

$$y_{ft} = \alpha_f + \alpha_t + \beta FDI_{ft} + \gamma X_{ft} + \varepsilon_{ft}$$

- Include interactions:

$$y_{fit} = \alpha_f + \alpha_t + \beta_1 FDI_{ft} + \beta_2 FDI_{it} + \beta_3 FDI_{fit} * FDI_{it} + \gamma X_{fit} + \varepsilon_{fit}$$

- Thoughts on this regression?
  - Why do foreign firms invest in particular firms?
  - Technology spillovers vs. product market effects? (i.e., if you lose business, your TFP may go down if you cannot easily adjust capital)

Aitken and Harisson (1999)

- Find positive own effects, negative spillovers, but only for small firms.

TABLE 3—IMPACT OF FOREIGN OWNERSHIP BY PLANT SIZE:
REGRESSING LOG OUTPUT AT THE PLANT LEVEL ON INPUTS AND THE SHARE OF FOREIGN OWNERSHIP
AT THE PLANT LEVEL, THE SECTOR LEVEL, AND THE LOCAL LEVEL[a]

	Small plants (less than or equal to 49 employees)				Large plant (greater than 49 employees)			
	(1) OLS	(2) Within[b]	(3) OLS	(4) Within[b]	(5) OLS[c]	(6) Within[b,c]	(7) OLS[c]	(8) Within[b,c]
Foreign ownership in the plant (*Plant_DFI*)	0.104	0.100	0.167	0.182	0.121	−0.018	0.174	−0.123
	(0.052)	(0.055)	(0.065)	(0.084)	(0.031)	(0.049)	(0.036)	(0.073)
Foreign ownership in the sector and region (*Local_Sector_DFI*)	—	—	0.061	0.072	—	—	−0.020	0.196
			(0.035)	(0.058)			(0.032)	(0.218)
Plant_DFI * *Local_Sector_DFI*	—	—	−0.395	−0.359	—	—	−0.203	−0.285
			(0.138)	(0.170)			(0.080)	(0.247)
Foreign ownership in the sector over all regions) (*Sector_DFI*)	−0.349	−0.340	−0.366	−0.363	−0.127	−0.214	−0.128	−0.180
	(0.074)	(0.074)	(0.076)	(0.093)	(0.105)	(0.111)	(0.113)	(0.173)
Plant_DFI * *Sector_DFI*	1.184	0.046	1.475	0.559	0.351	0.411	0.590	1.033
	(0.595)	(0.564)	(0.584)	(0.837)	(0.205)	(0.279)	(0.225)	(0.372)
Number of observations	29,179	29,179	28,069	28,069	13,831	13,831	13,264	13,264
Number of plants	7,620	7,620	7,563	7,563	2,637	2,637	2,627	2,627
R^2	0.90	0.96	0.90	0.94	0.90	0.94	0.90	0.96

[a] Industry dummies included in all OLS specifications. All standard errors (denoted in parentheses) are corrected for heteroskedasticity. Unless otherwise specified, other independent variables (not reported here) include log materials, log skilled labor, log unskilled labor, and log capital stock. *Plant_DFI* is percentage of equity owned by foreigners. *Sector_DFI* is employment-weighted percentage of equity which is foreign owned at the four-digit ISIC level.

[b] Estimated by subtracting from each variable its plant-specific mean over all years.

[c] Regional controls include the real skilled wage and energy prices.

International technology adoption

- This is not the last word on this subject – would be nice to say something more direct.