Technology Adoption among Manufacturing Firms: Evidence from Pakistan
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Productivity Varies Tremendously Across Countries

Source: Jones and Romer (2012)
Productivity Varies Tremendously Within Countries

Productivity Varies Tremendously Within Countries

Inconclusive Answers

• “Macro” studies frame the debate, but answers are often inconclusive

1. Measurement
   o Americans and Indians produce fundamentally different goods
   o Can we accurately measure productivity when Tata Motors and Indians produce fundamentally different goods?

2. Confounding factors
   o Dozens of possible explanations for the patterns
   o How to ascertain cause from effect?

• The typical Indian firm uses 3rd generation technology
  o Is it because consumers don’t demand latest technology?
  o Or, is it constraints to capital that prevent adoption?
  ➢ Policy prescription hinges vitally on separating these kinds of stories
Technology Adoption among Soccerball Producers

• We study technology adoption among soccer ball producers in Pakistan

1. If provided with a beneficial new technology, do firms adopt?
   • How quickly do firms adopt?
   • What are the characteristics of successful and unsuccessful adopters?

2. Does the technology spillover beyond the firm?
   • If so, what are the channels through which spillovers occur?
   • What are the characteristics of the most effective technology spreaders and receivers?

3. Why weren’t firms already using the improved technology?
   • Is private cost > private benefit (but social benefit > private cost?)
   • If not, why was “money left on the table”?
Soccer Ball Cluster in Sialkot, Pakistan

- 70% of world production of hand-stitched balls (WSJ, 2010)
- 40% of total soccer ball production
- 136 active firms
  - 5-10 large firms produce high-quality balls
  - Small-medium size firms produce lower-quality balls
  - All exports
Step 1: Laminate
Step 2: Cut Hexagons and Pentagons
Step 3: Print Logos
Step 4: Stitch
Step 5: Inflate
The Existing Cutting Technology

- Balls use “Buckyball” design: 20 hexagons, 12 pentagons
- Panels cut from the sheets, which are 55% of total input costs
- Cutters use hydraulic press and two-piece metal die to cut sheets
- Hexagons tessellate (8% wasted)
  - Pentagons don’t (23% wasted)
    - Cutters obtain ~250 pentagons/sheet
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Existing Cutting Technology

• Thin consulting market:
  – We offered ~$4,125 to the one consultant we could find to come up with a cutting innovation. He failed.

• In a YouTube video of a Chinese factory producing the Adidas Jabulani ball, Eric noticed a different layout of pentagons
Existing Cutting Technology


**Examples.** An application of the algorithm described in Remark 2 to the case when $K$ is a regular pentagon results in a double-lattice packing of density $(5 - \sqrt{5})/3 = 0.92131\ldots$, shown in Fig. 7. This packing may have the maximum

![Diagram of maximum density double-lattice packing with regular pentagons.](image)
Existing Cutting Technology

- Or, we could have gone to the Wikipedia Pentagons page!
New Cutting Technology

- Eric and his wife (Annalisa Guzzini, an architect) developed blueprint for a 4-pentagon die to implement optimal packing

![The new “offset” die](image1)

![New Cutting Pattern](image2)

- Previous technology cuts 250-256 pentagons from a standard sheet
  - Ours cuts 272-280

- Conservative cost-benefit analysis indicates that median firm can recover fixed costs of adoption after 3 weeks
Technology Drop Experiment

• Stratified on size and randomly assigned firms into three groups

1. Technology Group
   – Die + blueprint
   – 30 minute demonstration of new cutting technology
   – Offer to trade in die for a different size at no cost
     • Panel sizes vary even for a given size ball
     • Pentagon size needs to exactly match hexagon size

2. Cash Group
   – Rs 30,000 ($300) – the amount we paid for each die
   – Controls for credit constraints hypothesis

3. Nothing Group
   – No intervention
Initial Adoption Rates Low

• Some treatment and control firms adopted
  – Evidence that technology is beneficial
  – One of the largest firms (control) has purchased 39 dies on 9 separate occasions, and as of April 2013 cut ~50% of balls with offset die

• After 15 months, adoption rates were low
  – Only 6 of the original 35 Technology firms were using the die
Employee Resistance

• Survey evidence pointed to employee resistance
  – The one large control that purchased 39 dies firm pays fixed wages to cutters and printers
  – Most firms pay piece rates

• Our hypothesis:
  – Adapting to new die slows cutters and printers down, lowering their wage
  – Workers misinform owners about the true costs/benefits of the new die

• Currently running a new experiment to test this hypothesis by changing wage contracts for employees

• Preliminary results suggest mis-aligned incentivize is a constraint to adoption
Concluding Thoughts

• Results still preliminary
  – Will be following firms over longer period to observe technology adoption and if labor contracts are modified

• Results suggested that piece-rate-induced worker resistance can block technology adoption

• Technological innovation and organization changes appear complementary

• But important puzzles remain...
Concluding Puzzles

• Why did owners not adjust labor contracts themselves?
  – Owners didn’t think about this?
  – Workers misinform owners about the true benefits of the new die?
  – Employment contracts are bound by market norms?

• Why didn’t the firms come up with this innovation themselves?

• Why is there no consulting market to whittle away inefficiencies?
  – Why is there no “MBAs without Borders”?