Import Price and Quality Adjustment after Exchange Rate Shocks

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This paper

- Documents new facts related to price adjustment of manufacturing imports across a broad set of devaluation episodes.
- Relies on structural modeling to quantify the contribution of three channels towards the decrease in border prices of imported products (measured in USD).
- Finds that quality adjustment and substitution across varieties explain the bulk of import price reduction.

Related Literature

- Quality and trade: Schott (2004); Hallak (2006); Khandelwal (2010); Levchenko, Lewis, & Tesar (2011).
- Large devaluations: Burstein, Eichenbaum, & Rebelo (2005); Cravino & Levchenko (2017).
- Exchange rate pass-through: Goldberg & Knetter (1997); Burstein & Gopinath (2013).

Quality adjustment's hypothesis

- When there is a depreciation real income falls, and consumers become less willing to pay for quality.
- Substitution towards lower quality product varieties.
- Firms may also find it profitable to reduce the quality of a given variety.
- The quality channel affects border prices of imported products.

Objective of the paper

1. Present a simple model with the arguments.

2. Document empirical findings using produce-level import data for 12 devaluation episodes.

3. Estimate structural model using higher quality data for Argentina (1999-2004):
    - 2002: end of ten-year long currency board.
    - The US dollar apreciated by 200% relative to the AR peso.

Objective of the paper

Empirics:

- Show that border prices (measured in USD) go down.
- Show that quality goes down at the variety level.
- Show that there is substitution towards lower price and lower quality varieties.
- Use model to structurally quantify the contribution of three channels to the decrease in border prices: mark-ups, variety quality, substitution towards lower quality varieties.

Product and variety terminology

Product: 6 digits of the harmonized system

Variety: 8 digits of the harmonized system $\times$ country of origin

Example 1: 294110 Penicillin:
21411010 Ampicillin from Spain, 21411020 Amoxicillin from Mexico, ...

Example 2: 610310 suits for men:
61031010 made of wool from Italy, 61031020 made of synthetic fibers from Vietnam, ...

Caveat: changes in quality at the variety level may include changes in composition at a finer level.

No firm-level or barcode data.

Consumers (discrete choice)

Utility

$$U_{hjs} = \theta_{js} - \alpha(y)\ln(p_{js}) + \epsilon_{hjs}$$

h : individuals
j : products
s : varieties within product

p : variety price in USD
θ : variety quality
α : marginal utility of income (inverse of willingness to pay for quality)

$\alpha'(y) < 0$: willingness to pay for quality is increasing in income (in USD)

Consumers (discrete choice)

Error component model. Correlation of shocks

$$\epsilon_{hjs} = \psi_{hj}(\sigma) + (1-\sigma)\widetilde{\psi}_{hjs}$$

Nested logit: $\widetilde{\psi} \sim$ type I extreme value.

Consumers (discrete choice)

Objective: find demand function (for estimation and simulation of prices)

$$U_{hjs} = \theta_{js} - \alpha(y)\ln(p_{js}) + \epsilon_{hjs}$$

Under the nested logit assumption market share is of js:

$$\omega_{js}(p_{js}, \theta_{js}; \mathbf{D}, y) = \frac{\exp\left(\frac{\theta_{js} - \alpha(y)\ln(p_{js})}{1-\sigma}\right)}{D_j^{\sigma} \sum_{j'=0}^{J} D_j^{1-\sigma}}$$

$$D_j = \sum_{s \in S} \exp\left(\frac{\theta_{js} - \alpha(y)\ln(p_{js})}{1-\sigma}\right)$$

Firms

Firms sell one differentiated variety.
Fixed number of firms.

Monopolistic competition.

Constant marginal cost that is increasing in quality:

$$c(\theta_{js})$$

c : marginal cost;
θ : quality;

$c' > 0$;
$c'' > 0$.

Firms

Firms choose price p and quality θ to maximize:

$$\max_{p_{js},\theta_{js}} (p_{js} - c(\theta_{js}))\,\omega_{js}(p_{js}, \theta_{js}, \mathbf{D}, y),$$

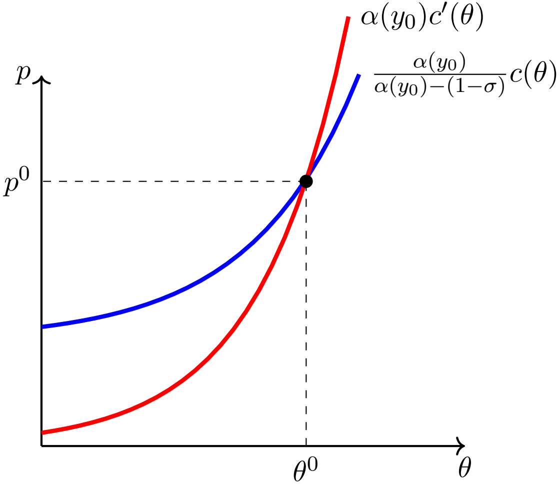
FOCs:

$$\text{p:}\;\; p_{js} = \frac{\alpha(y)}{\alpha(y) - (1-\sigma)} c(\theta_{js})$$

$$\theta\text{:}\;\; p_{js} = c'(\theta_{js})\alpha(y)$$

Solve $p(y)$ and $\theta(y)$

Equilibrium price and quality at the variety level



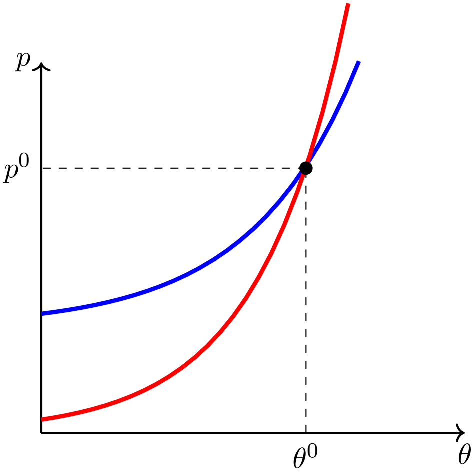
Exchange rate shock

There is a depreciation of the local currency.

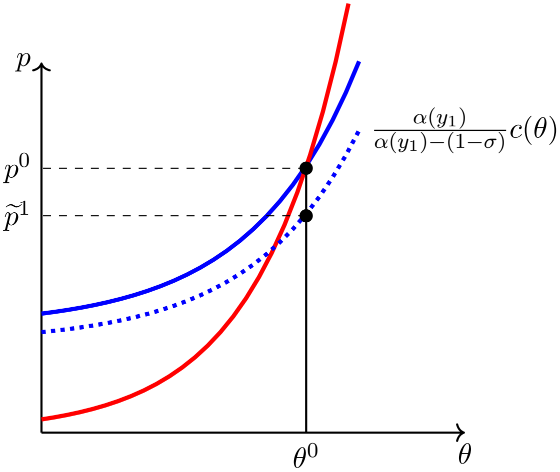
Income in USD falls so that $y_1 < y_0$.

Willingness to pay for quality falls $\alpha(y_1) > \alpha(y_0)$.

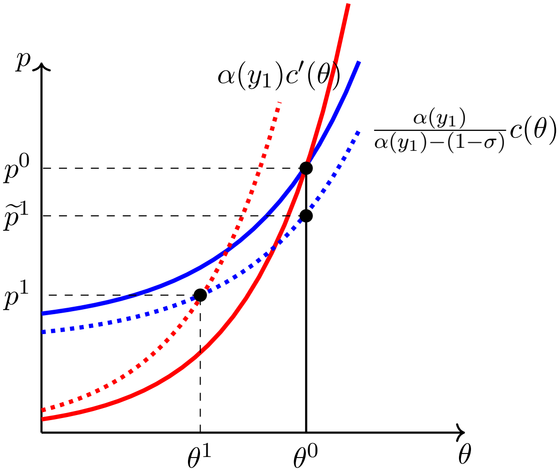
Exchange rate shock at the variety level



Exchange rate shock at the variety level



Exchange rate shock at the variety level



Product prices

At the product level we can define prices as a weighted average across varieties

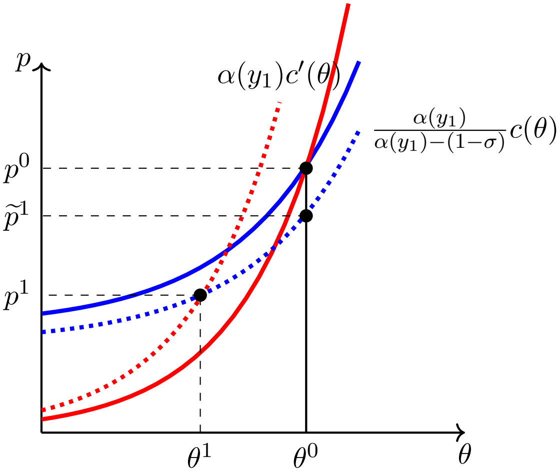
$$P_{j0} = \sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(y_0)$$

After the exchange rate shock

$$P_{j1} = \sum_s \omega(p_{js1}, \theta_{js1}, \mathbf{D}_1, y_1) p(y_1)$$

$$\begin{aligned} \Delta P_j &= P_{j1} - P_{j0} \\ &= \sum_s \omega(p_{js1}, \theta_{js1}, \mathbf{D}_1, y_1) p(y_1) \\ &- \sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(y_0) \end{aligned}$$

Prices at the variety level



Product prices

Adding and subtracting terms

$$
\begin{aligned}
\Delta P_j \quad = \quad & \left.\begin{array}{l} \sum_s \omega(p_{js1}, \theta_{js1}, \mathbf{D}_1, y_1) p(\theta_1, y_1) \\ \\ -\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_1, y_1) \end{array}\right\} \Delta_3 \\
& \left.\begin{array}{l} +\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_1, y_1) \\ \\ -\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_0, y_1) \end{array}\right\} \Delta_2 \\
& \left.\begin{array}{l} +\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_0, y_1) \\ \\ -\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_0, y_0) \end{array}\right\} \Delta_1
\end{aligned}
$$

Product prices and exchange rate shock

We can decompose ΔP into changes due to:

Δ_1: Mark-up adjustment (variety level)

Δ_2: Quality adjustment (variety level)

Δ_3: Substitution across varieties (product level)

Product prices and exchange rate shock

$$\Delta P_j = \Delta_{1j} + \Delta_{2j} + \Delta_{3j}$$

Proposition 2: reduction in mark-ups ($\Delta_{1j} < 0$)
At the variety level, keeping quality fixed at θ_0, price is decreasing in α

Proposition 3: reduction in quality ($\Delta_{2j} < 0$)
At the variety level, equilibrium quality and price are decreasing in α. The total decrease in price is larger than the decrease due to reduction in mark-ups.

Proposition 4: substitution towards lower quality ($\Delta_{3j} < 0$)
The market share of varieties with below-average quality is increasing in α

Empirics

1. Show that prices go down, $\Delta P < 0$
2. Show that there are reductions in variety quality $\Delta\theta < 0$
3. Show that there is variety substition $\Delta\omega < 0$
   for high p, high θ varieties
4. Quantify contribution of three channels of adjustment
   towards decrease in prices

Reminder: we are looking at border prices in USD

Data

Product-level imports during 6 years, for 12 devaluation episodes.

At the 6-digit level of the harmonized system (COMTRADE).
At the 8-digit level of the harmonized system (INDEC).

We keep manufacturing. We keep the top 50 source countries.

Definitions:

Product j: 6-digit product.

Variety s: 8-digit product by country of origin.

Devaluation episodes

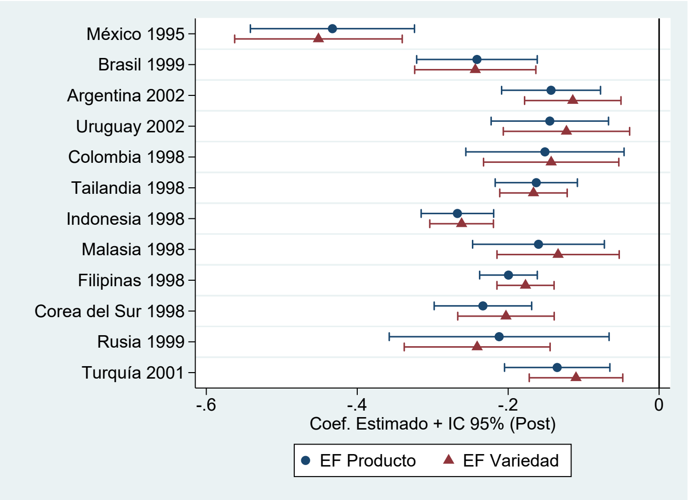
	Δ% NER	Δ% GDP p.c.	Δ% Imports	Δ Trade Bce. (% GDP)	Δ% number hs6 x Origin	Δ origin within hs6
Mexico 1995	90.2	-7.5	-19.7	6.9	-12.5	-1.0
Brazil 1999	56.3	-1.0	-15.1	0.5	-6.6	-0.7
Argentina 2002	206.5	-11.9	-50.1	13.7	-24.4	-1.9
Uruguay 2002	59.6	-7.8	-27.9	3.9	-13.2	-0.7
Colombia 1998	25.0	-0.9	-3.9	0.0	0.0	0.0
Thailand 1998	31.9	-8.7	-19.6	14.2	-9.8	-0.7
Indonesia 1998	244.2	-14.3	-5.3	10.0	-14.9	-1.2
Malaysia 1998	39.5	-9.7	-18.8	21.1	-8.3	-0.7
Philippines 1998	38.8	-2.7	-14.7	1.2	-6.0	-0.3
South Korea 1998	47.3	-6.2	-24.0	11.5	-17.3	-1.5
Russia 1999	153.7	-5.1	-17.0	10.4	-15.6	-2.1
Turkey 2001	96.0	-7.4	-24.1	6.9	-3.2	-0.3
Simple average	90.7	-6.9	-20.0	8.4	-11.0	-0.9

Notes. Annual changes (in percentages) in the year when the bulk of devaluation occurs in each country. Bilateral nominal exchange rate of domestic currency agains U.D. dollar. GDP per capita in constant PPP. Sources. WDI (World Bank), ERA (IMF), and COMTRADE (United Nations).

Change in prices

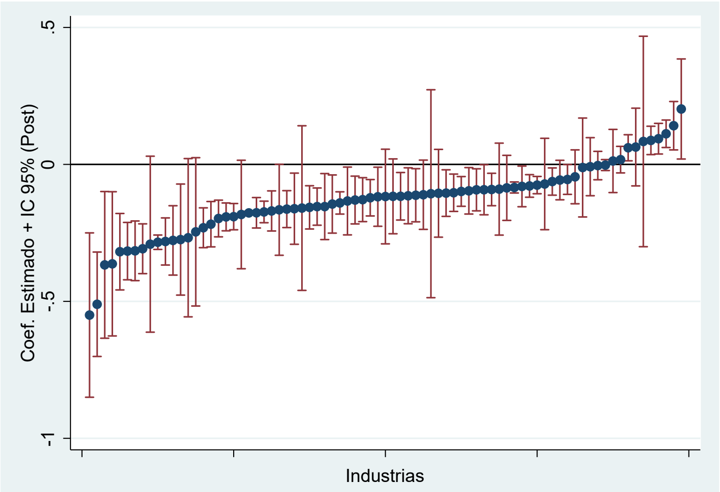
$$\log(p_{jst}) = \varphi^p_{js} + \beta^p POST_t + u^p_{jst}$$

Price regressions



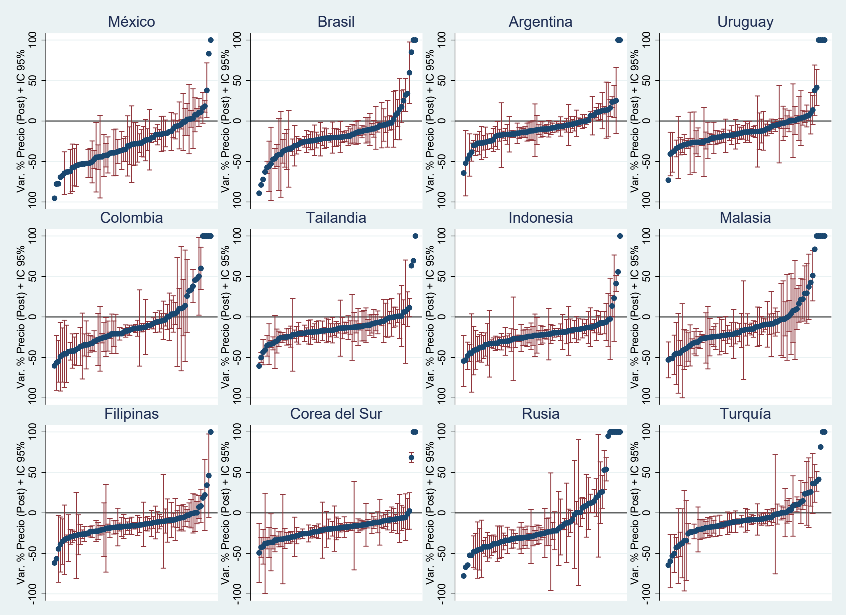
Notes. Estimated coef. + 95% CI from 24 regressions (2 x country). Dep. var. is $log(p)$ of imported varieties (in dollars at the dock) as a function of a binary variable $Post$ (=0 in 1999-2001, =1 in 2002-2004). First specification includes product-level FR (blue), and second variety-level FE (red). Each variety is weighted by its participation in total industry imports. Robust standard errors clustered at hs2. Source. *COMTRADE* (United Nations).

Price regressions by industry. Argentina



Notes. Estimated coef. + 95% CI from 80 regressions (1 x industry). Dep. var. is $log(p)$ of imported varieties (in dollars at the dock) as a function of a binary variable $Post$ (=0 in 1999-2001, =1 in 2002-2004). Industries defined at 2-digits of the HS. Regressions include variety-level FE. Each variety is weighted by its participation in total industry imports. Robust standard errors clustered at hs4. Source. Customs data from INDEC.

Price regressions by industry (cont.)



Summing up...

We confirm that border prices in USD do go down after a depreciation of the local currency

We now estimate a structural model to estimate quality and cost and verify that:

- Quality falls at the variety level
- At the product level there is substitution towards lower quality and lower price varieties
- Decompose changes in product prices into changes in mark-ups, quality, and variety substitution

Estimation of demand parameters

Utility

$$U_{hjs} = \theta_{js} - \alpha(y)\ln(p_{js}) + \epsilon_{hjs}$$

Demand

$$\omega_{js}(p_{js}, \theta_{js}; \mathbf{D}, y) = \frac{\exp\left(\frac{\theta_{js} - \alpha(y)\ln(p_{js})}{1-\sigma}\right)}{D_j^{\sigma}\sum_{j'=0}^{J} D_j^{1-\sigma}}$$

Linear regression

$$\ln\left(\frac{\omega_{jst}}{\omega_{0t}}\right) = \theta_{jst} - \alpha_t \ln(p_{jst}) + \sigma\ln(s_{st|j}) + \varepsilon_{jst}$$

ω_{js}: variety market share
ω_0: "outside option" (market size normalization)
$s_{st|j}$: variety market share within product

Estimation of demand parameters

Marginal utility of income (willingness to pay for quality)

$$\alpha_t = \alpha_0 + \alpha_1 \times Post_t$$

Quality is unobserved

We need to parameterize quality

$$\theta_{jst} = \theta_j + \theta_{origin \times t} + \theta_{industry \times t} + \theta_{origin \times industry}$$

Estimation of demand parameters

Instruments:

Import unit costs (hs8 x Origin)

Average price in other destinations (hs6 x Origin)

Number of varieties within product (hs6)

First-Stage regressions for Demand Estimation

	Log(prices)			Log(ns)		
	(1)	(2)	(3)	(1)	(2)	(3)
log (Import costs)	0.786***	0.787***	0.785***	-1.024***	-1.023***	-1.007***
	(0.036)	(0.037)	(0.037)	(0.131)	(0.132)	(0.134)
log (Import costs) × Post	-0.010***	-0.012***	-0.012***	0.019**	0.015	0.014
	(0.002)	(0.002)	(0.002)	(0.008)	(0.010)	(0.010)
log (P other)	0.060***	0.062***	0.058***	-0.000	-0.005	-0.023
	(0.016)	(0.016)	(0.016)	(0.028)	(0.026)	(0.020)
log (P other) × Post	-0.033***	-0.036***	-0.035***	0.017**	0.025*	0.029**
	(0.005)	(0.006)	(0.005)	(0.008)	(0.014)	(0.013)
Varieties-hs6	-0.005***	-0.004**	-0.004**	-0.130***	-0.130***	-0.123***
	(0.002)	(0.002)	(0.002)	(0.010)	(0.010)	(0.011)
Varieties-hs6 × Post	0.000	-0.000	-0.001	-0.015***	-0.016***	-0.016***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.003)	(0.003)
Product × FE (hs6)	Yes	Yes	Yes	Yes	Yes	Yes
Year × Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Industry FE	No	Yes	Yes	No	Yes	Yes
Country × Industry FE	No	No	Yes	No	No	Yes
Observations	347,904	347,904	347,904	347,904	347,904	347,904

Note: Robust standard errors clustered by industries. Regressions pass joint significant and overidentifying restriction tests.

Estimation of Structural Parameters. Demand

	(1)	(2)	(3)
α	1.45***	1.53***	1.72***
	(0.13)	(0.14)	(0.17)
$\alpha \times$ Post	0.08**	0.09***	0.10***
	(0.037)	(0.030)	(0.031)
σ	0.63***	0.64***	0.67***
	(0.04)	(0.04)	(0.05)
Product FE (6 digits)	Yes	Yes	Yes
Year $\times$ Country FE	Yes	Yes	Yes
Year $\times$ Industry FE	–	Yes	Yes
Country $\times$ Industry FE	–	–	Yes
Observations	347904	347904	347904
Nests	8033	8033	8033

Note: Excluded instruments are variety's unit import costs, average prices in other destinations and number of varieties within products. Regressions pass joint significant and overidentifying restriction tests. Robust standard errors clustered by industries.

Estimated Quality and GDP per capita

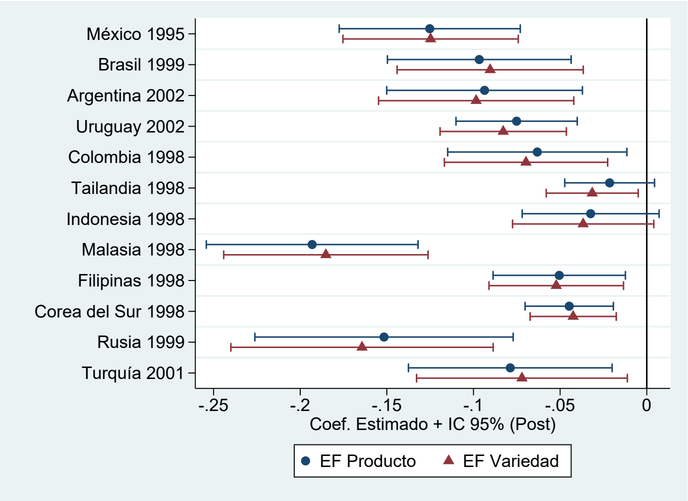
	(1)	(2)	(3)
Log(GDP pc)	0.49**	0.53***	0.68***
	(0.07)	(0.07)	(0.07)
Product $\times$ Year FE	Yes	Yes	Yes
Observations	354334	354334	354334
FE groups	23415	23415	23415

Note: Robust standard errors clustered by industries. GDP per capita is measured in constant 2005 PPP USD. Source: World Bank (WDI).

Changes in quality

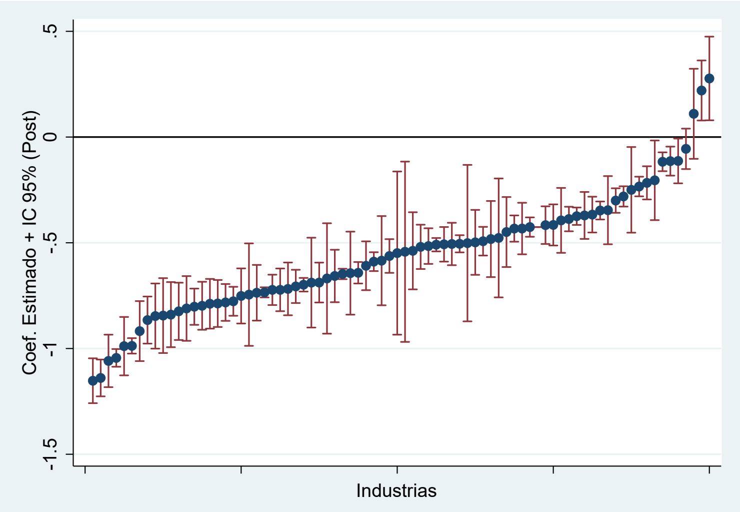
$$\hat{\theta}_{jst}^{estand.} = \varphi_{js}^{\theta} + \beta^{\theta} POST_t + u_{jst}^{\theta}$$

Quality regressions



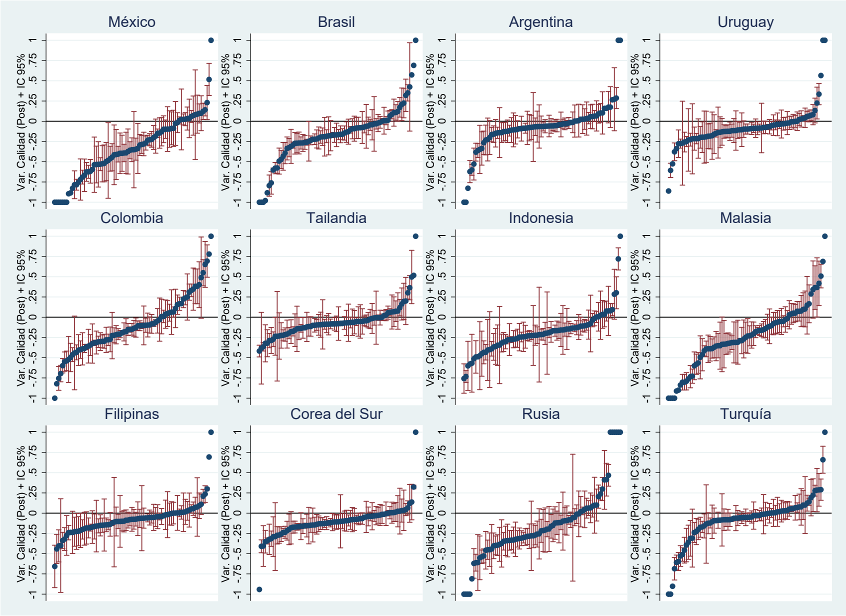
Notes. Estimated coef. + 95% CI from 24 regressions (2 x country). Dep. var. is estimated quality (standarized) of imported varieties as a function of a binary variable $Post$ (=0 in 1999-2001, =1 in 2002-2004). First specification includes product-level FR (blue), and second variety-level FE (red). Each variety is weighted by its participation in total industry imports. Robust standard errors clustered at hs2. Source. *COMTRADE* (United Nations).

Quality regressions by industry. Argentina



Notes. Estimated coef. + 95% CI from 80 regressions (1 x industry). Dep. var. is estimated quality (standarized) of imported varieties (in dollars at the dock) as a function of a binary variable $Post$ (=0 in 1999-2001, =1 in 2002-2004). Industries defined at 2-digits of the HS. Regressions include variety-level FE. Each variety is weighted by its participation in total industry imports. Robust standard errors clustered at hs4. Source. Customs data from INDEC.

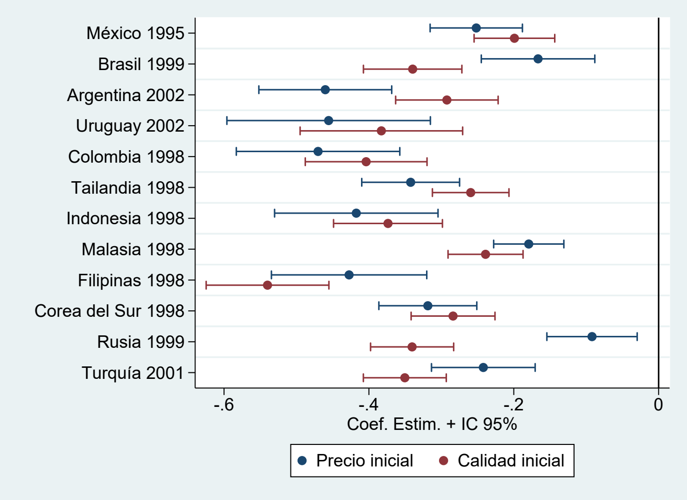
Quality regressions by industry (cont.)



Substitution across varieties

$$\Delta_t \omega_{js} \quad = \quad \gamma^p \theta_{js0} + \gamma^\theta p_{js0} + u^c_{jst}$$

Share regressions



Notes. Estimated coef. + 95% CI from 12 regressions (2 x industry). Dep. var. is the change in (within product) variety's participation across periods (pre and post devaluation) as a function of variety's initial price and initial quality. Robust standard errors clustered at hs2. Source. *COMTRADE* (United Nations).

Share regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: 1999-2003						
Initial Price	-0.04	-0.15***	.	.	-0.30***	-0.27***
	(0.03)	(0.03)			(0.04)	(0.04)
Initial Quality	.	.	-0.18***	-0.15***	-0.32***	-0.14***
			(0.02)	(0.02)	(0.03)	(0.03)
Initial Share	.	-0.21***	.	-0.21***	.	-0.21***
		(0.009)		(0.009)		(0.009)
Observations	38648	38648	38648	38648	38648	38648
Panel B: 1999-2004						
Initial Price	-0.11***	-0.23***	.	.	-0.41***	-0.37***
	(0.03)	(0.03)			(0.04)	(0.04)
Initial Quality	.	.	-0.24***	-0.21***	-0.36***	-0.17***
			(0.02)	(0.02)	(0.03)	(0.03)
Initial Share	.	-0.23***	.	-0.23***	.	-0.23***
		(0.009)		(0.009)		(0.009)
Observations	40273	40273	40273	40273	40273	40273

Note: Dependent variable is the change in variety's share within product between selected years. Sample is restricted to varieties imported in both years.

Summing up...

We estimate demand parameters and quality

We find that:

Willingness to pay for quality goes down after the exchange rate shock

Quality estimates make sense when compared to GDPpc of source country

Quality goes down after the exchange rate shock

Market share of high-price high-quality varieties goes down after the exchange rate shock (i.e. substitution towards lower quality)

Estimation of cost parameters

We need to parameterize the cost function

$$c_{jst}(\theta_{jst}) = \phi^0_{jst} + \mathbf{e}^{\phi^1_{jst}\theta_{jst}}$$

Under these parametric assumptions the solution for price and quality is

$$\begin{aligned} p_{jst} &= \frac{\alpha_t \phi^0_{jst}\phi^1_{jst}}{\phi^1_{jst}\left(\alpha_t - (1-\sigma)\right) - 1} \\ \theta_{jst} &= \frac{1}{\phi^1_{jst}} \log\left(\frac{\phi^0_{jst}}{\phi^1_{jst}\left(\alpha_t - (1-\sigma)\right) - 1}\right) \end{aligned}$$

Estimation of cost parameters

Evaluate the FOCs at the observed prices p and estimated quality $\widehat{\theta}$ and demand parameters $\widehat{\alpha}_t$ and σ

$$
\begin{aligned}
p_{jst} &= \frac{\widehat{\alpha}_t \phi^0_{jst} \phi^1_{jst}}{\phi^1_{jst}\left(\widehat{\alpha}_t - (1-\widehat{\sigma})\right) - 1} \\
\widehat{\theta}_{jst} &= \frac{1}{\phi^1_{jst}} \log\left(\frac{\phi^0_{jst}}{\phi^1_{jst}\left(\widehat{\alpha}_t - (1-\widehat{\sigma})\right) - 1}\right)
\end{aligned}
$$

For each jst we numerically find $\widehat{\phi}^0_{jst}$ and $\widehat{\phi}^1_{jst}$ that solve the FOCs for p, $\widehat{\theta}$, $\widehat{\alpha}_t$ and $\widehat{\sigma}$

Estimation of Structural Parameters. Cost

	(1)	(2)	(3)
Average ϕ_1	2.24	2.06	1.58
ϕ_1 10th	1.08	1.01	0.83
ϕ_1 90th	4.31	3.91	2.85
Average ϕ_0	0.015	0.016	0.021
ϕ_0 10th	0.0002	0.0002	0.0002
ϕ_0 90th	0.031	0.032	0.035
Mark-up (pre)	0.35	0.32	0.24
Mark-up (post)	0.32	0.30	0.22
Observations	57%	59%	65%

Note: Columns (1)-(3) follow demand specifications. ϕ^1_{jst} is recovered applying Newton-Raphson method. For consistency we need to impose $\phi^0_{jst} > 0$ $\phi^1_{jst} > 0$ and $\phi^1_{jst} > \frac{1}{\alpha_t - (1-\sigma)}$.

Cost Parameters and GDP per capita

Dep. variable: Log(ϕ0)	(1)	(2)	(3)
Log(GDP pc)	0.47**	0.48***	0.48***
	(0.03)	(0.03)	(0.02)
Dep. variable: Log(ϕ1)			
Log(GDP pc)	-0.07**	-0.09***	-0.06***
	(0.04)	(0.04)	(0.03)
Product × Year FE	Yes	Yes	Yes
Observations	177062	189409	213915
FE groups	19515	19854	20473

Note: Robust standard errors clustered by industries. GDP per capita is measured in constant 2005 PPP USD. Source: World Bank (WDI).

Decomposing the change in border prices

$$
\begin{aligned}
\Delta P_j \quad = \quad & \left.\begin{aligned} &\textstyle\sum_s \omega(p_{js1}, \theta_{js1}, \mathbf{D}_1, y_1) p(\theta_1, y_1, \Phi) \\ &- \textstyle\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_1, y_1, \Phi) \end{aligned}\right\} \Delta_3 \\
& \left.\begin{aligned} &+ \textstyle\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_1, y_1, \Phi) \\ &- \textstyle\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_0, y_1, \Phi) \end{aligned}\right\} \Delta_2 \\
& \left.\begin{aligned} &+ \textstyle\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_0, y_1, \Phi) \\ &- \textstyle\sum_s \omega(p_{js0}, \theta_{js0}, \mathbf{D}_0, y_0) p(\theta_0, y_0, \Phi) \end{aligned}\right\} \Delta_1
\end{aligned}
$$

Simulated change in variety prices

	Δ Variety Price	Explained by Mark-up Δ_1	Explained by Quality Δ_2
Mean	-0.14	0.17	0.83
10th p.	-0.36	0.03	0.63
90th p.	-0.03	0.37	0.97

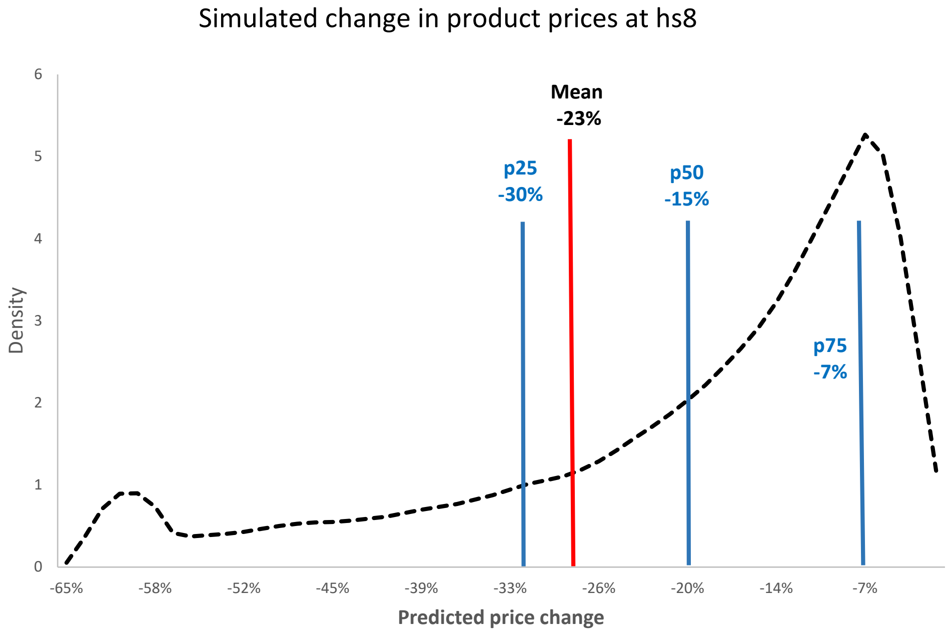
Simulated change in 8-digit product prices

	Δ Product Price 8 digits	Explained by Mark-up Δ_1	Explained by Quality Δ_2	Explained by Variety Subsitution Δ_3
Mean	-0.23	0.11	0.57	0.31
10th p.	-0.55	0.02	0.23	0.00
90th p.	-0.05	0.26	0.92	0.71

Simulated change in 6-digit product prices

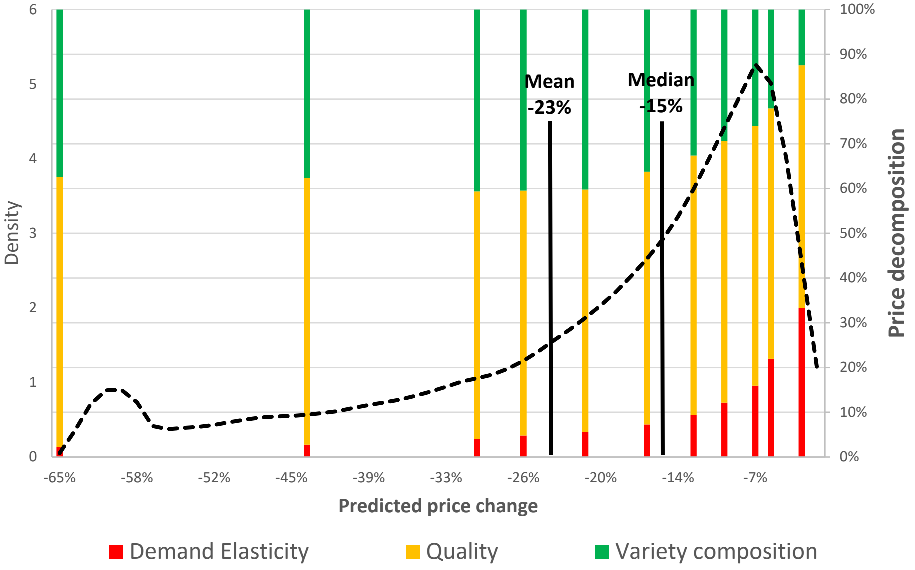
	Δ Product Price 6 digits	Explained by Mark-up Δ_1	Explained by Quality Δ_2	Explained by Variety Subsitution Δ_3
Mean	-0.23	0.10	0.49	0.41
10th p.	-0.51	0.02	0.17	.
90th p.	-0.05	0.23	0.84	.

	Explained by Demand Mark-up Δ_1	Explained by Quality Δ_2	Explained by Source country Substitution Δ_3	Explained by 8-digit Substitution Δ_3
Mean	0.10	0.49	0.31	0.10
10th p.	0.02	0.17	0.02	0.00
90th p.	0.23	0.84	0.66	0.41



Note: non-parametric estimation of density function of product-hs8 predicted price changes.

Simulated change in product prices at hs8



Note: non-parametric estimation of density function of product-hs8 predicted price changes. Total price change is structurally decomposed in its three components.

Conclusion

Empirical findings after large exchange rate shock:

- Border prices fall at the variety and product level
- Willingness to pay falls
- Quality falls at the variety level
- Within products there is substitution towards lower quality varieties

Conclusion

Price reductions are attributed to

- Mark-up adjustment: 10-17%
- Within-variety quality adjustment: 50-57%
- Substitution across varieties (composition): 31-41%

Quality adjustment and substitution across varieties explain the bulk of reduction in border prices at the product level

Substitution is more important at finer levels of disaggregation