How Firms Accumulate Inputs: Evidence from Import Switching

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Switching

Simultaneous adding and dropping of
imported intermediates at the firm level.

Overview: Facts

- Most of importers simultaneously add and drop varieties, 60%

- On average, they add and drop 30% of their imports

- Switching patterns relate to firms' age and the import price

  - Younger firms switch more intensively conditional on size

  - During depreciation, less switching

Overview: Model

- Facts cannot be explained by static models of import:
  $\rightarrow$ propose a dynamic model

- How firms search and accumulate foreign inputs

- Searching for new suppliers is costly

- Through searching, firms increase the number of suppliers over time, and switch to better inputs

- Switching changes with firms' lifecycle and import price, and generates reallocation

Literature

- Firm imports and productivity
  - Amiti and Konings 2007; Goldberg et al. 2010; Halpern et al. 2011; Gopinath and Neiman 2011; Kasahara and Lapham 2013

- Import switching and product switching
  - Damijan et al. 2012; Bernard et al. 2010; Timoshenko 2015

- New exporter/firm dynamics
  - Eaton et al. 2014; Arkolakis et al. 2014; Fitzgerald et al. 2015; Ruhl and Willis 2014; Alessandria et al. 2014; Foster et al. 2008; Hsieh and Klenow 2014

- Turnover of labor
  - Davis et al. 2012; Shimer 2012; Pries and Rogerson 2005

Data

- Colombian manufacturing survey

- Customs transaction data: import and export. HS 10 digit industry, total value and quantity, the source country, and the name of suppliers.

- Merge using common tax id.

- We avoid distribution

Switching Definitions

- Continuing importers

- Focus on add and drop of products

- Conservative definition (avoid inventory):

    - Add defined as never used before

    - Drop as never used again

- HS10 to capture large substitutability.

Switching Within Firms: Static Patterns

- Most importers add and drop simultaneously

- Add and drop are not a small share at firm level

	Percentage of continuing importers	Weighted by firm imports
Add and Drop	0.65	0.94
Only Add	0.12	0.02
Only Drop	0.12	0.02
Do nothing	0.11	0.01
	Share in firm imports	Weighted by firm imports
Add Share	0.38	0.12
Drop Share	0.33	0.11

- Add and Drop shares of imports positively correlated at firm level.

Dynamic Patterns: Age and RER Variation

- Look at add and drop shares of import value

- Conditional on an import growth:

  - Drop share is large in growing firms, as in labor lit: reallocation.

  - Young firms add and drop higher shares

  - High import prices (low RER), induce lower add and drop shares

Summary of Facts

- Firms frequently switch imported input varieties

- Larger firms are more likely to switch

- Firms switch more intensively when they are young

- There is more inaction during depreciation:
  - fewer firms switch, and
  - firms switch a lower share

Model

Model: Intuitive Overview

- Explains the switching of inputs as firms searching for new suppliers and reorganizing their imported inputs

    - Searching for new suppliers is costly, the more productive firms search

    - Through searching, firms accumulate the number of foreign suppliers over time, and have the opportunity to switch to better ones

    - Over age profile: Younger firms switch more as the benefit of searching new suppliers has decreasing return to scale

    - Over business cycle: The benefit of searching decreases during depreciations, hence there is more inaction

Choices: Overview

1. Firm's binary decision of searching or not

2. Optimal searching intensity, $n' - n$, conditional on searching

3. Imported input choice conditional on the firm's measure of suppliers $b_{n'}^*$

   Solve backwards.

Static: Production and Imported Inputs

- Demand firm face is:

$$q = Dp^{-\rho}.$$

- Firm production function is:

$$Y = AL^{1-\alpha}X^{\alpha}.$$

Intermediate inputs consist of a continuum of intermediate goods indexed by $j \in [0, 1]$

$$X = \exp \int_0^1 \ln X_j dj.$$

For each type j of intermediate goods, there are two varieties: home, H, and foreign, M,

$$X_j = \left[H_j^{\frac{\sigma-1}{\sigma}} + \left(b_j M_j \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, b_j > 1$$

Static: Imported Inputs and Productivity

- Each supplier-firm specific productivity b draw from a distribution $F(b)$, with support $[1, \infty]$.

$$F(b) = Prob[\tilde{b} < b]$$

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- Trade off:
    - Productivity benefit: production function has love-of-variety
    - Import cost: convex on number of foreign varieties (next slide more)

- Static optimal choice
    - Firms use all the domestic inputs
    - Firms use imported inputs that have productivity larger than $b^*(A)$
- Today assume $\tilde{b}$ is Frechet.

Static: Optimal Input Choice

- Firm maximization problem is

$$\pi\left(A\right) = \max_{Y,b^*} D^{\frac{1}{\rho}} Y^{1-\frac{1}{\rho}} - \lambda\left(A, b^*\right) Y - m(b^*)^{\eta} wF$$

- $m(b^*) = \int_{b^*}^{\infty} f\left(b\right) db$ is the measure of imported inputs

- $\eta > 1$: convex cost.

- λ is unit cost

$$\frac{1}{A} \underbrace{\left(\frac{w}{1-\alpha}\right)^{1-\alpha} \left(\frac{p_H}{\alpha}\right)^{\alpha}}_{C} \left(\underbrace{\exp \int_{b^*}^{\infty} \ln\left[1 + \left(\frac{bp_H}{p_F}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}} dF\left(b\right)}_{G(b^*)}\right)^{-\alpha}$$

- $G(b^*) > 1$ is the benefit from using foreign inputs

Static: Optimal Input Choice

- Optimal b^* satisfies

$$\underbrace{A^{\rho-1} \ln B^* G(b^*)^{\alpha(\rho-1)}}_{MR} = \underbrace{m(b^*)^{\eta-1} \eta w F}_{MC}$$

- Larger A has a lower cutoff

Dynamics: Imported Input Search: Gains

- With n measure of suppliers,

$$F_n(b) = Prob[\max_n \{\tilde{b}_n\} < b]$$

  - With a larger measure of suppliers, the distribution of input productivity shifts to the right

    $\rightarrow$ Better distribution $\rightarrow$ firms use more inputs, so some will be added $\rightarrow$

    Convex import cost $\rightarrow$ some inputs will be dropped (higher cutoff)

- Firm can increase the measure of suppliers by searching

Dynamics: Cost

- Searching is costly

  If a firm pays search fixed cost F_s, it can choose an optimal search
  intensity $n' - n$, subject to a convex cost

$$\Phi\left(n, n'\right) = \frac{\phi}{\gamma}\left(n' - n\right)^{\gamma}$$

- $\gamma > 2$

- Similar to capital adjustment costs

Dynamic Decision

- The firm decides to search or not:

$$V\left(n; A\right) = \max\left\{ V^s\left(n; A\right), V^d\left(n; A\right) \right\}$$

  - If search

  $$V^s\left(n; A\right) = \max_{n'}\left\{ \pi\left(n'; A\right) - F_s - \Phi\left(n, n'\right) + \beta V\left(n'; A\right) \right\}$$

  - If not

  $$V^d\left(n; A\right) = \pi\left(n; A\right) + \beta V\left(n; A\right)$$

Optimal Policy: Qualitative

Optimal Policy: Intuition

- Searching for more suppliers increases TFP hence profit
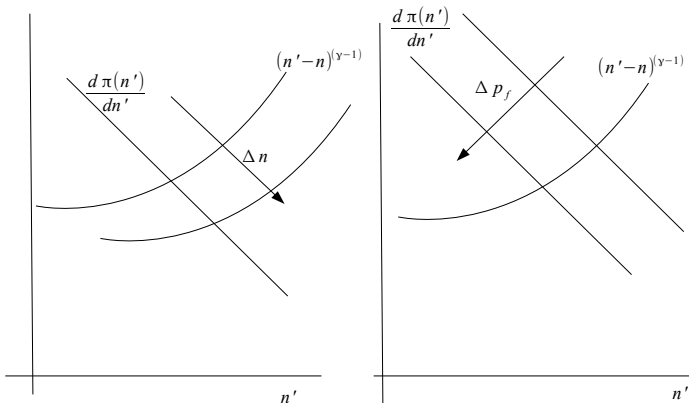
$$\frac{d\pi\left(n, A\right)}{dn} > 0$$

- DRS of searching: its harder and harder to find more productive suppliers

$$\frac{d^2\pi\left(n, A\right)}{dn^2} < 0$$

Optimal Policy: Intuition

The search intensity decreases with age and import price

$$\frac{d\pi\left(n', A\right)}{dn'} = \phi\left(n' - n\right)^{\gamma-1} - \beta\phi\left(n'' - n'\right)^{\gamma-1}$$

Model Predictions

- More productive firms use more imported inputs, conditional on age

- If firms pay the search costs to find new suppliers, they add and drop varieties simultaneously

- More productive firms have larger dynamic gains from searching, hence, they are more likely to do add and drop

- Older firms import more varieties but there are decreasing returns to searching, hence they switch less

Model Predictions

- When prices of imports go up,

    - Firms use less imported inputs

    - Fewer firms would like to pay the search costs to find new suppliers

    - Firms that switch would add and drop a smaller share of their imported inputs

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- When prices of imports go up,

    - Firms use less imported inputs

    - Fewer firms would like to pay the search costs to find new suppliers

    - Firms that switch would add and drop a smaller share of their imported inputs

- Conditional on importing, the higher an input's productivity, the lower the probability of it being dropped

- Larger firms have more input varieties/suppliers and buy from smaller suppliers

Evidence

- Main empirical evidence that supports the model mechanism

- Results are robust

  - when using suppliers switching

  - controlling export status, export share, export switching, crisis periods

  - adding a first year dummy

  - controlling for the number of imports

  - all results have firmFE

Summary of Evidence

- Within firm variation

- Controlling for sales (A), as a firm becomes older:

  - more foreign inputs

  - switch less (value, numbers, also as shares of imports)

- Controlling for sales (A) and age, devaluations reduce switching

- Across imported inputs: more productive intermediates (size) are less likely to be dropped

- Firm sales grow more when (more) switching

  - RER as IV for switching.

  - Large effect.

Evidence: Imports with Age and Firm Size

As firms age, more inputs

VARIABLES	(1) Import Number	(2) Import Number
Age	0.0656***	0.0488***
	(8.662)	(6.458)
Age^2	-0.00130**	-0.000615
	(-2.558)	(-1.232)
Lagged Sales		0.214***
		(12.26)
Constant	0.952***	-2.246***
	(21.23)	(-8.511)
Observations	15,153	15,153
R-squared	0.794	0.799

Robust t-statistics in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Evidence: Switching, RER, Age and Size

For a given firm, switching decreases with age and devaluation/lowRER

VARIABLES	(1) Add and Drop Value	(2) Add and Drop Value Share	(3) Add and Drop Number	(4) Add and Drop Number Share
RER	1.375***	1.050***	0.227***	0.355***
	(7.799)	(5.159)	(2.655)	(4.335)
Age	-0.0783***	-0.178***	-0.0126	-0.0774***
	(-3.168)	(-6.200)	(-1.070)	(-6.896)
Age^2	0.00561***	0.00580***	0.00241***	0.00286***
	(3.494)	(3.197)	(2.622)	(4.028)
Lagged Sales	0.298***	-0.266***	0.137***	-0.0695***
	(5.946)	(-4.987)	(6.248)	(-3.557)
Constant	6.462***	4.018***	-0.155	1.440***
	(8.397)	(4.868)	(-0.458)	(4.776)
Observations	6,411	6,411	6,411	6,411
R-squared	0.691	0.679	0.777	0.613

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Evidence: Dropped Inputs

Within firms, imported input dropping relates to it's productivity

VARIABLES	(1) Input Drop Dummy	(2) Input Drop Dummy	(3) Input Drop Dummy	(4) Input Drop Dummy	(5) Input Drop Dummy
Input share	-0.0625***			-0.0628***	
	(-362.7)			(-364.5)	
Input size		-0.0640***			-0.0640***
		(-369.3)			(-369.1)
Lagged Sales			-0.00968***	-0.0361***	-0.00320***
			(-7.685)	(-30.70)	(-2.745)
Constant	-0.0824***	0.860***	0.494***	0.554***	0.917***
	(-34.50)	(323.7)	(22.07)	(26.52)	(44.16)
Observations	802,704	802,704	802,704	802,704	802,704
R-squared	0.237	0.240	0.119	0.238	0.240

Robust t-statistics in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Evidence: RER as IV

Within firms, sales growth caused by gross import switching

VARIABLES	(1) 1st stage Add and Drop Value	(2) 2nd stage Sales Change	(3) 1st stage Add and Drop Number	(4) 2nd stage Sales Change	(5) 1st stage Add and Drop Dummy	(6) 2nd stage Sales Change
RER	1.234***		0.483***		0.137***	
	(5.12)		(4.40)		(4.90)	
Add and Drop Value		0.156***				
		(4.400)				
Add and Drop Number				0.399***		
				(3.927)		
Add and Drop Dummy						1.403***
						(4.283)
Lagged Sales	0.279***	-1.124***	0.157***	-1.128***	0.0542***	-1.155***
	(4.80)	(-51.55)	(4.53)	(-47.69)	(6.66)	(-42.29)
Constant	-0.0111*	-0.00217	-0.0849**	-0.000609	-0.00946***	0.00470
	(-1.89)	(-0.530)	(-2.01)	(-0.130)	(-3.63)	(0.976)
Observations	27,778	27,778	27,778	27,778	32,490	32,490
Number of Firms	4,208	4,208	4,208	4,208	4,600	4,600
First Differences	Yes	Yes	Yes	Yes	Yes	Yes

Robust z-statistics in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Evidence: Quantitative Implications for Firm Growth

- Accumulation and reorganization of inputs are important for firm growth

  - 1999 in Colombia, RER depreciated 26% $\rightarrow$ reduce sales growth by 5 percentage points

  - On average, the yearly growth of sales during our sample period was 2.3%

Conclusions: Firm Growth

- We show accumulation and reorganization of inputs are important for firm growth

- It is a costly and time consuming process for firms, and affected by policies, similar to capital and labor

    - Capital accumulation
      Capital adjustment cost affects the life-cycle dynamics of plants, Hsieh and Klenow (2014)

    - Worker turnover
      Labor market friction affects the efficient use of inputs, which involves reallocation of workers, Pries and Rogerson (2005)

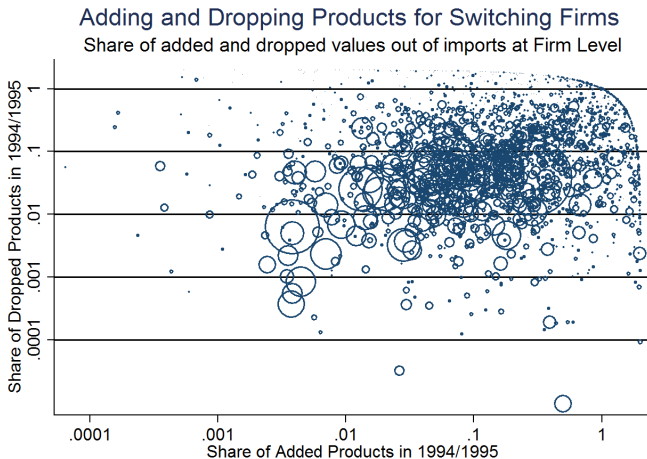- Next: Quantitative macro implications

What next?

- Explore heterogeneity in evidence: ρ, α, A

- Quantitative exploration of macro implications

    - Changes over time due to RER or trade policy for different A firms

    - Short-run vs Long-run adjustment

Definition of Add and Drop/Robust Check

- We define dropped products as the products firms never buy again, added products as the ones firms have never bought before, to rule out lumpy purchase/ inventory story

- We use matched manufacturing firms to check the role of trade intermediaries

- We exclude capital goods to check the effect of capital goods and one time purchase

- In the case of HS code changes, we use detailed documents of HS revision for the concordance
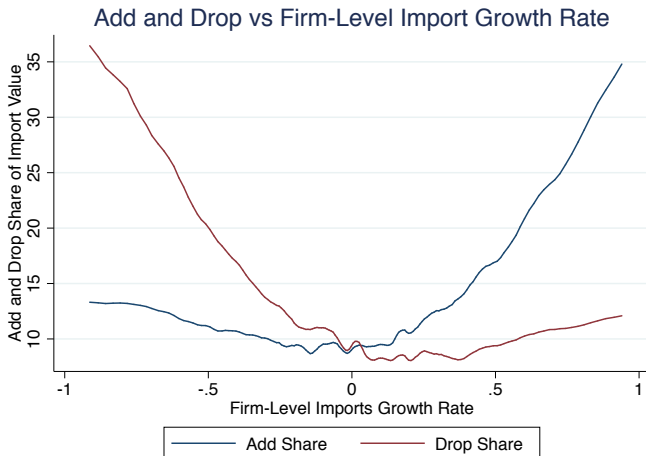
Switching Within Firms
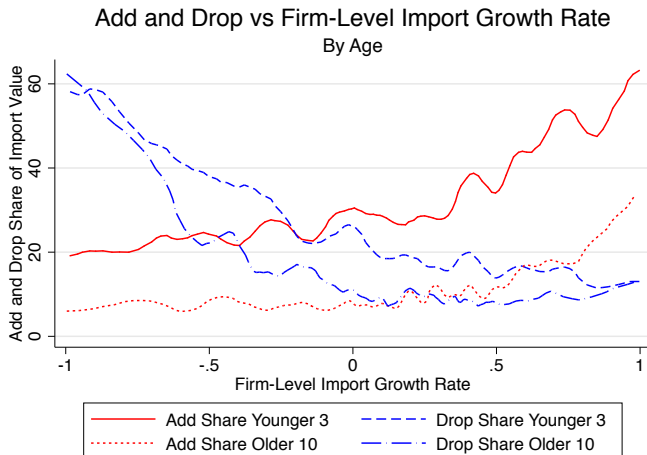
Add and drop shares are positively correlated

Adding and Dropping Products for Switching Firms
Share of added and dropped values out of imports at Firm Level

Dynamic Patterns

Add and drop share vs import growth

Add and Drop vs Firm-Level Import Growth Rate

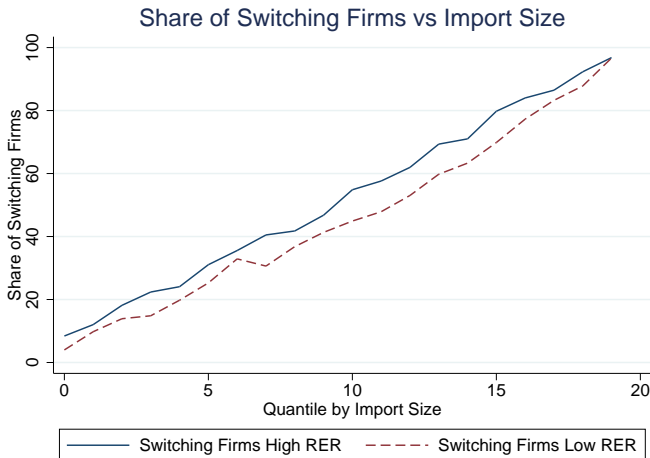# Dynamic Patterns: With Age

The cross-sectional relations shift with age:
Younger importers switch more intensively

Add and Drop vs Firm-Level Import Growth Rate
By Age

Dynamic Patterns: With Import Price

Fewer firms switch during depreciation

Share of Switching Firms vs Import Size

Dynamic Patterns: With Import Price

The cross sectional relations shift with RER
Importers switch less intensively when prices are high

Add and Drop vs Firm-Level Import Growth Rate