Upgrading and Shared Prosperity: Some Insights from Micro Research

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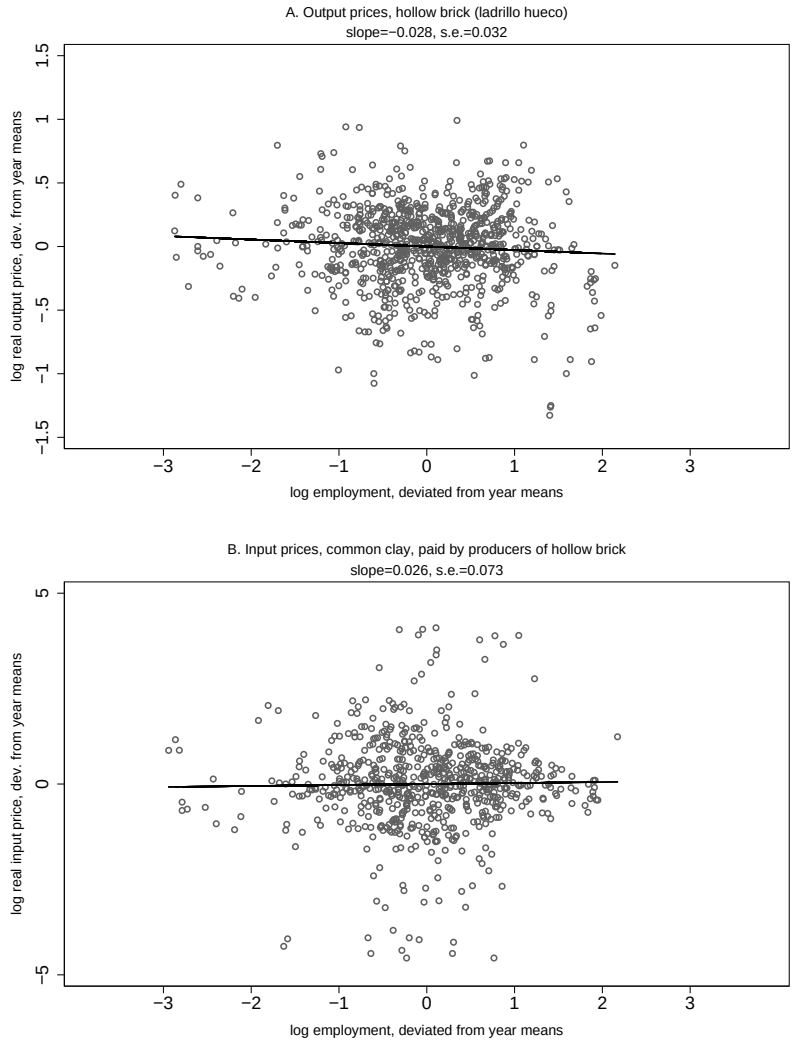
Introduction

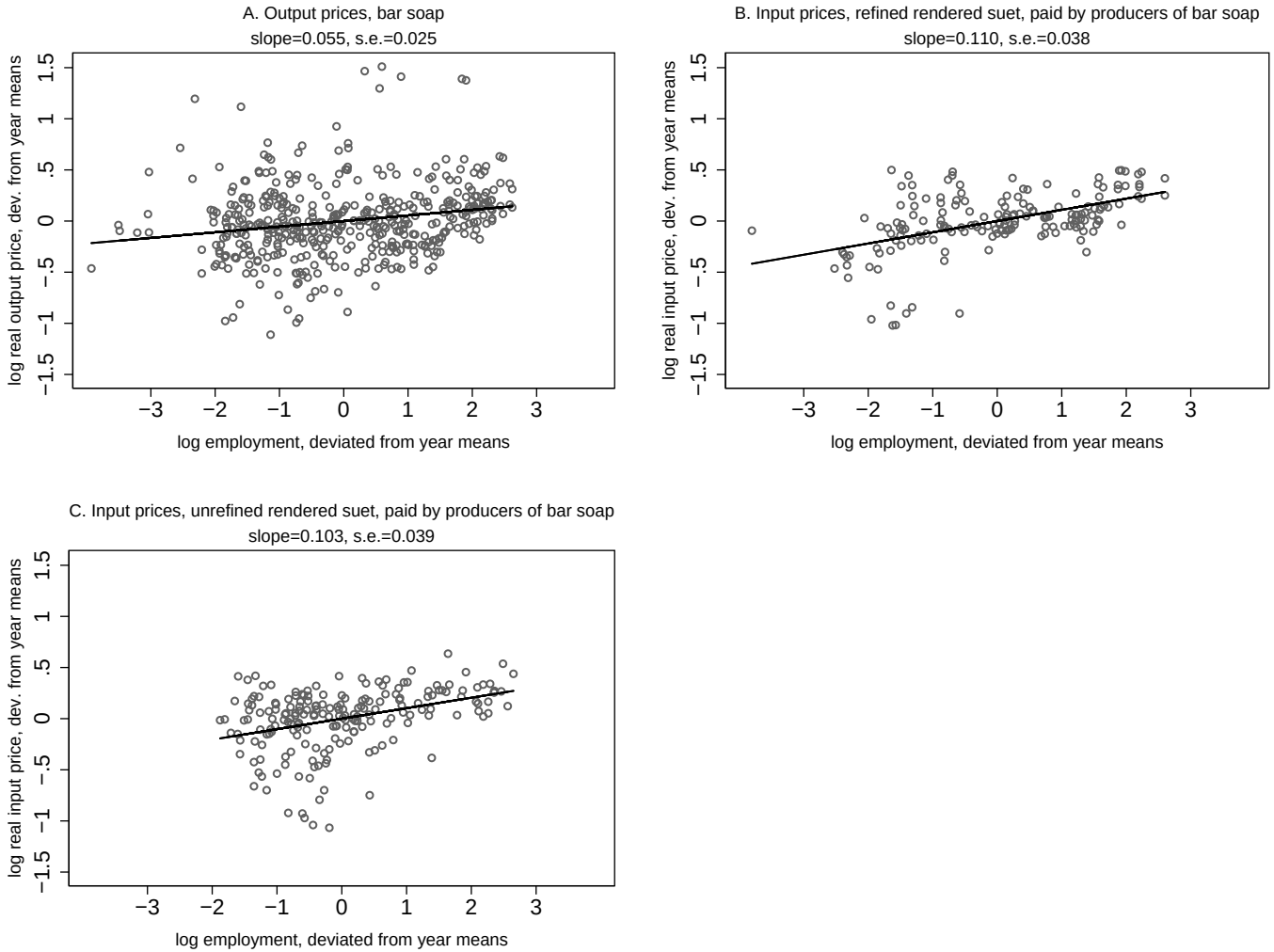
- There is broad agreement that innovation and productivity improvements in manufacturing are a key ingredient in economic growth.
- Important point from Mark's talk: not all innovation is new-to-the-world.
  - All forms of upgrading and the firm level can contribute to growth.
- Key question 1: How can we promote upgrading?
- Key question 2: What are the links between *upgrading* and *shared prosperity*?
  - Within sectors, firms that do more upgrading also tend to pay higher wages.
  - Direction of causality unclear.
- Here I will talk about 5 insights into these questions from my micro research on manufacturing firms in developing countries.

Insight 1: Input quality matters for output quality



- Fig. 1 from Kugler & Verhoogen, REStud 2012.

Insight 1: Input quality matters for output quality



- Fig. 2 from Kugler & Verhoogen, REStud 2012.

Insight 1: Input quality matters for output quality

- On average, larger, more-productive firms use higher-quality inputs, produce higher-quality outputs than smaller firms.
  - Colombian manufacturing overall more like bar soap than like hollow bricks.
- Industrial upgrading requires upgrading of entire complex of final-good producers and input suppliers.
- Imported inputs tend to be higher-quality, may be important for facilitating quality upgrading of final goods (Kugler & Verhoogen, AER P&P, 2009).
- Related idea: producing new varieties of outputs may require new varieties of inputs (Goldberg et al., 2010)

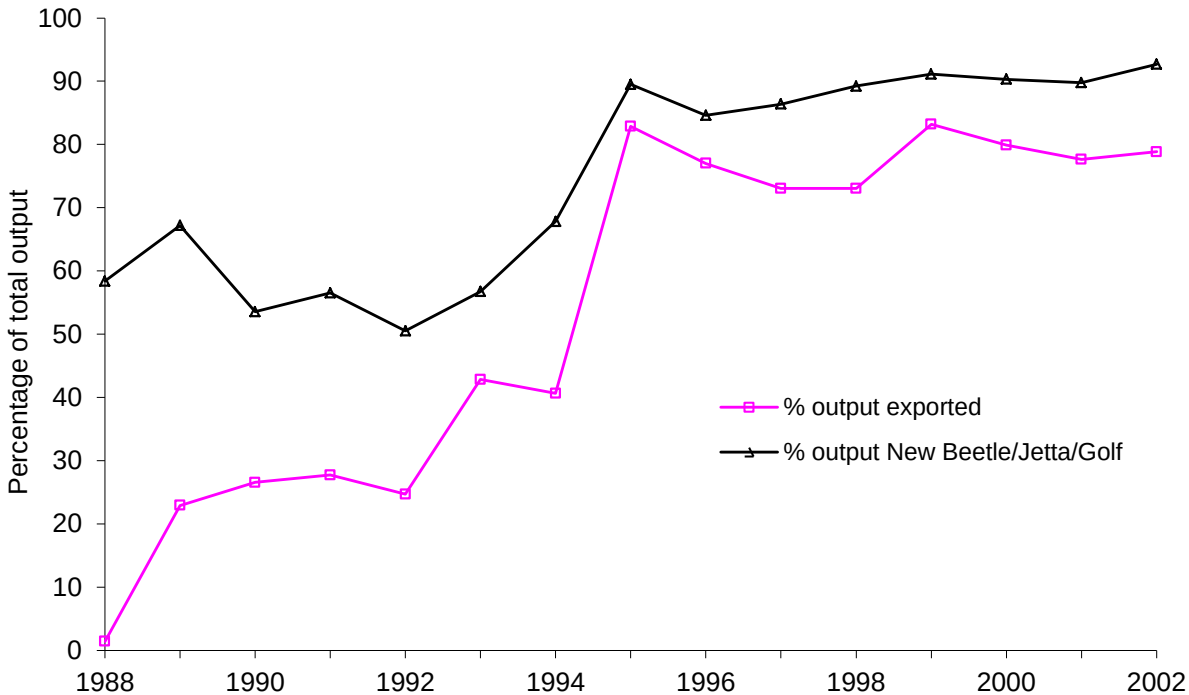
Insight 2: Exports ↑ → Quality ↑, Wages ↑

- New Beetle, almost all exported.

- Old Beetle, almost all sold domestically (produced until 2003).

- Source: Verhoogen, QJE 2008.

Insight 2: Exports ↑ → Quality ↑, Wages ↑

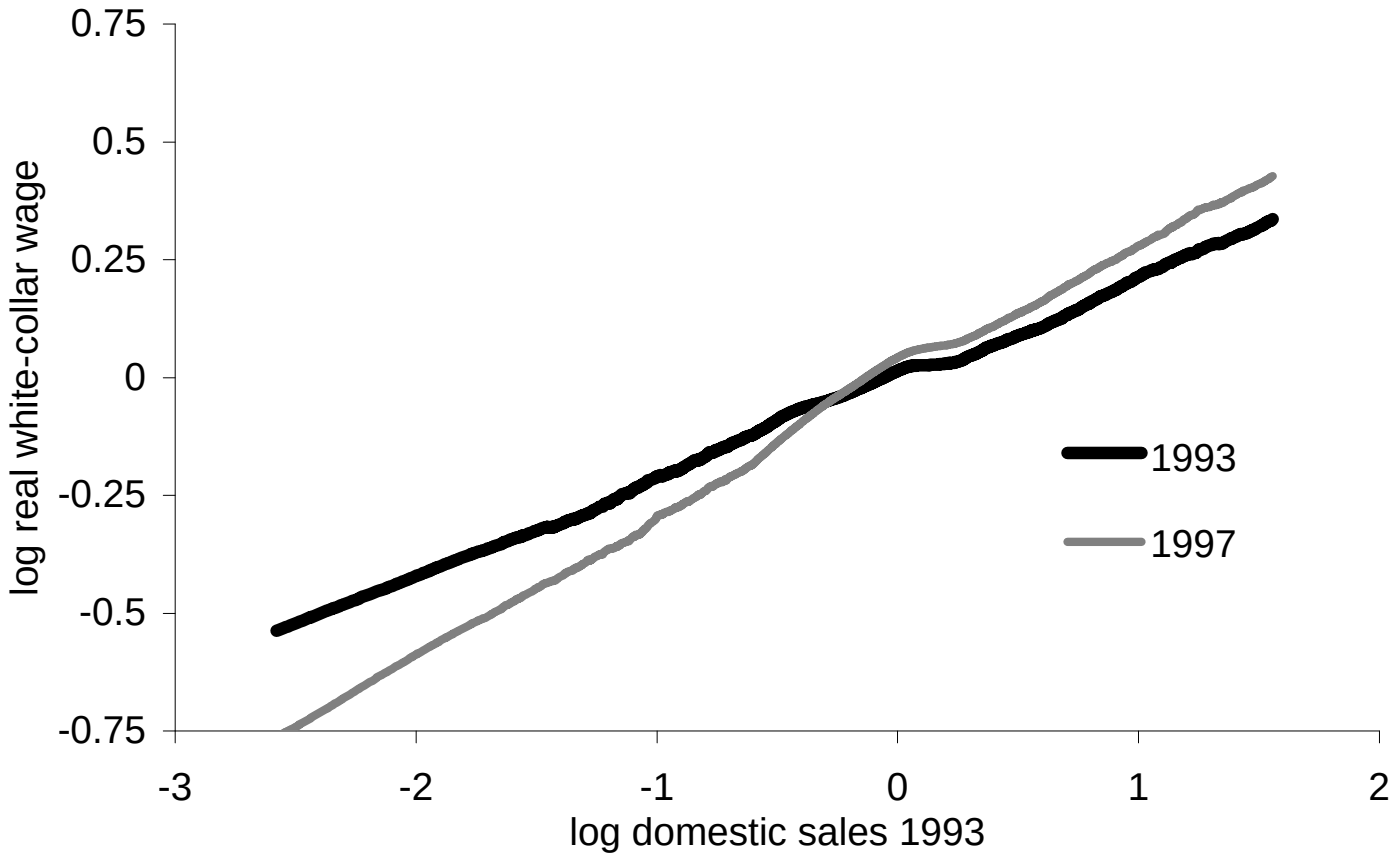


Insight 2: Exports ↑ → Quality ↑, Wages ↑

- Técnico: 9 yrs. education, 2003 starting wage ∼US$11/day.
- Especialista: 12 yrs. education, 2003 starting wage ∼US$18/day.

Insight 2: Exports ↑ → Quality ↑, Wages ↑

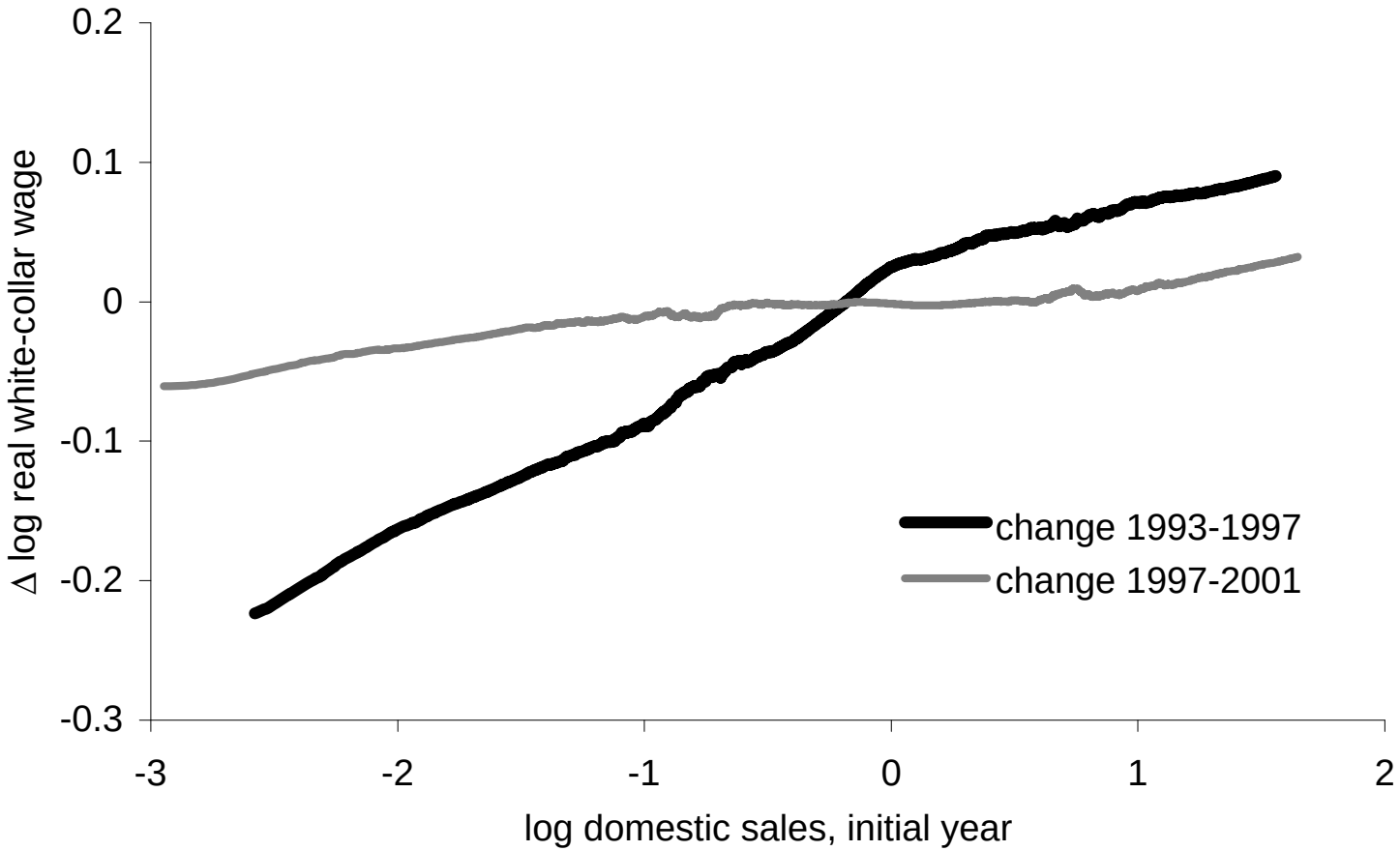
App. Fig. IVb: Log white-collar wage



- Non-parametric regressions, variables deviated from industry-year means.
- Similar patterns hold for ISO 9000 certification.

Insight 2: Exports ↑ → Quality ↑, Wages ↑

App. Fig. Vb: Changes in log white-collar wage



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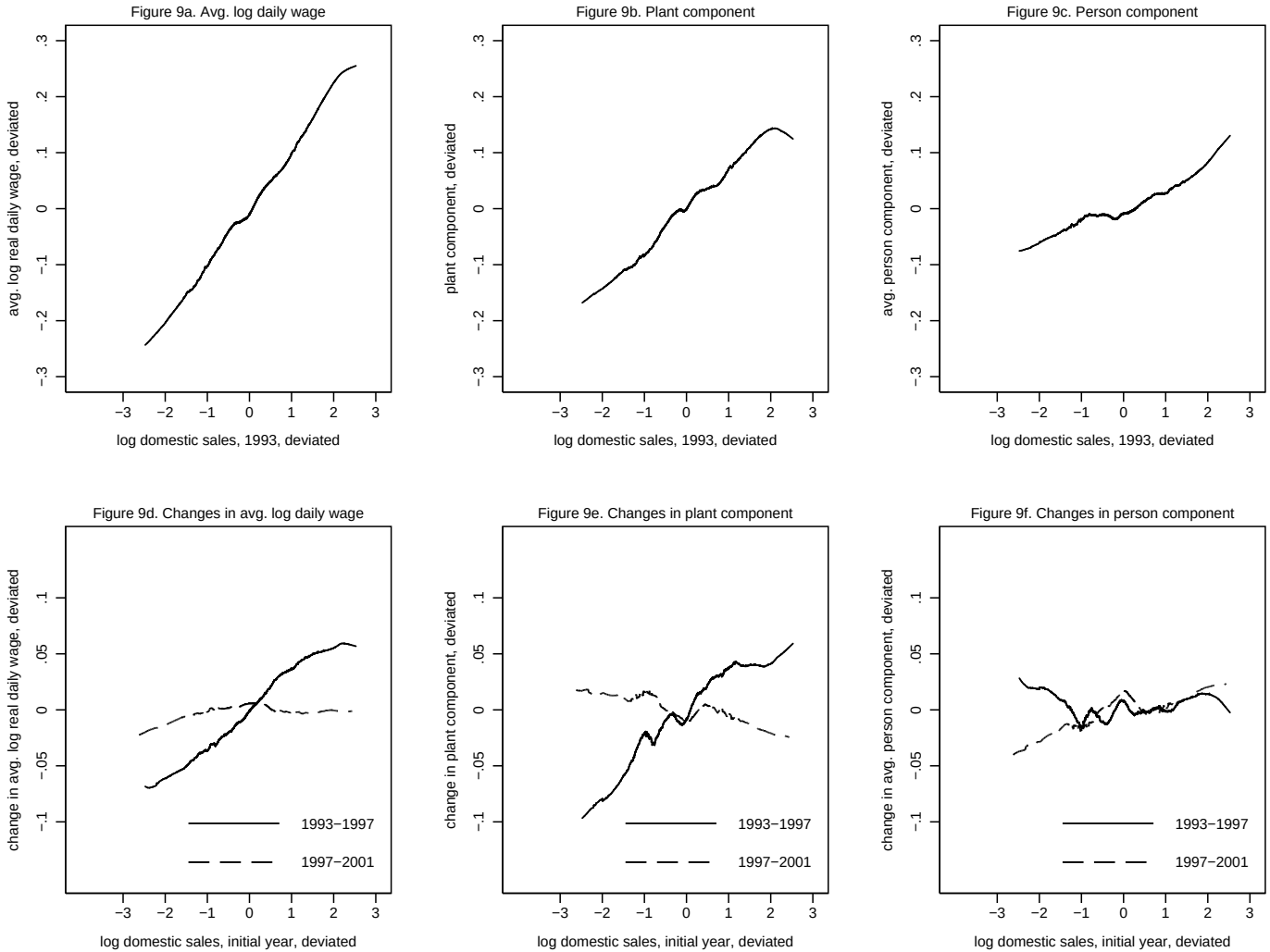
- Similar patterns hold for ISO 9000 certification.

Insight 3: Exports ↑ → Wage *premia* ↑



- Source: Frías, Kaplan & Verhoogen, Unpub. 2011.

Insight 4: Adoption not Automatic

- Ongoing project with Atkin, Chaudhry, Chaudry and Khandelwal, 2015.
- Setting: Soccer-ball cluster in Sialkot, Pakistan
  - ∼30 million balls/year, almost all exported.
  - 40% of world production, 70% within hand-stitched segment (WSJ, 2010).

1st Stage: Glue Cotton/Polyester to Artificial Leather

▸ More on industry

2nd Stage: Cut Hexagons and Pentagons

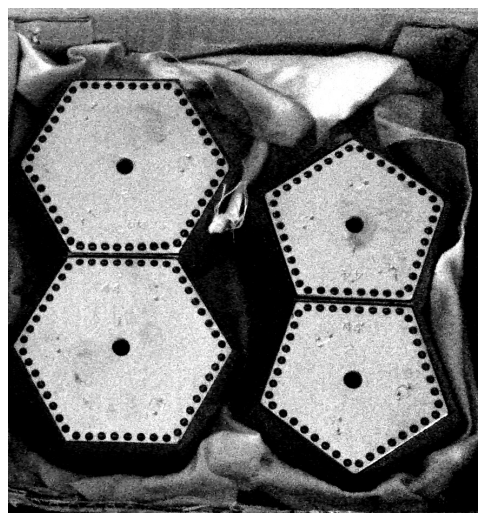
3rd Stage: Print Logos/Designs on Panels

4th Stage: Stitch Panels around Bladder

Existing Cutting Technology

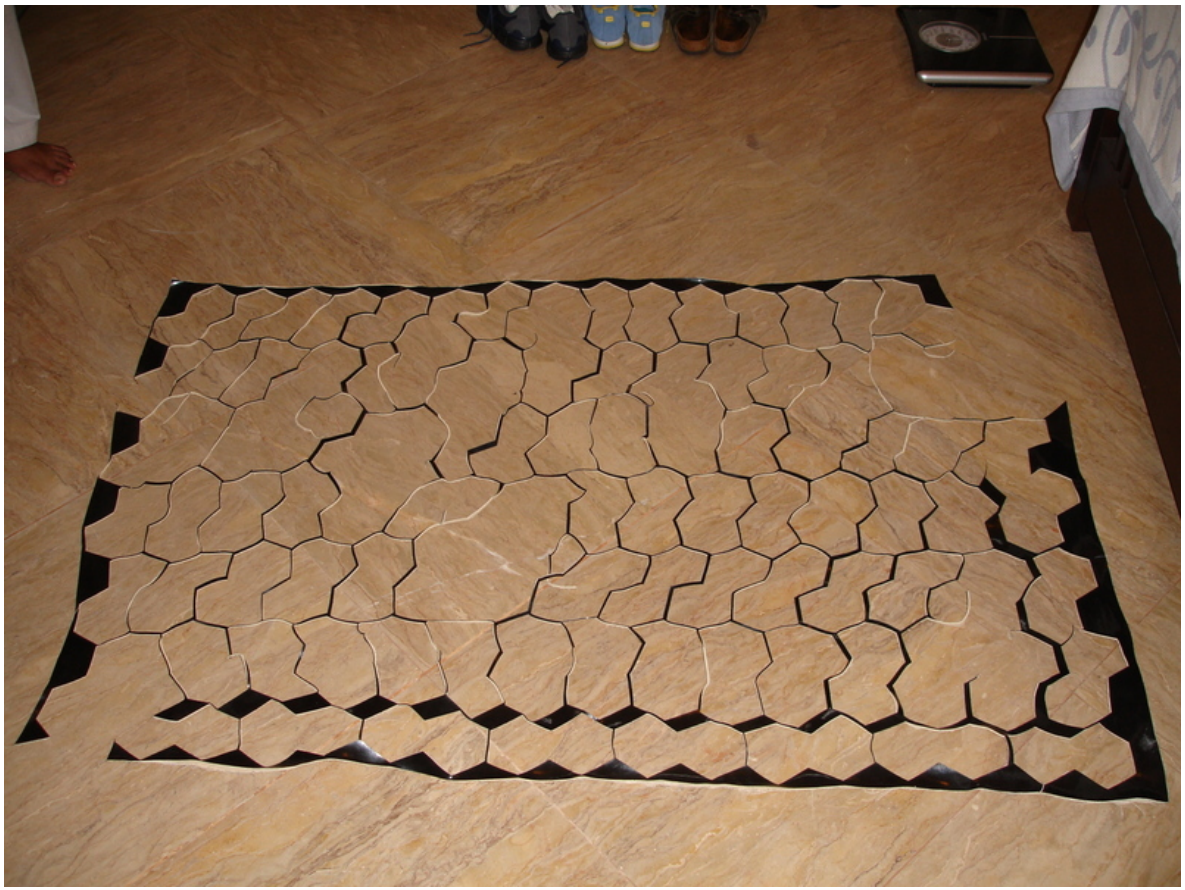
Standard "buckyball" design: 20 hexagons, 12 pentagons.

For standard ball, almost all firms use 2-hexagon and 2-pentagon "flush" dies.



Existing Cutting Technology (cont.)

Hexagons tessellate. $\sim$ 8% of rexine wasted.



Existing Cutting Technology (cont.)

Pentagons don't. $\sim$ 20-24% of rexine wasted.

Origin of Idea

In a YouTube video of a Chinese factory producing the Adidas Jabulani ball, I noticed a different layout of pentagons.

Origin of Idea (cont.)

We could also have gone to: G. Kuperberg and W. Kuperberg, "Double-Lattice Packings of Convex Bodies in the Plane," *Discrete & Computational Geometry*, 5: 389-397, 1990.

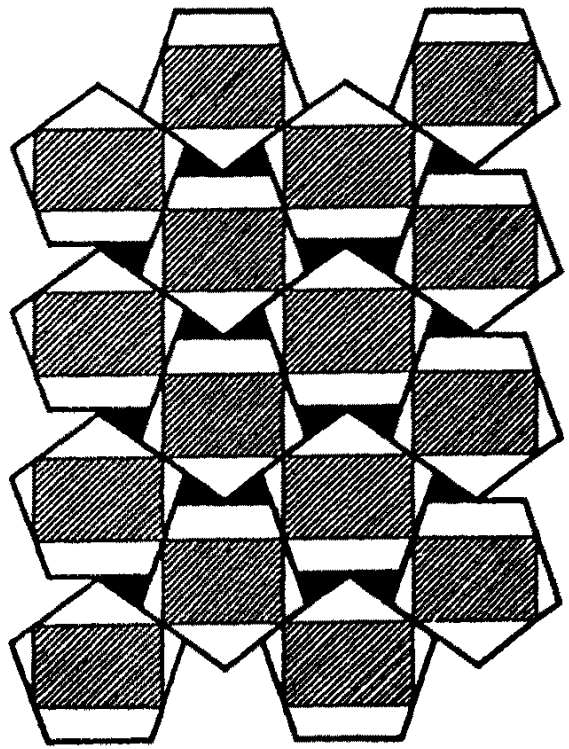
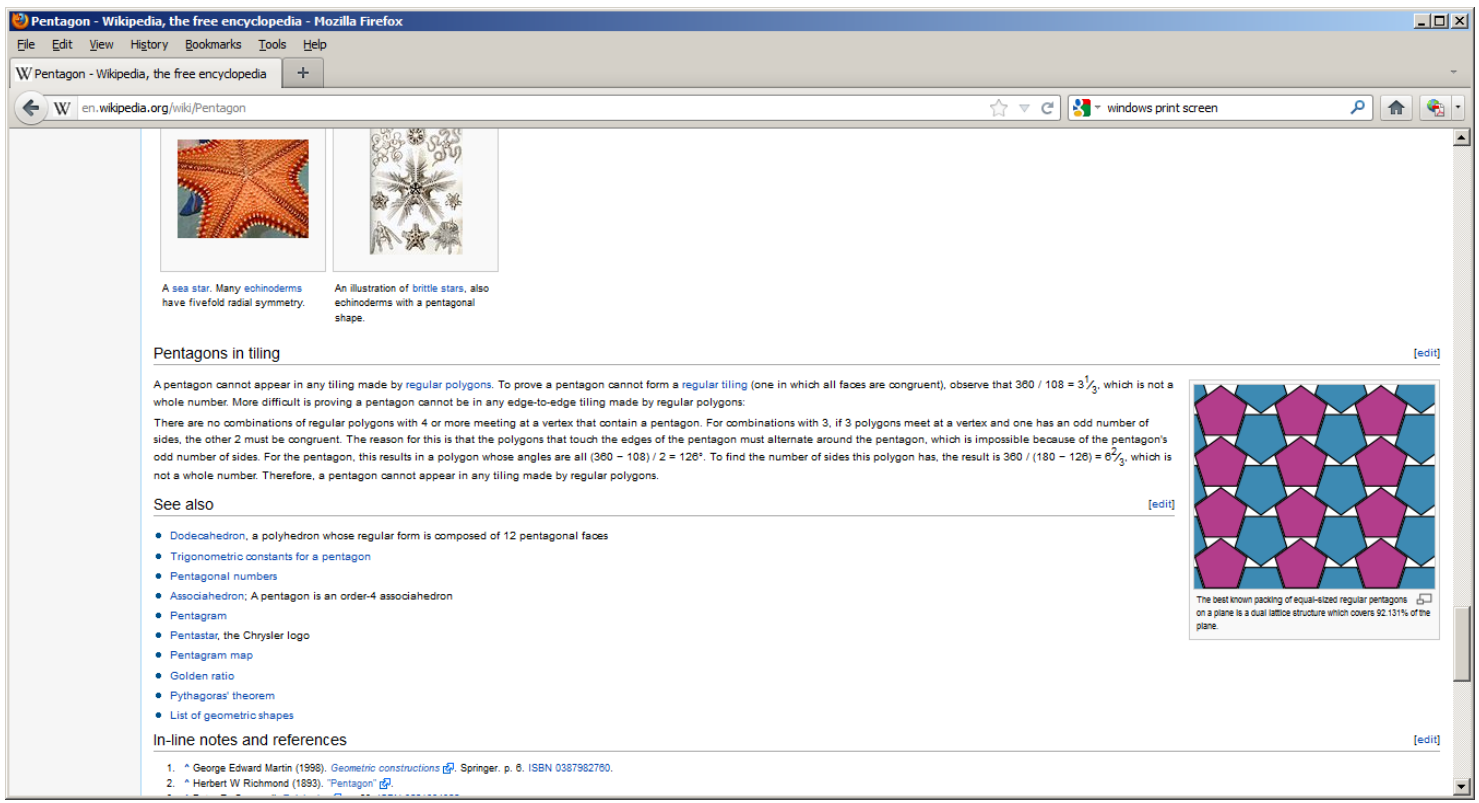


Fig. 7. Maximum density double-lattice packing with regular pentagons.

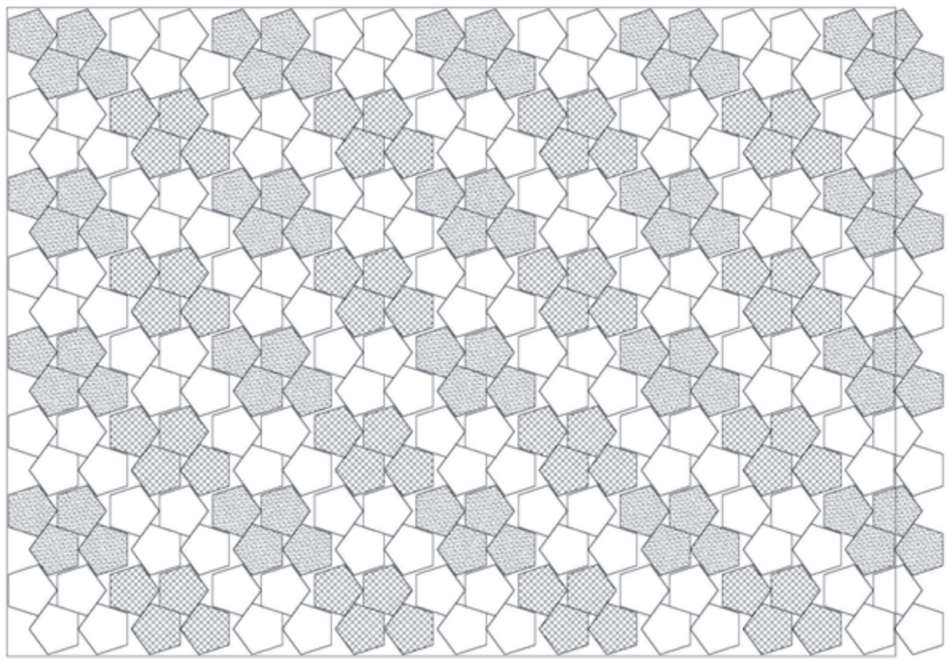
Origin of Idea (cont.)

Or the Wikipedia Pentagons page:



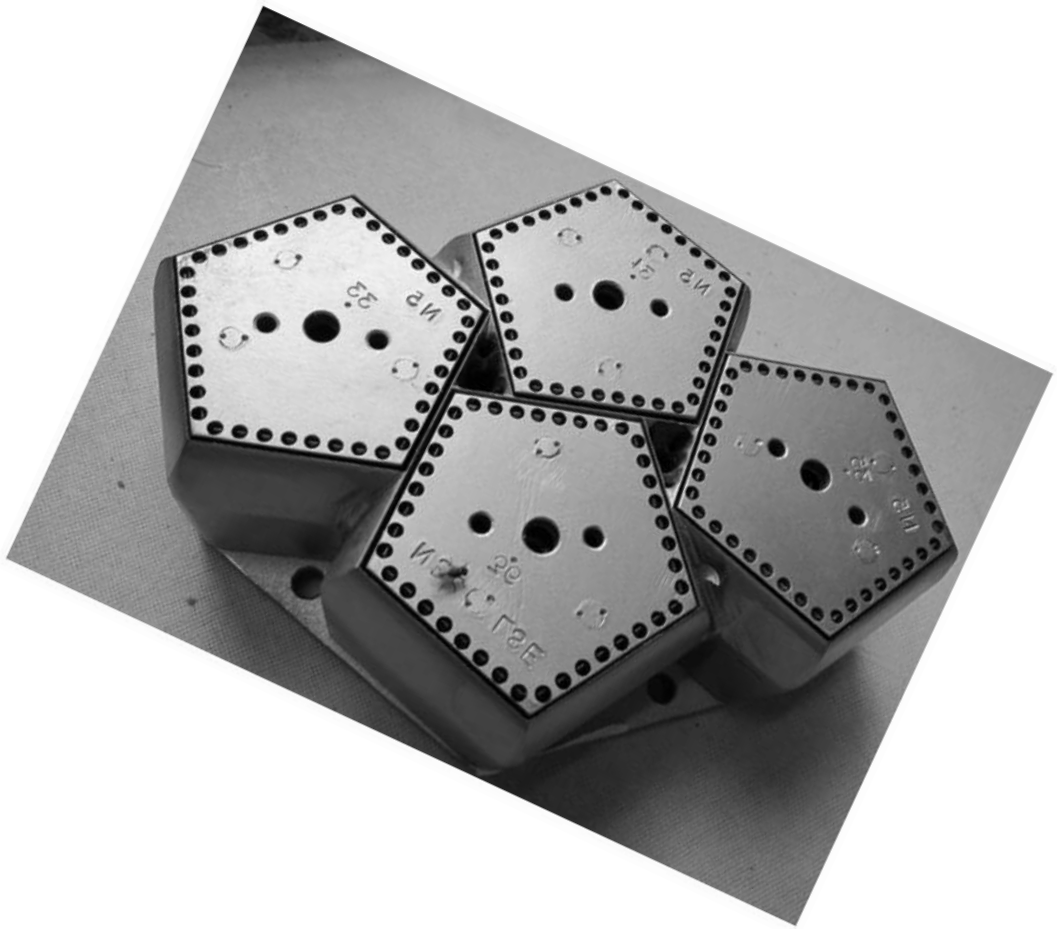
Blueprint

Annalisa Guzzini (an architect, also my wife) and I developed a blueprint for a 4-pentagon die to implement the optimal packing.

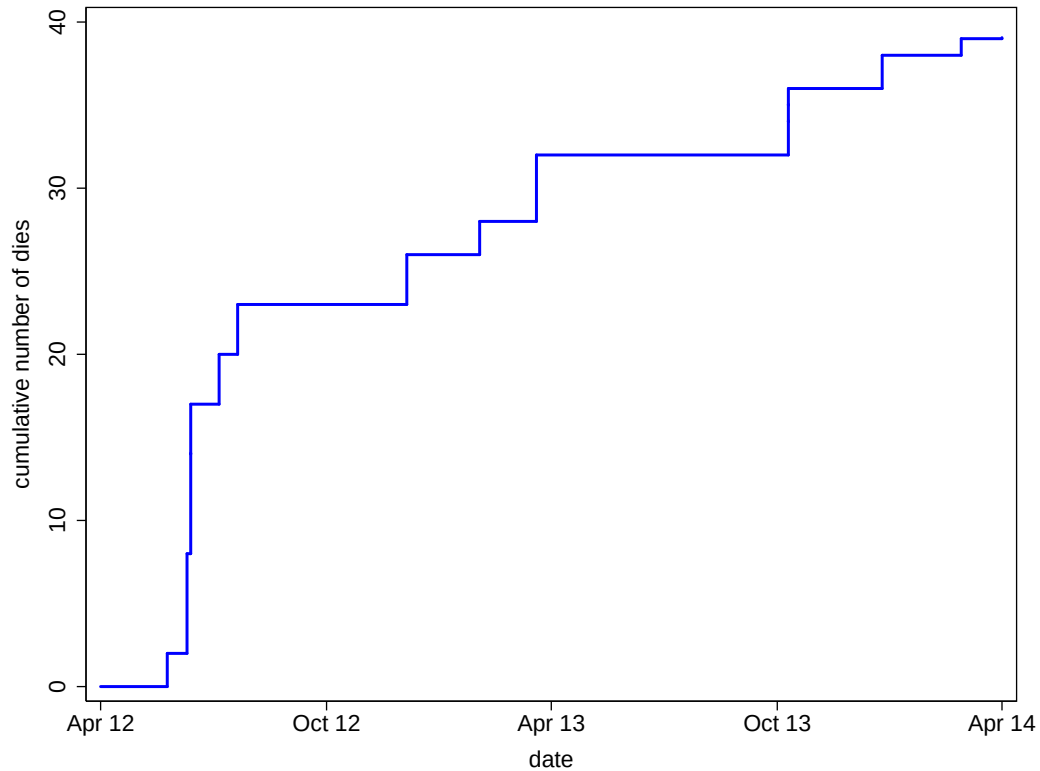


- 44mm-edge pentagons: ∼250 with old die vs. 272 with ours.
- 43.5mm-edge pentagons: ∼258 vs. 280.

The "Shamyla" Die



Die Purchases by Firm Z



- Second-largest by employment in Sialkot (∼2,200 employees).
- No-drop group, late responder.
- As of March 2014, using offset die for ∼100% of production.

Adoption as of Aug. 2013

	Tech Drop	Cash Drop	No Drop	Total
Full sample				
# ever active firms	35	18	79	132
# ever responded	35	17	64	116
# currently active and ever responded	32	15	59	106
# traded in	19	0	0	19
# ordered new die (beyond trade-in)	1	0	6	7
# received new die (beyond trade-in)	1	0	3	4
# ever used new die (>1000 balls, conservative)	4	0	1	5
# ever used new die (>1000 balls, liberal)	5	0	1	6

Insight 5: Worker Buy-In Matters

firm	no orders to try on	too busy	doubt profitable	waiting for others to prove value	waiting for others to iron out kinks	cutters unwilling	printing problems	other production issues	other
1	2	3					1		
2	2						1		
3	2						1		
4	2						1		
5	2					1			
6	4		3			1	2		
7	3		2			1			
8	3					1	2		
9	3	2				1			
10	1								
11	1								
12	1								
13	3					1	2		
14	3					1	2		
15	2					1			3
16	1								
17	5	3				1	2	4	
18	2					1			3

- Numbers indicate order of importance indicated by respondent.
- Sample is round-4 respondents who have had die in their factory but are not currently using it.

Insight 5: Worker Buy-In Matters

- Why were cutters resisting?
  - Most employees paid piece-rate and new technology slows them down, at least initially.
  - Cost savings accrue to owner.
  - In absence of changes to labor contract, effective wage falls.
- A few owners changed labor contracts, but most did not.
  - Either they simply did not realize that a change would be desirable, or
  - they found it too costly relative to expected benefits of technology.

Insight 5: Worker Buy-In Matters

- We ran a second experiment in firms we had given technology to:
  - In some firms, we offered lump-sum bonus equal to 1 month salary to cutter (and printer), if they could demonstrate competence using the technology in presence of owner.
  - Returned in one month to do test. All passed.
  - Had significant effect on adoption:
    - Half of firms that could have responded ended up adopting.
    - None in control group in short term, one in medium term.
- One generalization we think we can draw: workers need to expect to share in gains to adoption in order for adoption to be successful.

Conclusion

- Some (tentative) lessons for Brazil:
  - Quality upgrading is an important part of of innovation, broadly defined, within firms.
  - Upgrading of final goods requires access to high-quality inputs, both foreign and domestic.
  - Upgrading products and productivity also requires "upgrading" the workforce:
    - In part this requires finding new higher-skilled workers.
    - But in larger part it requires motivating and training the existing workforce.
  - Labor relationships (and labor-market institutions) matter for technology adoption/productivity improvement.

Conclusion

- Direction of causality between upgrading and shared prosperity (i.e. wages, employment) still an open question.
  - Standard view: innovations arrive exogenously, change skill demand in firm.
  - Alternative view: innovations arise endogenously, in part through worker input. Workers have to have incentives to share knowledge, ideas, good will.
- Results from Mexico, Pakistan provide some evidence for alternative view. But there is still a lot of work to do.

Conclusion

- This seems a promising direction for future work:
  - Minimum wage study
  - Evaluation of innovation-policy interventions.
    - What are effects of innovation on wages, employment at firm level?
    - Is there an interaction of policies and labor-market conditions in generating innovation?

References I

Atkin, David, Azam Chaudhry, Shamyla Chaudry, Amit K. Khandelwal, and Eric Verhoogen, "Organizational Barriers to Technology Adoption: Evidence from Soccer-Ball Producers in Pakistan," 2015. Mimeo, Columbia University.

Goldberg, Pinelopi K., Amit Khandelwal, Nina Pavcnik, and Petia Topalova, "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India," Quarterly Journal of Economics, 2010, 125 (4), 1727–1767.

Kugler, Maurice and Eric Verhoogen, "Plants and Imported Inputs: New Facts and an Interpretation," American Economic Review Papers and Proceedings, May 2009, 99 (2), 501–507.

___ and ___ , "Prices, Plant Size and Product Quality," Review of Economic Studies, January 2012, 79 (1), 307–339.

Kuperberg, G. and W. Kuperberg, "Double-Lattice Packings of Convex Bodies in the Plane," Discrete & Computational Geometry, 1990, 5, pp. 389–397.

Verhoogen, Eric, "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector," Quarterly Journal of Economics, 2008, 123 (2), 489–530.

Wright, Tom, "Pakistan Defends Its Soccer Industry," Wall Street Journal, 2010. April 26, 2010.