Exporting and Firm Performance: Evidence from a Randomized Experiment

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Motivation

- Large differences in productivity between developed and developing world (Hall & Jones 1999, Bloom & Van Reenan 2007)
- Access to export markets may help developing-country firms close this gap
  - One motivation for aid-for-trade initiatives ($48bn annual commitment) and proliferation of export-promotion agencies (tripling over last 20 years (Lederman et al 2009))

- Central to this goal is the concept of learning-by-exporting (LBE)
  - Exporting improves firm productivity (i.e. shifts out the PPF) (Clerides et al 1998, Aw et al 2000)
- In presence of LBE, trade leads to efficiency gains which magnify GFT (Alvarez, Buera & Lucas 2014)

- Despite the pervasiveness of these initiatives, there are open questions:
  - Does exporting have a causal impact on firm performance?
  - If so, do improvements occur through learning-by-exporting rather than movements along the PPF?

Motivation

- Difficulty stems from the fact that it is notoriously difficult to identify the causal effects of exporting

1) What appears as learning-by-exporting may just be self-selection into export markets

2) We typically lack detailed data needed to pin down within-firm changes that occur due to exporting
   - Changes in revenue-based TFP measures may reflect many things (changing markups, product mix, quality)
   - Quantity-based TFP measures solve markup issue but typical datasets don't record changes in product mix or quality for differentiated goods
   - ➢ Measured improvements may simply reflect movements along the PPF, rather than outward shifts of the PPF

This Paper

- First randomized control trial on exporting to examine whether (and how) access to export markets affects firm performance
  - Focus on rug manufacturers in Egypt

1) Generate exogenous variation in access to high-income export markets
   - Our partners secured orders through marketing and trade fairs
   - Provide a random set of rug producers with the opportunity to fill orders
     - Treatment induces firms to export by reducing important trade friction—matching frictions between producers and overseas buyers

2) Track key performance metrics through regular firm surveys
   - Record overall profits
   - Production-line level data record:
     - Quantities, prices, rug specifications (rug-type, thread count etc)
   - Direct measures of rug quality along 11 dimensions (e.g. flatness of rug)
   - At endline, firms paid to make identical domestic rug in "quality lab"
   - Track information flows between buyers, intermediary, producers

Preview of Results

- Firms provided with opportunity to export have 16-26% higher profits

- Explore sources of rise in profits:
  - Prices net of input costs rise, labor inputs rise, but quantities (m^2 rug) fall
  - Quality rises, productivity measures not adjusting for rug specifications fall (e.g. m^2/hour)

- Two potential explanations:
  - *No Learning*: price of quality rises, firms upgrade specifications and hence quality (movement along the PPF)
  - *Learning-by-exporting*: export-induced changes in technical efficiency (shift out in the PPF)

- Guided by a simple framework, five pieces of evidence for presence of LBE:

1. Conditional on rug specifications, output/hour & quality rise relative to control
2. On identical rugs, treatment has higher quality despite not taking longer to mfg
3. Evidence of learning curves
4. Quality improves most along the dimensions discussed with intermediary
5. Rule out alternative investment hypotheses

Existing Literature

- Learning by exporting:
  - Clerides et al. (1998), Bernard & Jensen (1999), Aw et al. (2000), Van Biesebroeck (2003), Blalcok & Gertler (2004), Javorcik (2004), de Loecker (2007,2010), Wagner (2007), Lileeva & Trefler (2010), Aw et al (2011), Marin & Voigtlander (2013)
  - Large literature has struggled to convincingly solve either selection or measurement issue
  - The RCT combined with detailed data can directly address both

- Relationship between quality and exporting
  - Schott (2004), Hallak (2006), Hallak (2010), Verhoogen (2008), Hallak & Sividasan (2013), Brambilla et al. (2012), Crozet et al. (2012), Roberts et al (2011), Artopoulos et al (2013), Manova & Zhang (2012), Bastos et al (2014) [exception Marin & Voigtlaender (2013)]
  - Trade exposes firms in developing countries to sophisticated buyers
  - Direct measures of product quality and rug specifications allow us to distinguish quality upgrading with and without learning

- Using RCTs to understand supply constraints in firms in developing countries
  - del Mel et al. (2008, 2010, 2013), Bloom et al. (2013)
  - First paper to explore demand constraints using an RCT

Roadmap

1. Setting and Experimental Design
2. The Causal Effect of Export-Market Access on Profits
3. Detecting Learning-by-Exporting
4. Conclusion

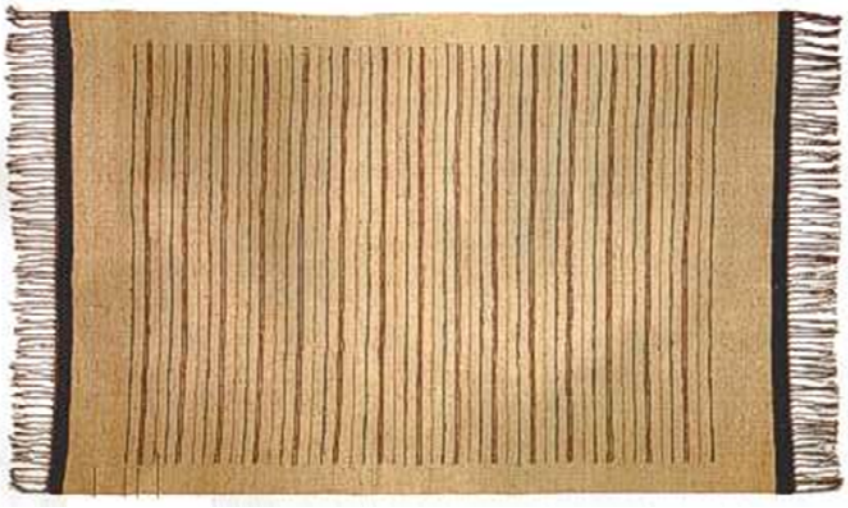
The Industry and the Location

- Partnered with Aid to Artisans (ATA) as they started project in Egypt
  - Followed their protocol: Find viable Egyptian products, market products on Western markets, send orders through local intermediary
  - ATA acts in similar ways to many Export Promotion Agency programs (Lederman et al 2009)

- Identified handmade flat-weave rugs from Fowa as viable product
  - About 2hrs from Alexandria
  - Population 65,000
  - $3,600 PPP adjusted GDP/Capita
  - Well-known carpet cluster
  - Viable intermediary in Hamis Carpets

Rugs and Production Technology

Flat-weave “Dubs” Rug



Wooden Foot-Treadle Loom

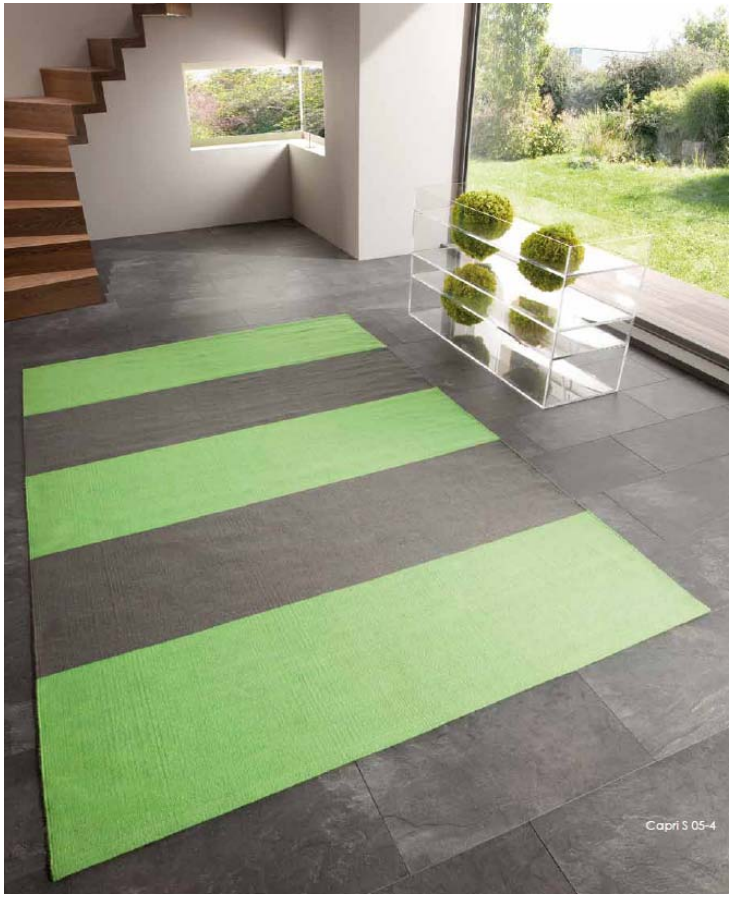
External Validity: Part 1

- Advantages
  - Large sample size (of small relatively homogenous firms)
  - Technology is common across firms and easy to track
  - Process of exporting via intermediary common in other industries
    - 36% of exporters use intermediaries (62% of exporters with <5 employees) World Bank Enterprise Surveys

- Disadvantages
  - Firms are small (median firm is 1 employee), unlikely to become large
  - Handmade products, rather than mechanized production
    - Do not expect adoption of new technologies through exporting

Generating Export Orders

- ATA would display rugs at large trade shows, and use US-based rug intermediaries to match Hamis Carpets to retailers in high-income markets

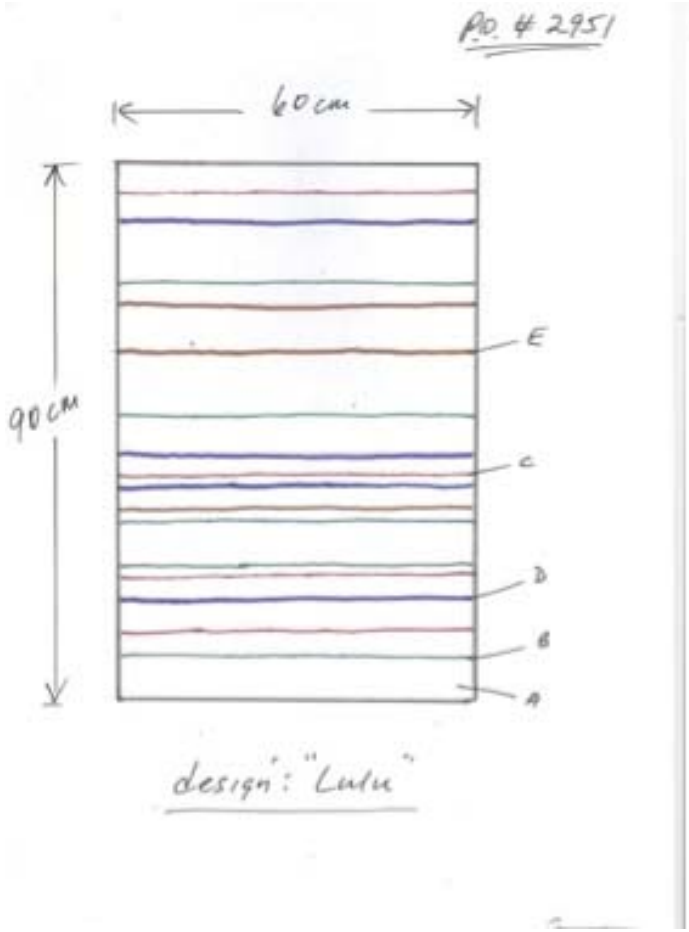


Foreign buyers demand higher *quality*

- Designs have more demanding *specifications* (difficult patterns, thread count, better inputs etc.)

Generating Export Orders

- Example of codifiable specifications:



samples

Purchase Order No. 2951

Delivery deadline: 10 oct. 2011

Order Date: 22 Aug. 2011

QUALITY: Plain Cotton flatweave

DESIGN: Lulu

COLOR: V3

SIZE	Rug No.
60cm × 90cm	7828
60cm × 90cm	7829

2 pcs.

Colors:

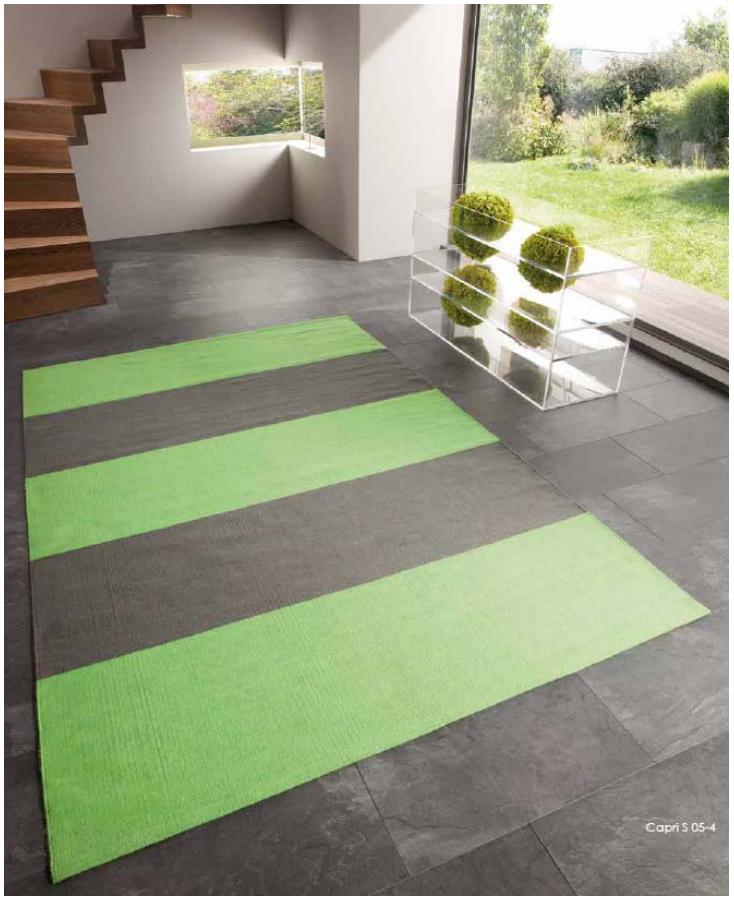
A = V3
B = V103
C = V195
D = V122
E = V139

⇒ Plain ends (bound) No fringe.

Artwork attached for design and color placement.

Generating Export Orders

- ATA would display rugs at large trade shows, and use US-based rug intermediaries to match Hamis Carpets to retailers in high-income markets



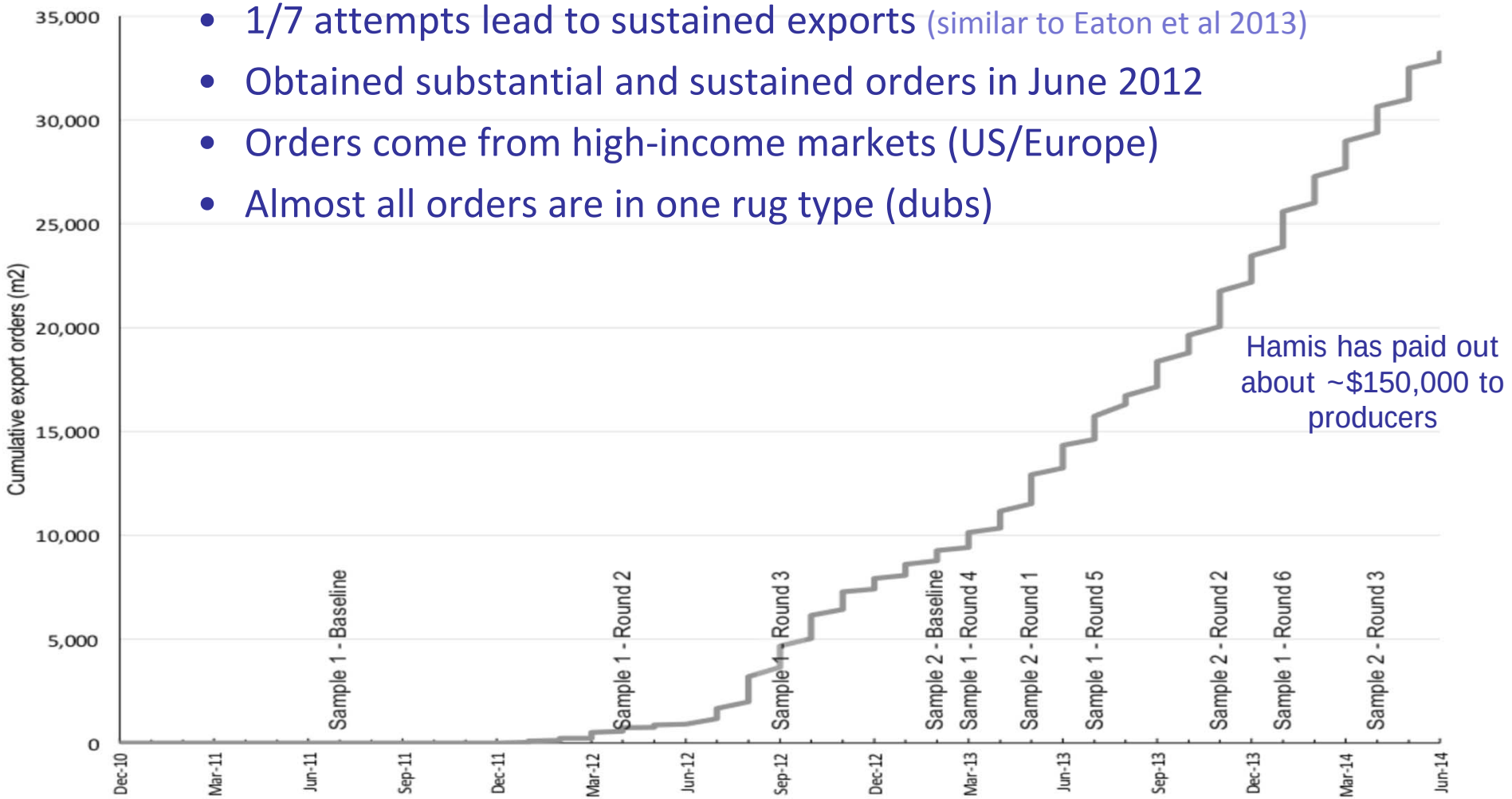
Foreign buyers demand higher *quality*

- Designs have more demanding *specifications* (difficult patterns, thread count, better inputs etc.)
- Also demand higher quality along hard to codify dimensions that depend on firm's *skill*:

Less waviness	Sharp corners
Consistent sizes	Design accuracy
Softer to touch	Etc.

Generating Export Orders

- Generating export orders was slow and difficult
  - Failure is common in export markets
  - 1/7 attempts lead to sustained exports (similar to Eaton et al 2013)
  - Obtained substantial and sustained orders in June 2012
  - Orders come from high-income markets (US/Europe)
  - Almost all orders are in one rug type (dubs)



Example of Successful Marketing

DESIGN WITHIN REACH

EMAIL SIGN-UP
DWR BLOG | DESIGN NOTES
REQUEST A CATALOG
DWR 3-D ROOM PLANNER
TRADE & CONTRACT

ABOUT DWR | DWR LOCATIONS | 800.944.2233 | LIVE CHAT

Enter keyword or Item#

MY ACCOUNT | CUSTOMER SERVICE | CART (0 items) $0.00

NEW | LIVING | DINING | BEDROOM | OUTDOOR | WORKSPACE | STORAGE | LIGHTING | RUGS | ACCESSORIES | DESIGNERS | SALE

Home > Rugs > View All > Zep

Zephyr Rug

Designed by Curtis Fletcher and Emily Greenberg

Inspired by patterns in the sand made by the wind, the Zephyr Rug (2012) brings a modern twist to how something as simple as a g...**more info**

Zephyr Rug #29727

$1,400.00 USD

Item: Select a Color

Status:

Quantity: 1

ADD TO WISH LIST | ADD TO CART

Experimental Design

- Treatment:
  - Hamis Carpets offers an initial order to each treatment firm
  - An order of 110m^2 (about 11 weeks of work)
    - Firms receive market price (set by intermediary) for these rug types

- Post-Treatment: What about follow-up orders?
  - Hamis Carpets may optimally allocate future orders within treatment group (based on firm quality, reliability, etc.)
    - Mimics a normal buyer-seller relationship

- So the treatment is the opportunity to export to high-income countries
  - Only a small fraction of firms had knowingly exported at baseline

External Validity: Part 2

- Treatment targets matching frictions:
  - Matching frictions sizeable component of trade frictions (Allen 2014)
  - Reducing matching frictions is a key goal for export promotion policies (Lederman et al 2009)

  - But… We think exporting to high-income markets likely has similar productivity impacts on developing-country SMEs induced to export by reducing tariffs, trade costs

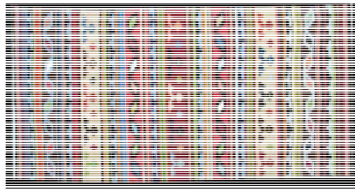
- Can't distinguish exporting from rich domestic buyer demanding high quality
  - But these buyers scarce in developing world: major difference between internal and external trade in literature (e.g. Verhoogen 2008, or x-country variation in Schott (2004), Manova & Zhang (2012) and Brambilla et al. (2012))

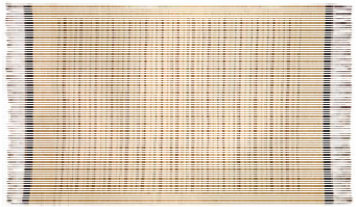
Experimental Design

- Conducted recruitment drive for firms in Fowa in early 2011

- Found 303 firms who:
  - Worked on own account (e.g., bought own inputs)
  - Less than 5 employees
  - Never worked with our intermediary partner

- Stratify by (self-identified) rug type and loom size
  - 103 make Goublan, 83 make Tups, 38 make Kassaes, 79 make Dubs



  - Since only obtained Dubs orders, will focus on 79 Dubs firms (Sample 1)

Initial Treatment Status

- In first 12 months, we were unable to generate sufficient orders to employ the treatment group full time
  - Initial 110m^2 packet size was spread over multiple orders

- Only 14/39 treatment firms took up opportunity to export
  - Primary reason: Firms not willing to jeopardize relationship with existing intermediary for small amounts of work

	Sample 1
	Dubs
Number of Firms	79
Number of Treated Firms	39
Number of Takeup Firms	14
Number of Successful Takeup Firms	14
Average Output Conditional on Takeup	778

Treatment Status: Samples 1 and 2

- By June 2012, intermediary began generating sustained export orders
  - We now knew foreign demand was concentrated in dubs rugs and were in position to offer full 110 m^2 initial packet size in one go
  - Recruited every remaining firm making dubs rugs that was willing to partake in the research. A total of 140 firms.

- 35 firms treated in the same way as Sample 1
  - 32/35 took up when given full initial packet size
  - Sample 2 is closer to our intended treatment, but to be conservative we will present all results for the Joint Sample (other Samples in appendix)

	Sample 1	Sample 2	Joint Sample
	Dubs	Dubs	Dubs
Number of Firms	79	140	219
Number of Treated Firms	39	35	74
Number of Takeup Firms	14	32	46
Number of Successful Takeup Firms	14	32	46
Average Output Conditional on Takeup	778	434	538

Survey Timeline

Sample 1:

- Baseline July-August 2011
- Follow-ups
  1. Nov-Dec 2011
  2. Apr-June 2012
  3. Sept-Dec 2012
  4. Mar-Apr 2013
  5. July-Oct 2013
  6. Jan-Mar 2014
- Quality Lab June 2014

Sample 2:

- Baseline Feb-March 2013
- Follow-ups
  1. May-June 2013
  2. Nov-Dec 2013
  3. May-June 2014
- Quality Lab June 2014

- Data modules
  - Firm module (output, inputs, employment, investments)
  - Quality surveys by a master rug-maker
  - "Quality lab" (firms made identical domestic rugs in rented workshop)
  - Intermediary's records of quality
  - Log book of intermediary/producer visits and what was discussed

Baseline Balance

	Control Group Mean	Difference in Treatment	N
Panel A: Household Characteristics			
Age	51.0	0.9	218
	(0.7)	(1.6)	
Number of years in rug business	37.7	0.2	213
	(0.8)	(1.7)	
Illiterate?	0.63	0.10	214
	(0.03)	(0.07)	
Household size	4.2	0.0	219
	(0.1)	(0.2)	
Household income	1,090.0	76.5	219
	(91.2)	(228.0)	
Digit Span Recall	5.8	0.2	204
	(0.1)	(0.2)	
Panel B: Firm Characteristics			
Price per square meter	30.2	6.8	218
	(3.3)	(7.8)	
Direct monthly profits from rug business	646	7.9	218
	(41.8)	(81.5)	
Hours worked last month	247	-1.7	218
	(5.6)	(11.7)	
Number of employees	1.09	0.0	218
	(0.0)	(0.1)	
Total produced last month (m^2)	50.0	3.3	218
	(4.3)	(10.0)	
Ever exported?	0.12	0.02	219
	(0.02)	(0.05)	
Average Quality	2.63	-0.13 ***	218
	(0.03)	(0.05)	
Joint F-test		1.23	
Attrition in Follow Up Surveys	0.11	0.00	815
	(0.01)	(0.02)	
Attrition in Quality Lab	0.14	0.02	219
	(0.03)	(0.05)	

Roadmap

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The Causal Effect of Export-Market Access on Profits

- Regression specification: Intent to Treat (ITT) with baseline controls (McKenzie 2012)

$$y_{it} = \beta Treatment_i + \gamma y_{i0} + \tau_t + \delta_s + \varepsilon_{it} \qquad \text{(ITT)}$$

  - regressions include time and strata fixed effects τ_t and δ_s

- Given low takeup in Sample 1, Treatment on Treated (TOT) may be more useful:

$$y_{it} = \beta Takeup_{it} + \gamma y_{i0} + \tau_t + \delta_s + \varepsilon_{it} \qquad \text{(TOT)}$$

  - where $Takeup_{it}$ instrumented by $Treatment_i$

- Standard errors are clustered at the firm level

Quasi First Stage: Did Treatment Increase Exporting?

	ITT	TOT
	(1)	(2)
Indicator for Ever Exported	0.55 ***	0.76 ***
	(0.06)	(0.07)
R-squared	0.33	0.45
Control Group Mean	0.20	0.20
Observations	191	191

- Probability of ever knowingly exported rises 55 p.p. (baseline 13%)

Monthly Profits

What was the total income from the rug business after paying all expenses (inputs, wages to weavers but excluding yourself). That is, what were your profits from this business last month?

	Log (Direct Profits)	
	ITT	TOT
	(1A)	(1B)
Treatment	0.26 ***	0.42 ***
	(.05)	(.08)
R-squared	0.21	0.22
Control Group Mean	929	929
Observations	573	573

Profits

Firms report total revenues and total costs in previous month

	Log (Direct Profits)		Log (Reported Revenues - Reported Costs)	
	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)
Treatment	0.26 ***	0.42 ***	0.21 ***	0.37 ***
	(.05)	(.08)	(.06)	(.10)
R-squared	0.21	0.22	0.16	0.18
Control Group Mean	929	929	931	931
Observations	573	573	644	644

Firms report prices and quantities of inputs and outputs in previous month

Profits

	Log (Direct Profits)		Log (Reported Revenues - Reported Costs)		Log (Constructed Revenues - Constructed Costs)	
	ITT	TOT	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)
Treatment	0.26 ***	0.42 ***	0.21 ***	0.37 ***	0.19 ***	0.34 ***
	(.05)	(.08)	(.06)	(.10)	(.06)	(.10)
R-squared	0.21	0.22	0.16	0.18	0.16	0.18
Control Group Mean	929	929	931	931	951	951
Observations	573	573	644	644	685	685

Monthly Profits

How much would it cost to purchase 25 kg of the thread used in previous month? How much would earn from selling the output?

	Log (Direct Profits)		Log (Reported Revenues - Reported Costs)		Log (Constructed Revenues - Constructed Costs)		Log (Hypothetical Profits)	
	ITT	TOT	ITT	TOT	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)
Treatment	0.26 ***	0.42 ***	0.21 ***	0.37 ***	0.19 ***	0.34 ***	0.37 ***	0.68 ***
	(.05)	(.08)	(.06)	(.10)	(.06)	(.10)	(.11)	(.19)
R-squared	0.21	0.22	0.16	0.18	0.16	0.18	0.19	0.19
Control Group Mean	929	929	931	931	951	951	541	541
Observations	573	573	644	644	685	685	687	687

- Profits go up by 19-26%

Profits Per Owner Hour

	Log (Direct Profits)		Log (Reported Revenues - Reported Costs)		Log (Constructed Revenues - Constructed Costs)		Log (Hypothetical Profits)	
	ITT	TOT	ITT	TOT	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)
Treatment	0.26 ***	0.42 ***	0.21 ***	0.37 ***	0.19 ***	0.34 ***	0.37 ***	0.68 ***
	(.05)	(.08)	(.06)	(.10)	(.06)	(.10)	(.11)	(.19)
R-squared	0.21	0.22	0.16	0.18	0.16	0.18	0.19	0.19
Control Group Mean	929	929	931	931	951	951	541	541
Observations	573	573	644	644	685	685	687	687

Panel B: Profit per Owner Hour

	Log (Direct Profits)		Log (Reported Revenues - Reported Costs)		Log (Constructed Revenues - Constructed Costs)		Log (Hypothetical Profits)	
	ITT	TOT	ITT	TOT	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)
Treatment	0.20 ***	0.32 ***	0.17 ***	0.29 ***	0.16 ***	0.28 ***	0.25 ***	0.46 ***
	(.05)	(.08)	(.05)	(.09)	(.05)	(.09)	(.07)	(.12)
R-squared	0.14	0.14	0.12	0.13	0.13	0.13	0.19	0.18
Control Group Mean	3.53	3.53	3.54	3.54	3.55	3.55	5.56	5.56
Observations	573	573	637	637	684	684	687	687

- Most firms are owner-operated, so look at profits per owner hour
- Profits per owner hour increase 16-20%
  - Effort may have risen, but find no significant increase in stress

Discussion of Profit Results

- Sign of effect unsurprising, but magnitude is
  - Many supply-side interventions (business training, credit) show no impact (McKenzie and Woodruff 2013, Banerjee 2010)
  - Results suggest demand constraints may be important

- Goal of this paper is not to carry out a cost-benefit analysis or to isolate the market failures preventing firms from exporting themselves

- Instead, we use the experimental variation to uncover economic primitives, in particular how productivity evolves in response to exporting

- As a preliminary step, use firm module to examine sources of profit increase
  - So look for changes in p, x, l and F in profit function:

$$\pi = px - wl - F$$

Prices, Hours, Fixed Costs and Output

Panel A: Components of Profits

	Output Price (LE/m^2)		Output (m^2)		Hours Worked		Number of Looms		Warp Thread Ball (kg)	
	ITT	TOT	ITT	TOT	ITT	TOT	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)	(5A)	(5B)
Treatment	0.43 ***	0.78 ***	-0.26 ***	-0.47 ***	0.05 **	0.08 **	-0.02	-0.04	0.15 ***	0.25 ***
	(.10)	(.19)	(.09)	(.17)	(.02)	(.04)	(.04)	(.06)	(.05)	(.08)
R-squared	0.16	0.15	0.24	0.22	0.12	0.13	0.13	0.13	0.24	0.24
Control Group Mean	28.2	28.2	64.1	64.1	269.0	269.0	1.1	1.1	6.0	6.0
Observations	691	691	676	676	678	678	694	694	600	600

- Prices rise, hours worked rise, longer production runs, output falls
- Suggestive of quality upgrading where high quality slower to produce

Quality Levels

Panel A: Quality Metrics

	Control Mean	ITT (1)	TOT (2)
Corners	2.98	1.11 ***	1.70 ***
		(0.12)	(0.11)
Waviness	2.99	1.10 ***	1.68 ***
		(0.12)	(0.10)
Weight	3.08	1.07 ***	1.63 ***
		(0.11)	(0.11)
Touch	3.12	0.40 ***	0.66 ***
		(0.06)	(0.07)
Packedness	3.11	0.89 ***	1.59 ***
		(0.11)	(0.12)
Warp Thread Tightness	3.05	0.83 ***	1.49 ***
		(0.10)	(0.12)
Firmness	2.98	0.87 ***	1.60 ***
		(0.11)	(0.12)
Design Accuracy	3.17	0.79 ***	1.41 ***
		(0.10)	(0.12)
Warp Thread Packedness	3.05	1.07 ***	1.65 ***
		(0.11)	(0.11)
Inputs	3.07	0.89 ***	1.62 ***
		(0.10)	(0.12)
Loom	2.02	0.03	0.05
		(0.02)	(0.04)
R-squared		0.44	0.60
Observations		6,885	6,885

- Survey data confirm quality levels rise
- Quality measured from 1-5 by master artisan
- Estimate treatment effect for each metric, but stack metrics to allow firm-level clustering
- 10 out of 11 quality metrics rise
- Exception is loom quality, which matters little for rug quality

Quality Levels

Panel B: Stacked Quality Metrics

	Control Mean	ITT (1)	TOT (2)
Stacked Quality Metrics	2.96	0.79 ***	1.35 ***
		(0.09)	(0.08)
R-squared		0.39	0.54
Observations		6,885	6,885

- Average effect from imposing identical treatment effect across metrics
  - Corresponds to quality increase of ~1.5 standard deviations (baseline sd=0.55)

Unadjusted Productivity Measures Fall

	Log(Output Per Hour)		Log (Unadjusted TFP)	
	ITT	TOT	ITT	TOT
	(1)	(2)	(1)	(2)
Treatment	-0.24 ***	-0.42 ***	-0.28 ***	-0.50 ***
	(0.09)	(0.16)	(0.09)	(0.16)
R-squared	0.18	0.16	0.26	0.24
Control Group Mean	0.26	0.26	0.49	0.49
Observations	687	687	674	674

- Two productivity measures (unadjusted for specifications)
  - Output per hour
  - Total factor productivity [details ▶]
- Unadjusted productivity measures fall 24-28 percent

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Quality Upgrading and Learning-by-exporting

- Evidence of quality upgrading, but can occur with or without learning

Quality Upgrading and Learning-by-exporting

- Distinguish LBE by writing down the firm's optimization problem

$$\max_{\lambda,l,k} \pi = px - wl - rk - F$$

$$x(\lambda, l, k) = a(\lambda, \chi_a) f(l, k)$$

$$q(\lambda) = q(\lambda, \chi_q)$$

$$p = p_0 + bq$$

  - Where a is "unadjusted productivity", q is quality
  - λ indexes rug specifications (high λ slower $\frac{\partial a}{\partial \lambda} < 0$, higher quality $\frac{\partial q}{\partial \lambda} > 0$)
  - χ_a and χ_q are efficiency parameters ($\frac{\partial a}{\partial \chi_a} > 0, \frac{\partial q}{\partial \chi_q} > 0$)
  - Assume complementarities ($\frac{\partial^2 a}{\partial \lambda \partial \chi_a} > 0, \frac{\partial^2 q}{\partial \lambda \partial \chi_q} > 0$)

- No Learning: Movement along PPF through rise in price of quality b ($\frac{dq}{db} > 0$)
- Learning-by-exporting: Shift out in PPF through rise in efficiency parameters χ_a or χ_q ($\frac{dq}{d\chi_q} > 0, \frac{dq}{d\chi_a} > 0$)

Detecting Learning-by-Exporting

Step 1: Explore change in specification-adjusted quality & productivity

- LBE predicts increases in both metrics (if no learning, no change)

Step 2: Examine quality and productivity on identical domestic rugs

- LBE predicts higher quality among treatment (if no learning, no difference)

Step 3: Explore evolution of quality & productivity with cumulative exports

- LBE predicts learning curves (if no learning, one-off jump)

Step 4: Explore information flows between buyers, intermediary, producers

- Document knowledge transfers by showing quality increases most along dimensions discussed in meetings

Step 5: Rule out that firms are making complementary investments

Step 1: Conditional Productivity and Quality

Panel A: Specification Controls

	Log(Output per Hour)		Log(TFP)	
	ITT	TOT	ITT	TOT
	(3)	(4)	(5)	(6)
Treatment	0.18 **	0.44 **	0.14 **	0.35 **
	(0.08)	(0.18)	(0.07)	(0.16)
(log) Thread quantity	-0.12	-0.13	-0.07	-0.08
	(0.13)	(0.13)	(0.13)	(0.12)
Difficulty Control	-0.14 ***	-0.21 ***	-0.16 ***	-0.22 ***
	(0.04)	(0.05)	(0.04)	(0.05)
(log) # colors	-0.05 *	-0.07 **	-0.06 **	-0.07 ***
	(0.03)	(0.03)	(0.03)	(0.02)
Low-market Segment	0.43 ***	0.49 ***	0.42 ***	0.47 ***
	(0.08)	(0.09)	(0.07)	(0.08)
Mid-Market Segment	0.29 ***	0.36 ***	0.26 ***	0.32 ***
	(0.08)	(0.09)	(0.07)	(0.08)
Rug Type FEs	yes	yes	yes	yes
Input Tread Type FEs	yes	yes	yes	yes
R-squared	0.57	0.58	0.62	0.63
Observations	673	673	660	660

- Treatment effects on productivity flips sign, indicative of χ_a increasing
- Productivity decreasing in specifications (as assumed)

Overlap of Specifications ▶

Step 1: Conditional Productivity and Quality

Panel A: Specification Controls

	Log(Output per Hour)		Log(TFP)		Stacked Quality Metrics	
	ITT	TOT	ITT	TOT	ITT	TOT
	(3)	(4)	(5)	(6)	(1)	(2)
Treatment	0.18 **	0.44 **	0.14 **	0.35 **	0.32 ***	0.78 ***
	(0.08)	(0.18)	(0.07)	(0.16)	(0.04)	(0.08)
(log) Thread quantity	-0.12	-0.13	-0.07	-0.08	0.04	0.02
	(0.13)	(0.13)	(0.13)	(0.12)	(0.05)	(0.04)
Difficulty Control	-0.14 ***	-0.21 ***	-0.16 ***	-0.22 ***	0.47 ***	0.34 ***
	(0.04)	(0.05)	(0.04)	(0.05)	(0.02)	(0.03)
(log) # colors	-0.05 *	-0.07 **	-0.06 **	-0.07 ***	0.03 **	0.01
	(0.03)	(0.03)	(0.03)	(0.02)	(0.01)	(0.01)
Low-market Segment	0.43 ***	0.49 ***	0.42 ***	0.47 ***	-0.19 ***	-0.08 **
	(0.08)	(0.09)	(0.07)	(0.08)	(0.03)	(0.03)
Mid-Market Segment	0.29 ***	0.36 ***	0.26 ***	0.32 ***	-0.19 ***	-0.05
	(0.08)	(0.09)	(0.07)	(0.08)	(0.04)	(0.04)
Rug Type FEs	yes	yes	yes	yes	yes	yes
Input Tread Type FEs	yes	yes	yes	yes	yes	yes
R-squared	0.57	0.58	0.62	0.63	0.64	0.67
Observations	673	673	660	660	6,820	6,820

- Sign remains positive, indicative of χ_q increasing
- Quality increases with rug specifications (as assumed)

Sample 2 ▶ Sample 1 ▶ Conditional Quality by Metric ▶

Step 1: Conditional Productivity and Quality

Panel B: Specification Fixed Effects

	Stacked Quality Metrics		Log(Output per Hour)		Log(TFP)	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.13 **	0.53 ***	0.31 ***	1.26 ***	0.25 ***	0.94 ***
	(0.05)	(0.17)	(0.08)	(0.45)	(0.08)	(0.36)
Specification FEs	yes	yes	yes	yes	yes	yes
R-squared	0.71	0.72	0.69	0.62	0.70	0.68
Observations	6,820	6,820	428	428	416	416

- Include fixed effects for each possible combination of the six specifications (435 products defined in this way)
- Lose about 1/3 of observations that are unique rugs
- Acknowledging sample size reduction, results hold (and if anything are stronger)

Step 1: Specification-Adjusted Upgrading

Panel C: Specification-Adjusted Dependent Variables

	Stacked Quality Metrics		Log(Output per Hour)		Log(TFP)	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.42 ***	0.72 ***	0.18 **	0.33 ***	0.20 ***	0.36 ***
	(0.05)	(0.04)	(0.07)	(0.13)	(0.07)	(0.12)
R-squared	0.18	0.27	0.06	0.10	0.13	0.18
Observations	6,860	6,860	678	678	669	669

- Rug specifications are not necessarily exogenous
- We create specification-adjusted productivity (quality) measures
  1. For TFP, include specifications in the production function (estimated on control firms) and generate residuals
  2. For output/hour and quality: regress measure on specifications for control firms; use coefs. to adjust measure for each firm in each round
  3. Re-run ITT and TOT regressions

Step 2: Production of Identical Domestic Rugs

- Brought owners of all firms to rented workshop to manufacture an identical domestic rug using identical inputs and the same loom
  - Well-known design in domestic market
  - 140cm by 70cm, 1750 grams
  - Master artisan assigned difficulty rating of 3 (below 4.28 average difficulty rating for export orders)

- Rugs scored along 9 quality metrics, by master artisan (with anonymized firm IDs) and a Professor of Handicraft Science at Domietta University
- Measured rug length, width, and weight
- Recorded time to manufacture rug

Step 2: Production of Identical Domestic Rugs

Panel A: Quality Metrics

	Master Artisan			Professor		
	Control Mean	ITT (1A)	TOT (1B)	Control Mean	ITT (2A)	TOT (2B)
Corners	3.23	0.72 ***	1.05 ***	3.31	0.29 **	0.45 **
		(0.14)	(0.17)		(0.13)	(0.18)
Waviness	3.17	0.55 ***	0.80 ***	3.31	0.25 **	0.36 **
		(0.14)	(0.18)		(0.12)	(0.17)
Weight	3.60	0.62 ***	0.91 ***	3.64	0.58 ***	1.01 ***
		(0.13)	(0.16)		(0.17)	(0.27)
Packedness	3.30	0.77 ***	1.14 ***	3.28	0.28 **	0.43 ***
		(0.13)	(0.15)		(0.11)	(0.16)
Touch	3.29	0.52 ***	0.76 ***	3.27	0.36 ***	0.53 ***
		(0.11)	(0.14)		(0.12)	(0.17)
Warp Thread Tightness	3.00	0.51 ***	0.74 ***	3.30	0.25 **	0.39 **
		(0.09)	(0.11)		(0.12)	(0.17)
Firmness	3.21	0.71 ***	1.04 ***	3.23	0.29 **	0.43 **
		(0.14)	(0.17)		(0.12)	(0.17)
Design Accuracy	3.65	0.53 ***	0.77 ***	3.45	0.27 **	0.39 **
		(0.11)	(0.15)		(0.11)	(0.16)
Warp Thread Packedness	3.05	0.87 ***	1.28 ***	3.20	0.39 ***	0.62 ***
		(0.14)	(0.17)		(0.12)	(0.17)
R-squared		0.21	0.34		0.11	0.11
Observations		1,680	1,680		1,667	1,667

- Treatment firms produce higher quality

Step 2: Production of Identical Domestic Rugs

Panel C: Additional Quality Metrics

	Control Mean	ITT (1A)	TOT (1B)
Length Accuracy	-4.51	1.43 ***	2.09 ***
		(0.51)	(0.71)
Width Accuracy	-2.29	0.17	0.25
		(0.29)	(0.41)
Weight Accuracy	-221.0	89.1 ***	131.0 ***
		(20.3)	(29.6)
Time (in minutes)	247.0	-5.67	-8.3
		(6.6)	(9.5)
R-squared		0.84	0.84
Observations		748	748

- Treatment firms also produce more accurate rugs
  - Except width, which is determined by loom size
- But take (insignificantly) less time to weave rugs
- Evidence that χ_q increases, and quality-adjusted productivity rises

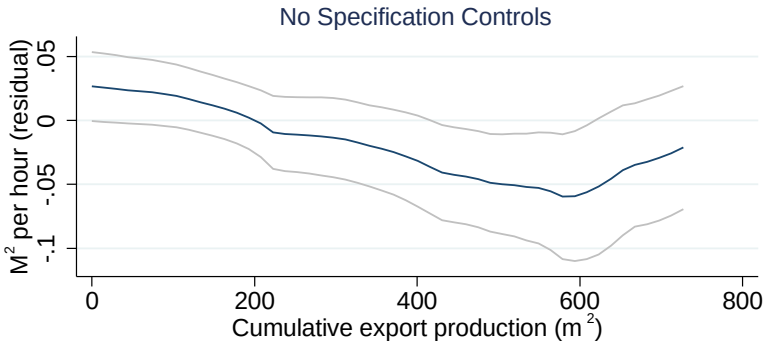
Sample 2 ▶ Sample 1 ▶

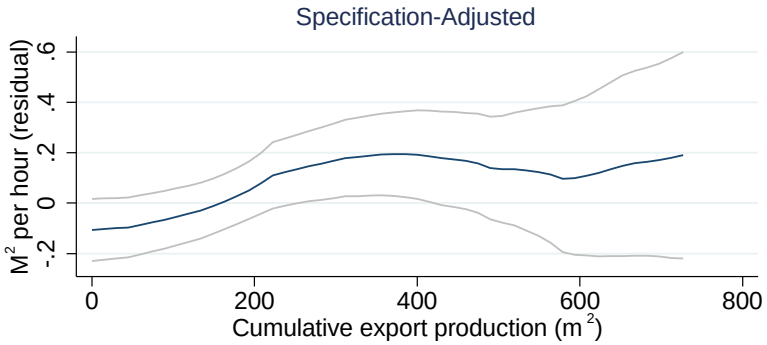
Step 3: Learning Curves

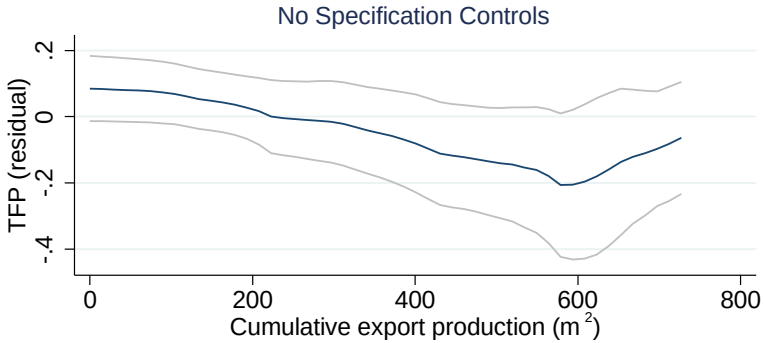
- Under LBE, knowledge parameters may evolve slowly with the cumulative production of export rugs
- If simply movement along PPF, a one off jump

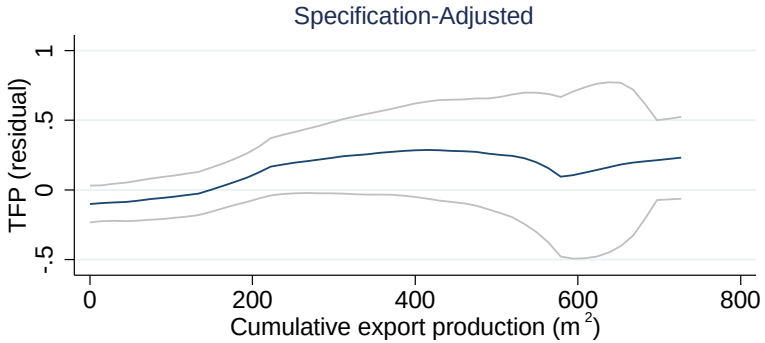
- Look for learning curves:
  1. Regress productivity (or quality) on firm and round fixed effects
  2. Plot residuals against cumulative export production
     - Perform on takeup firms since only these firms have exports
     - Similar results using partially linear panel data estimator

Step 3: Learning Curves



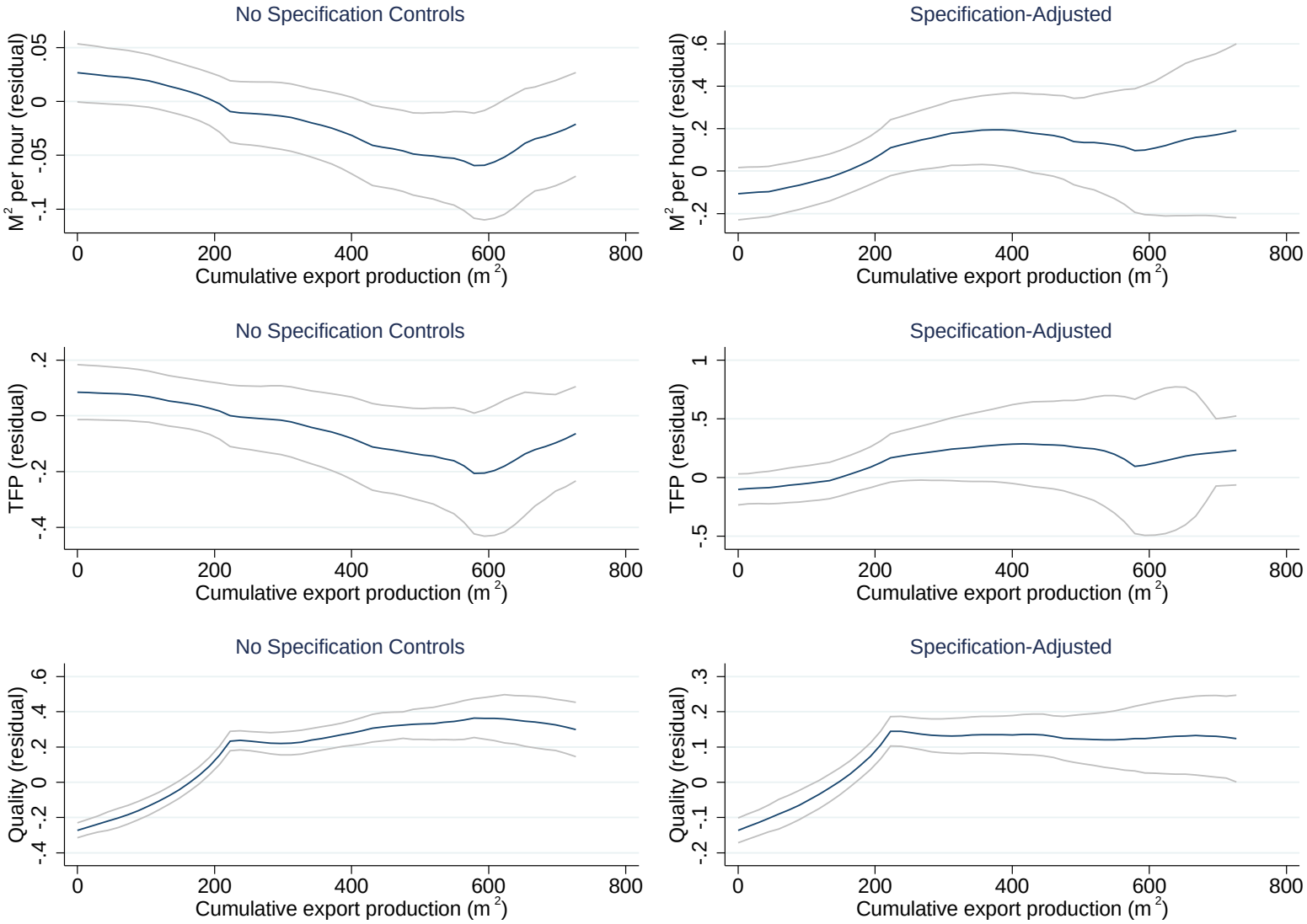






Export production CDFs ▶ High Frequency Order Book Data ▶

Step 3: Learning Curves



Export production CDFs ▶ High Frequency Order Book Data ▶

Step 4: Knowledge Transfers

- Step 4 shows that learning is not only learning-by-doing (-by-exporting)
- Document knowledge transfers between buyers, intermediary and firms:
- Buyers → Intermediary

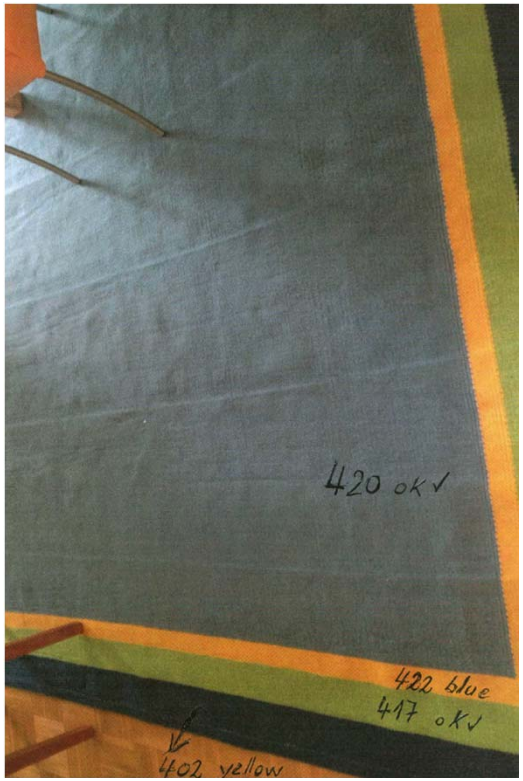
- Example 1: Buyer telling Hamis how to make flatter carpets:

From: [redacted]
Sent: Tuesday, June 11, 2013
To: <hamis_carpets[redacted]
Subject: next complain order 1590

Dear Mr. Magdy,

Wrapping the kelims tightly and strongly leaves waving marks on them, so please roll kelims and wrap them softly to avoid waviness.

Mit freundlichem Gruß / With best regards
Anton Sulzberger



Step 4: Knowledge Transfers

- Step 4 shows that learning is not only learning-by-doing (-by-exporting)
- Document knowledge transfers between buyers, intermediary and firms:
- Buyers → Intermediary

- Example 2: Buyer telling Hamis what "high-quality" entails:

From: [redacted]
Sent: Wednesday, August 14, 2013
To: <hamis_carpets[redacted]
Subject: complain to order 1418

Dear Mr. Magdy,
we have a problem with our client [redacted] As you remember, this client asked for two carpets with fringes in the colour uni 2 and 3.

Now after one and a half year using the carpets, the fringes crumble away, as you see on the pictures.
They will have two new pieces and give the whole problem to an lawyer.
What to do?

Step 4: Knowledge Transfers

- We can record and measure these information flows:
  - Buyer → intermediary
  - Intermediary → firm

- What details were discussed?
  - 91.1% of discussions involved intermediary providing "information on techniques to improve quality" (as opposed to only pointing out flaws)
  - E.g., intermediary explained optimal way to weave weft thread through warp to achieve correct rug firmness, how to hold weft to reduce waviness etc.

	(1)
Number of Visits	11.0
	(2.57)
Length of Visit (in minutes)	27.6
	(4.88)
Discussed technique?	90.3%

	Discussed Metric?	Discusssed Technique?
	(1A)	(1B)
Corners	31.8%	100.0%
Waviness	20.5%	100.0%
Weight	54.5%	92.9%
Touch	11.4%	100.0%
Packedness	20.5%	93.8%
Warp Thread Tightness	47.7%	78.9%
Firmness	31.8%	100.0%
Design Accuracy	50.0%	96.2%
Warp Thread Packedness	22.7%	75.0%
Observations	44	

Sample 2 ▶ Sample 1 ▶

Step 4: Knowledge Transfers

- $Quality_{id} = \beta_1 Takeup_i \times \mathbf{1}[Talked\ About\ Dimension\ d]_{id} + Quality_{id0} + \delta_i + \delta_d + \varepsilon_{id}$

	Stacked Quality Metrics (1)	Specification-Adjusted Quality Metrics (2)	Stacked Quality Metrics (3)	Specification-Adjusted Quality Metrics (4)
$Takeup_i$ x {Talked About Dimension}$_{id}$	0.19 **	0.16 **		
	(0.08)	(0.07)		
$Takeup_i$ x {Information on Techniques for Dimension}$_{id}$			0.32 ***	0.33 ***
			(0.09)	(0.09)
$Takeup_i$ x {Pointed Out Mistakes in Dimension}$_{id}$			0.30 ***	0.29 ***
			(0.04)	(0.04)
Quality Metric FEs	yes	yes	yes	yes
Firm FEs	yes	yes	yes	yes
Specification-adjusted Quality Metrics	no	yes	no	yes
R-squared	0.76	0.43	0.75	0.42
Observations	1700	1667	1670	1637

- Quality increases most along specific dimensions discussed during intermediary-firm communication
  - Same size coefs. for info about technique and pointing out errors
- Evidence that LBE occurs, at least in part, through knowledge transfers

Step 5: Alternative Hypotheses

1. Adjustment costs could explain learning curves in Step 3
   - Inconsistent with Steps 1-2 and 4

2. Treatment firms may make investments to raise efficiency parameters

- Firms do not purchase new equipment, spend time practicing or hire consultants to teach new skills
- Intermediary does not deduct training costs from payments to firms (price uncorrelated with number of visits)
- Finally, perhaps exporting simply raises the return to investing in skills
  - But, returns to quality in domestic market (10.4%) exceed cost of foregone production speed or cost of provision by intermediary
  - If firms were choosing to invest, they should have already done so

➢ Knowledge transfers appear to be just that: information flows that are not priced, which is what the LBE literature describe (Clerides et al 1998)

Conclusion

- Find that the opportunity to export improved firm performance
  - Profits rose 16-26 percent

- Evidence of learning-by-exporting
  1. Conditional on specifications, treatment has higher quality/productivity
  2. On identical domestic rugs, treatment has higher quality
  3. Evidence of learning curves
  4. Document knowledge transfers
  5. Rule out investment in efficiency parameter explanations

- As with any industry/location study, cautious to generalize findings too broadly
  - However, we believe that two features of study:
    - random assignment of export status
    - detailed surveys/quality lab to unpack within-firm changes

  allow us to contribute to literatures on both learning-by-exporting and impacts of trade in developing countries

Input Prices and Quantities

Panel B: Inputs

	Weft Thread Price		Warp Thread Price		Weft Thread Qty (g)		Warp Thread Qty (g)	
	ITT	TOT	ITT	TOT	ITT	TOT	ITT	TOT
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)
Treatment	0.20 ***	0.33 ***	-0.04	-0.07	-0.19 **	-0.34 **	0.04	0.06
	(.06)	(.10)	(.03)	(.06)	(.10)	(.17)	(.11)	(.20)
R-squared	0.22	0.24	0.27	0.27	0.23	0.22	0.10	0.11
Control Group Mean	12.8	12.8	18.1	18.1	110.0	110.0	17.8	17.8
Observations	564	564	685	685	677	677	686	686

- Observable (Weft) thread prices rise, quantities fall (but by less than output as export rugs heavier)

Samples 1 & 2 ▶ Inputs ▶

TFP Details

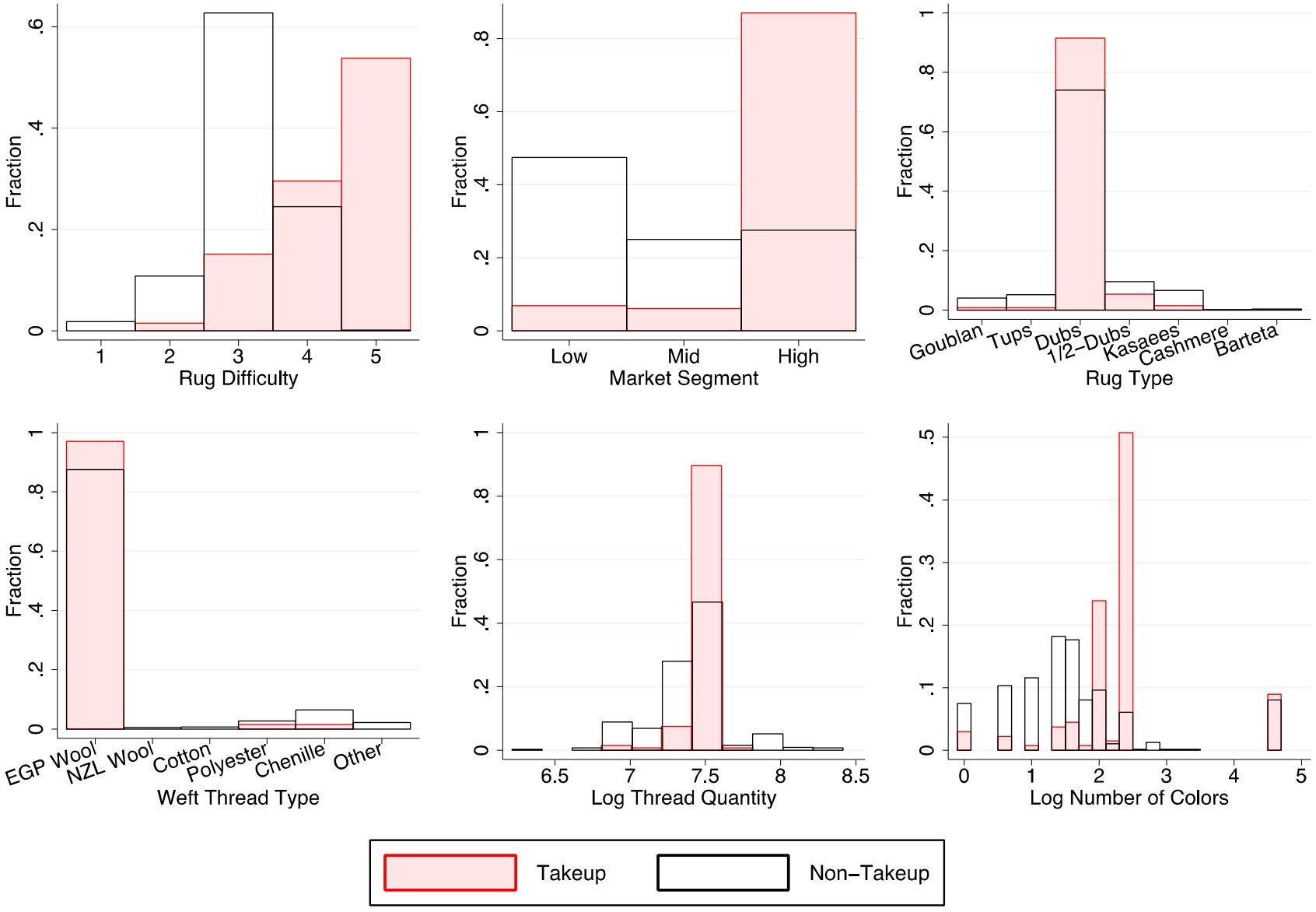
- Cobb Douglas production function

$$\ln x_{it} = \alpha_l \ln l_{it} + \alpha_k \ln k_{it} + \mathbf{Z}_{it}^{'}\Gamma + a_{it} + \nu_{it}$$

  - where Z are round fixed effects, rug specifications
  - a is productivity
- Unadjusted productivity: Impose Γ=0

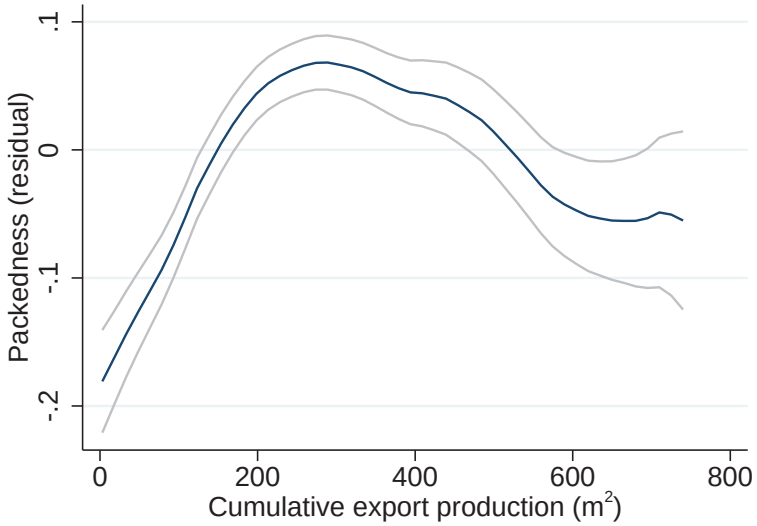
- Run regression on control firms (de Loecker 2012)
- Materials as the proxy (Wooldridge 2009)

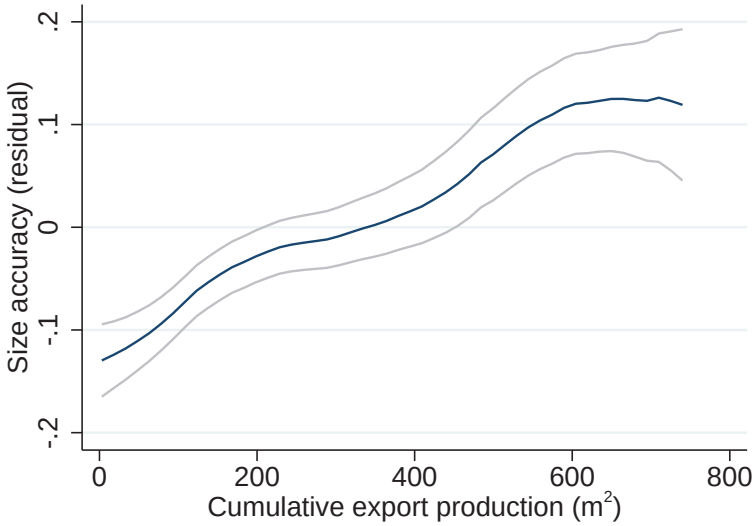
Overlap of Product Specifications

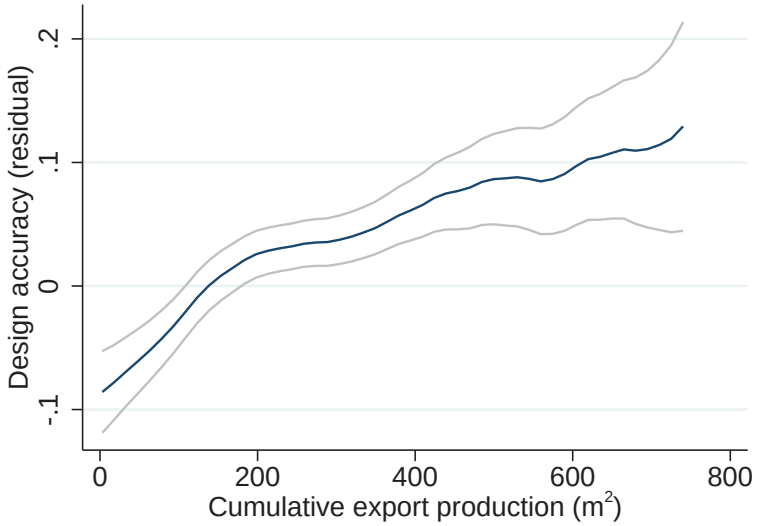


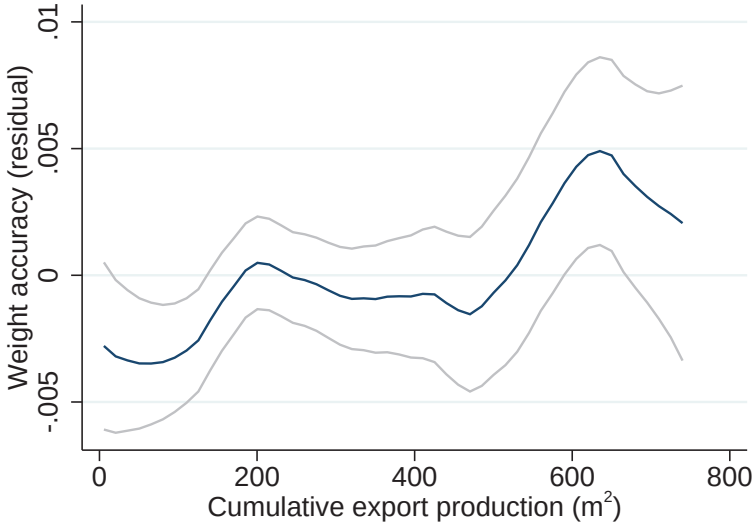
Notes: Figure plots the density of the six rug specifications for takeup (shaded) and non–takeup (outline) firms.

Step 3: High Frequency Learning Curves









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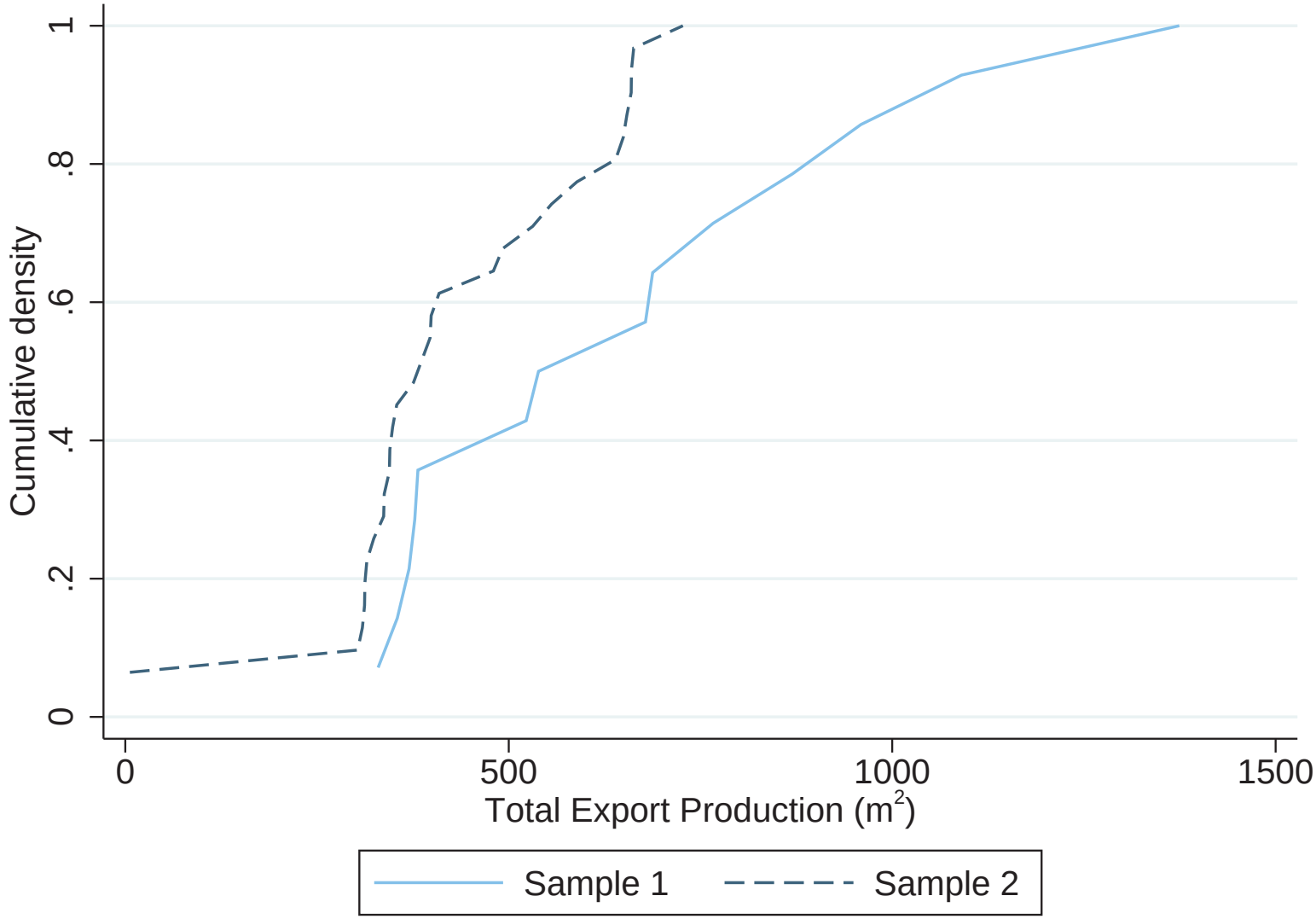
Export Production CDFs



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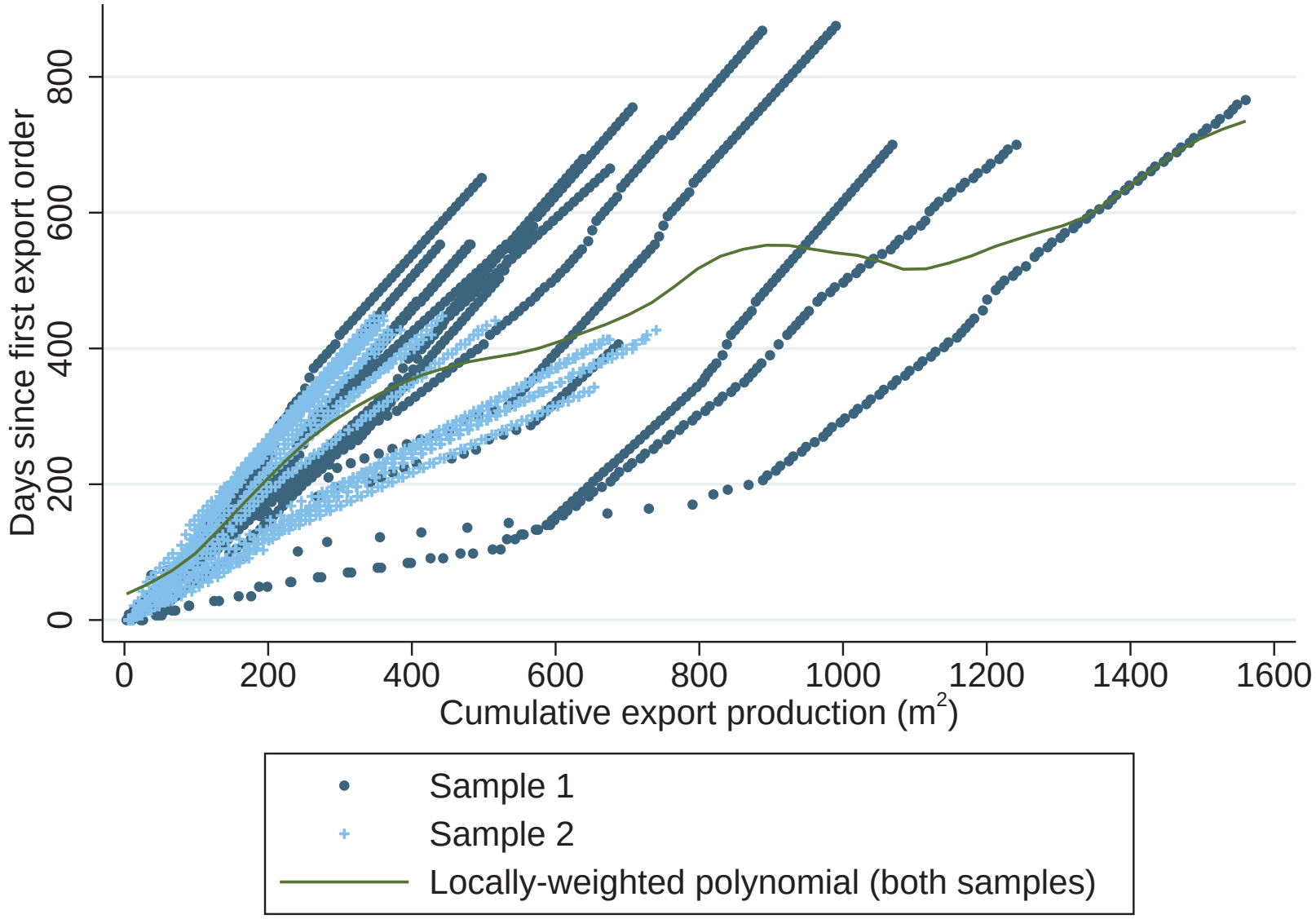
Cumulative Exports and Days Since First Order



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