Industry Heterogeneity and Exchange Rate Pass Through

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Motivation

- With price rigidities, nominal ER fluctuations can have real effects
- Some factors affecting ERPT into trade prices:
  - Currency in which prices are rigid
  - Imported inputs (MC channel)
  - Strategic complementarities (μ channel)
- Understanding differences in ERPT across industries is important for economic policy design

This Paper

- Using detailed operational firm-level data and customs declarations:

  1. Document differences across industries in the use of imported inputs and in markup variation

  2. Estimate the ERPT into export and import prices for each 2-digit manufacturing sector

  3. Evaluate whether industry characteristics are correlated with estimated ERPT

Main Findings

- There are significant differences across industries in terms of the use of imported inputs, but little variation across time
- There is some heterogeneity in markup variation, but differences are smaller
- There are significant differences across industries in ERPT estimates
  - $\Rightarrow$ In general, the USD appears to be the relevant ER, regardless of destination/origin
- I find evidence of the effect of the marginal cost channel on the ERPT into prices. The effect of markup variability is less clear.

Theoretical Background

- The model in "Dominant Currency Paradigm" (CDGG, 2017) serves as the theoretical background for the empirical analysis
- The model incorporates three key features:
  - Firms set their prices in a dominant currency (USD) regardless of destination/origin, and change them infrequently
  - Firms use domestic and imported inputs in production
  - Firms face strategic complementarities in pricing (variable μ)

Basic Features of the Model

- Small open economy H, that trades goods and assets with the rest of the world: U and R
- Prices and wages adjust infrequently *à la* Calvo
- H households maximize $U(C_t, N_t)$
  - C is implicitly defined by a Kimball (1995) homothetic demand aggregator
    - Elasticity of substitution is decreasing in the relative quantity consumed of a variety $\Rightarrow$ price elasticity increasing in own price
    - This demand structure gives rise to strategic complementarity in pricing, variable markups
    - Our aggregator allows for home bias
  - Households face a downward sloping demand for their specific variety of labor, with a constant elasticity of substitution

Basic Features of the Model

- Each home producer manufactures a unique variety ω, sold both domestically and internationally. The production function uses a combination of labor and domestic and imported intermediate inputs.
  - X: Kimball aggregator
  - L: CES aggregator
- Markets are segmented, so firms can price to market
- International asset markets are incomplete: only riskless bonds (in USD) are traded
- Domestic policy rate follows an IT Taylor rule with inertia
- The model is solved with log-linearization methods around a zero-inflation steady state

Exchange Rate Pass-Through

- Let Γ denote the elasticity of the optimal flexible price markup, α denote the the constant share of intermediate inputs in production, and γ_H denote home bias
  - $\Rightarrow$ If domestic wages are rigid, productivity is unchanged, all the Home/foreign currency j exchange rates are perfectly correlated, and prices are flexible, the ERPT into prices is given by:

$$ERPT^X \equiv \frac{\Delta p_{Hi,t}}{\Delta e_{i,t}} = 1 - \frac{1-\alpha}{(1+\Gamma)(1-\alpha\gamma_H)}$$

$$ERPT^M \equiv \frac{\Delta p_{iH,t}}{\Delta e_{i,t}} = \frac{1}{1+\Gamma} + \frac{\Gamma(1-\gamma_H)}{(1+\Gamma)(1-\alpha\gamma_H)}$$

Empirical Implications

- ERPT into export prices:
  1. *Sectors that are more intensive in their usage of imported intermediate inputs will have a **larger** ERPT into export prices.*
  2. *Sectors with stronger strategic complementarities (more variable markups) will have **larger** ERPT into export prices.*

- ERPT into import prices:
  3. *Sectors that are more intensive in their usage of imported intermediate inputs will have a **larger** ERPT into import prices.*
  4. *Sectors with stronger strategic complementarities (more variable markups) will have a **lower** ERPT into import prices (the direct effect dominates).*

Data

- DANE: Annual Manufacturers Survey (EAM)
  - Input purchases, domestic and imported
  - Output and input information, for markup estimation
- DANE/DIAN: Customs declarations
  - Value of exports/import (FOB USD)
  - Volume of exports/imports (net KGs)
  - Observations by firm/origin or destination/10-digit tariff code
- IMF: Average exchange rates, PPI, GDP by country
- Estimations cover period between 2004 and 2016
- Focus on manufacturing industries, except petrochemicals and basic metals

Descriptive Statistics: Average Share of Imported Inputs

ISIC	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
15	17.3	20.5	18.2	18.9	20.3	22.0	20.2	21.0	19.6	17.9	18.6	18.7	19.2
17	27.5	26.1	25.7	27.0	27.2	28.2	26.7	27.2	33.0	34.0	28.7	30.6	31.2
18	9.1	9.5	11.0	9.8	10.6	13.7	10.4	13.2	12.9	13.2	14.6	14.0	13.5
19	7.6	7.1	8.8	8.0	9.7	9.3	10.1	7.7	7.7	9.3	10.6	11.0	8.7
20	5.1	4.6	11.7	5.9	6.2	24.6	15.7	5.5	9.6	18.7	18.5	20.3	11.9
21-22	26.9	31.0	27.7	27.2	27.2	29.9	23.5	27.1	26.2	25.3	27.5	27.6	23.5
24	33.6	34.8	34.8	30.4	29.8	30.3	29.3	30.3	29.2	27.7	26.7	29.6	27.5
25	34.7	35.3	33.2	34.3	31.3	33.2	34.7	35.3	33.1	33.1	34.7	36.3	32.7
26	25.6	28.9	27.4	30.0	26.2	30.4	29.3	26.2	25.5	26.7	28.1	29.8	29.1
28	25.5	26.9	25.0	22.9	22.1	25.7	24.1	23.2	21.6	23.4	24.8	23.1	24.1
29	21.0	18.7	19.1	18.0	20.0	20.1	19.1	18.2	20.4	20.1	18.4	20.3	19.8
31	30.5	32.8	31.7	25.3	31.0	34.7	28.1	28.7	27.6	22.5	26.2	28.2	28.2
32	23.5	28.3	26.0	30.5	27.0	37.1	51.5	38.9	36.9	39.3	45.5	39.1	43.6
33	25.3	31.1	42.1	33.9	31.8	35.8	28.2	29.0	27.5	25.8	27.9	30.8	30.3
34-35	28.6	29.3	28.0	25.5	23.7	28.0	27.9	25.9	23.8	21.8	25.2	27.8	27.6
36	19.2	19.5	18.0	19.4	16.9	19.0	16.8	15.9	13.8	16.1	18.9	18.6	17.4
Overall	22.6	24.1	23.4	22.8	22.6	24.8	23.1	23.3	22.8	22.7	23.5	24.3	23.1

Source: Author's calculations based on data from EAM.
Notes: Averages calculated for the subsample of firms participating in international markets. In order to avoid disclosing confidential information, I do not report sector-specific statistics for ISIC 16 and 30; firms in these industries are included in the overall manufacturing averages. Producers of coke, refined petroleum, and nuclear fuel (ISIC 23), and basic metals (ISIC 27) are excluded.

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29	21.0	18.7	19.1	18.0	20.0	20.1	19.1	18.2	20.4	20.1	18.4	20.3	19.8
31	30.5	32.8	31.7	25.3	31.0	34.7	28.1	28.7	27.6	22.5	26.2	28.2	28.2
32	23.5	28.3	26.0	30.5	27.0	37.1	51.5	38.9	36.9	39.3	45.5	39.1	43.6
33	25.3	31.1	42.1	33.9	31.8	35.8	28.2	29.0	27.5	25.8	27.9	30.8	30.3
34-35	28.6	29.3	28.0	25.5	23.7	28.0	27.9	25.9	23.8	21.8	25.2	27.8	27.6
36	19.2	19.5	18.0	19.4	16.9	19.0	16.8	15.9	13.8	16.1	18.9	18.6	17.4
Overall	22.6	24.1	23.4	22.8	22.6	24.8	23.1	23.3	22.8	22.7	23.5	24.3	23.1

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Descriptive Statistics: Markup Variation

ISIC	CV(μ)
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19	17.0
20	14.3
21-22	16.5
24	18.5
25	14.2
26	16.6
28	15.4
29	19.4
31	18.5
32	16.9
33	21.7
34-35	17.6
36	18.2
Overall	17.8

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Descriptive Statistics: Currency Distribution, 2007–2014

ISIC	USD	Euro	COP	VEB/VEF	GBP	MXN	Other
15	97.24	0.57	0.28	1.84	0.00	0.05	0.01
17	99.30	0.38	0.08	0.13	0.01	0.07	0.03
18	99.18	0.44	0.09	0.20	0.02	0.01	0.05
19	97.61	1.97	0.32	0.05	0.00	0.00	0.05
20	98.07	1.03	0.86	0.02	0.00	0.00	0.02
21-22	97.20	0.24	2.38	0.13	0.00	0.00	0.05
24	98.77	0.62	0.58	0.00	0.01	0.00	0.02
25	96.89	1.85	1.16	0.02	0.05	0.00	0.03
26	98.70	0.46	0.11	0.73	0.00	0.00	0.01
28	99.28	0.34	0.15	0.21	0.01	0.00	0.01
29	98.28	1.09	0.19	0.41	0.01	0.00	0.02
31	98.23	1.52	0.23	0.01	0.00	0.00	0.02
32	99.41	0.44	0.12	0.00	0.01	0.00	0.03
33	97.75	1.44	0.66	0.06	0.02	0.00	0.06
34-35	99.49	0.33	0.06	0.11	0.00	0.00	0.01
36	98.85	0.77	0.22	0.07	0.01	0.00	0.08
Overall	98.39	0.70	0.52	0.33	0.01	0.01	0.03

Source: Author's calculations based on data from DIAN/DANE.
Notes: The distribution is calculated for the number of invoices in each currency. In order to avoid disclosing confidential information, I do not report sector-specific statistics for ISIC 16 and 30; firms in these industries are included in the overall manufacturing averages. Exports of coke, refined petroleum, and nuclear fuel (ISIC 23), and basic metals (ISIC 27) excluded.

Exchange Rate Pass-Through into Trade Prices

- To estimate the pass-through of exchange rates into import and export prices, I regress the log change of export/import unit values (FOB value per net kilogram) on the log change of the annual average exchange rate

- For transactions with the US and other dollarized trade partners:

$$\Delta p_t = \alpha + \beta \Delta e_t + X_t + \varepsilon_t$$

- For transactions with other trade partners:

$$\Delta p_t = \alpha + \beta_B \Delta e_{B,t} + \beta_D \Delta e_{D,t} + X_t + \varepsilon_t$$

ERPT: Export Prices, Dollar Destinations

	(1) Δp_{COP}	(2) Δp_{COP}	(3) Δp_{COP}	(4) Δp_{COP}	(5) Δp_{COP}	(6) Δp_{COP}	(7) Δp_{COP}	(8) Δp_{COP}
$\Delta e_{COP/USD}$	0.781***	0.823***	0.593***	0.575**	0.290*	1.054*	0.558***	0.962***
	(0.0799)	(0.0645)	(0.160)	(0.218)	(0.135)	(0.533)	(0.123)	(0.0615)
Observations	147,701	9,833	11,429	30,254	6,429	1,065	11,094	20,702
R-squared	0.348	0.353	0.412	0.344	0.384	0.549	0.323	0.313
Industry	M	15	17	18	19	20	21-22	24

	(9) Δp_{COP}	(10) Δp_{COP}	(11) Δp_{COP}	(12) Δp_{COP}	(13) Δp_{COP}	(14) Δp_{COP}	(15) Δp_{COP}	(16) Δp_{COP}
$\Delta e_{COP/USD}$	0.948***	0.792***	1.023***	1.036***	1.028***	1.571***	0.474**	0.441**
	(0.133)	(0.114)	(0.140)	(0.188)	(0.250)	(0.434)	(0.165)	(0.194)
Observations	11,204	3,929	8,777	10,227	4,983	3,089	5,214	7,179
R-squared	0.336	0.392	0.336	0.342	0.383	0.402	0.223	0.359
Industry	25	26	28	29	31	33	34-35	36

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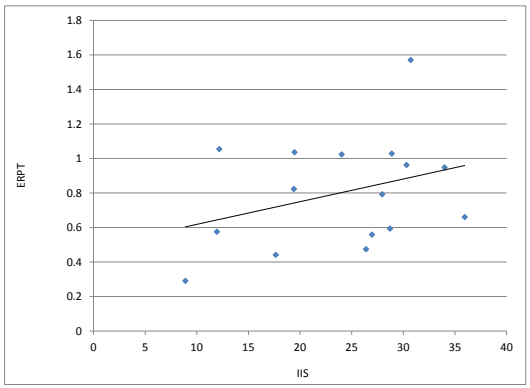
ERPT: Export Prices, Other Destinations

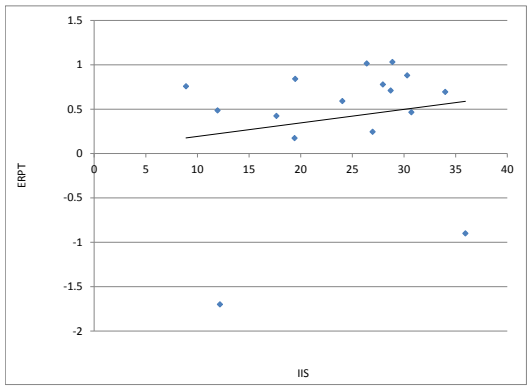
	(1) Δp_{COP}	(2) Δp_{COP}	(3) Δp_{COP}	(4) Δp_{COP}	(5) Δp_{COP}	(6) Δp_{COP}	(7) Δp_{COP}	(8) Δp_{COP}
$\Delta e_{COP/LCU}$	0.512***	0.0921	0.174	0.0161	0.486***	0.0705	0.881***	0.212*
	(0.128)	(0.0607)	(0.105)	(0.0629)	(0.116)	(0.186)	(0.121)	(0.111)
$\Delta e_{COP/USD}$		0.666***		0.464***		0.668***		0.902***
		(0.0632)		(0.120)		(0.193)		(0.116)
Observations	131,215	131,215	14,725	14,725	34,683	34,683	14,345	14,345
R-squared	0.373	0.375	0.378	0.381	0.371	0.374	0.354	0.360
Industry	M	M	15	15	18	18	24	24

	(9) Δp_{COP}	(10) Δp_{COP}	(11) Δp_{COP}	(12) Δp_{COP}	(13) Δp_{COP}	(14) Δp_{COP}	(15) Δp_{COP}	(16) Δp_{COP}
$\Delta e_{COP/LCU}$	0.695***	0.231	0.591*	0.0999	1.031***	0.890**	0.465	0.229
	(0.182)	(0.205)	(0.288)	(0.285)	(0.295)	(0.380)	(0.416)	(0.313)
$\Delta e_{COP/USD}$r		0.607***		0.664***		0.190		0.626**
		(0.154)		(0.190)		(0.290)		(0.277)
Observations	8,950	8,950	5,781	5,781	3,040	3,040	2,363	2,363
R-squared	0.329	0.330	0.439	0.441	0.396	0.396	0.386	0.387
Industry	25	25	28	28	31	31	33	33

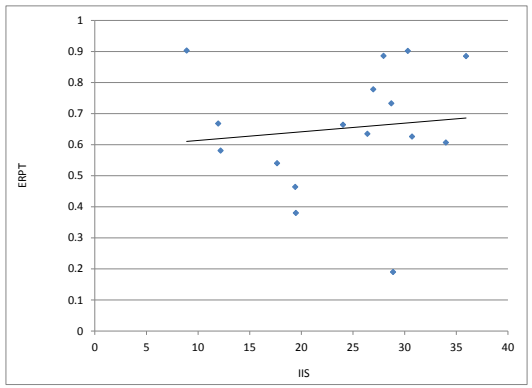
ERPT and IIS: Export Prices



(a) U

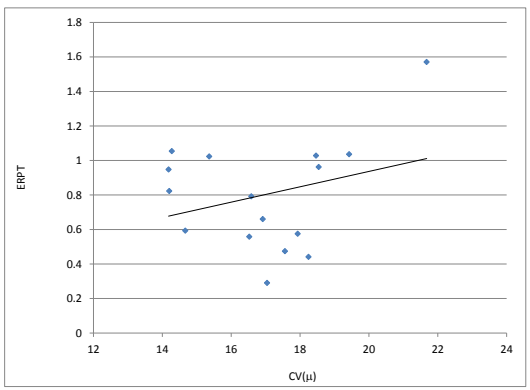


(b) R (LCU)



(c) R (USD)

ERPT and CV(μ): Export Prices



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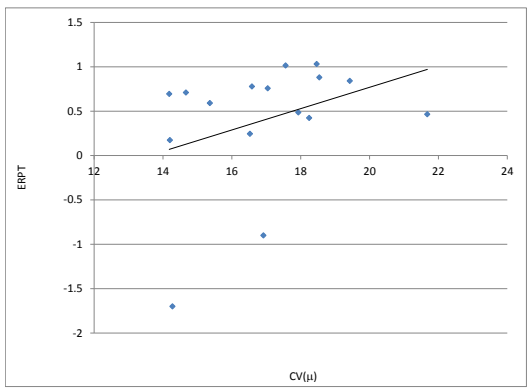
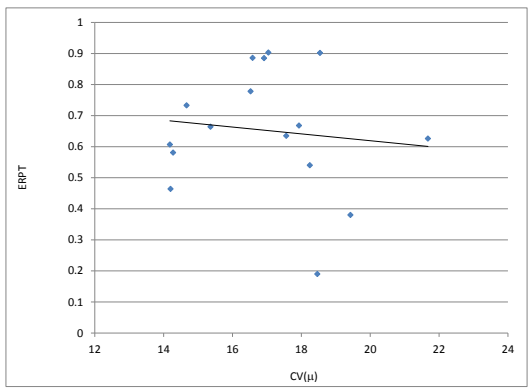


(b) R (LCU)



(c) R (USD)

ERPT: Import Prices, Dollar Origins

	(1) Δp_{COP}	(2) Δp_{COP}	(3) Δp_{COP}	(4) Δp_{COP}	(5) Δp_{COP}	(6) Δp_{COP}	(7) Δp_{COP}	(8) Δp_{COP}
$\Delta e_{COP/USD}$	1.002***	0.943***	0.952***	2.458***	0.806***	1.106***	1.355***	0.945***
	(0.0371)	(0.0777)	(0.121)	(0.772)	(0.179)	(0.184)	(0.157)	(0.0682)
Observations	596,277	15,999	12,399	9,493	2,193	1,676	21,370	82,406
R-squared	0.207	0.252	0.307	0.434	0.334	0.389	0.279	0.199
Industry	M	15	17	18	19	20	21-22	24

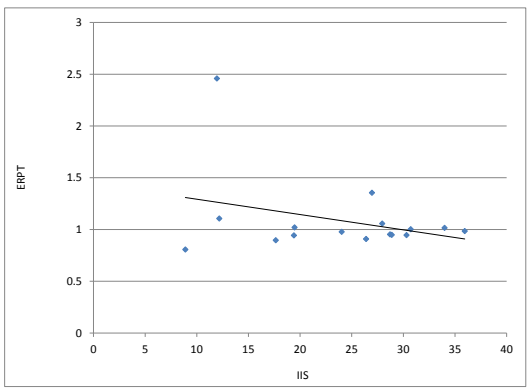
	(9) Δp_{COP}	(10) Δp_{COP}	(11) Δp_{COP}	(12) Δp_{COP}	(13) Δp_{COP}	(14) Δp_{COP}	(15) Δp_{COP}	(16) Δp_{COP}
$\Delta e_{COP/USD}$	1.015***	1.057***	0.977***	1.020***	0.948***	0.984***	1.002***	0.908***
	(0.0499)	(0.241)	(0.0792)	(0.0465)	(0.0629)	(0.0793)	(0.0726)	(0.0514)
Observations	51,836	10,367	61,090	137,846	59,367	22,899	51,832	32,661
R-squared	0.212	0.280	0.199	0.174	0.184	0.226	0.182	0.169
Industry	25	26	28	29	31	32	33	34-35

ERPT: Import Prices, Other Origins

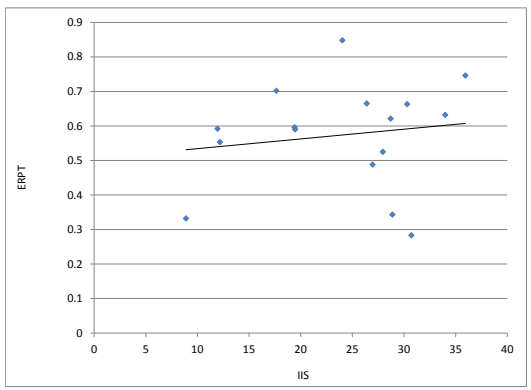
	(1) Δp_{COP}	(2) Δp_{COP}	(3) Δp_{COP}	(4) Δp_{COP}	(5) Δp_{COP}	(6) Δp_{COP}	(7) Δp_{COP}	(8) Δp_{COP}
$\Delta e_{COP/LCU}$	0.559***	0.358***	0.596***	0.324**	0.592***	0.294*	0.488*	0.210
	(0.147)	(0.113)	(0.179)	(0.109)	(0.149)	(0.154)	(0.256)	(0.211)
$\Delta e_{COP/USD}$		0.446***		0.467***		0.437***		0.701***
		(0.0711)		(0.0974)		(0.137)		(0.150)
Observations	644,438	644,438	21,930	21,930	11,276	11,276	30,523	30,523
R-squared	0.260	0.261	0.322	0.327	0.340	0.342	0.328	0.329
Industry	M	M	15	15	18	18	21-22	21-22

	(9) Δp_{COP}	(10) Δp_{COP}	(11) Δp_{COP}	(12) Δp_{COP}	(13) Δp_{COP}	(14) Δp_{COP}	(15) Δp_{COP}	(16) Δp_{COP}
$\Delta e_{COP/LCU}$	0.663***	0.411**	0.632***	0.402**	0.590***	0.444***	0.283	0.149
	(0.125)	(0.149)	(0.200)	(0.156)	(0.138)	(0.111)	(0.199)	(0.126)
$\Delta e_{COP/USD}$		0.362***		0.505***		0.346***		0.615***
		(0.0912)		(0.0807)		(0.0851)		(0.126)
Observations	102,931	102,931	55,058	55,058	127,414	127,414	39,625	39,625
R-squared	0.201	0.202	0.282	0.284	0.242	0.243	0.258	0.260
Industry	24	24	25	25	29	29	33	33

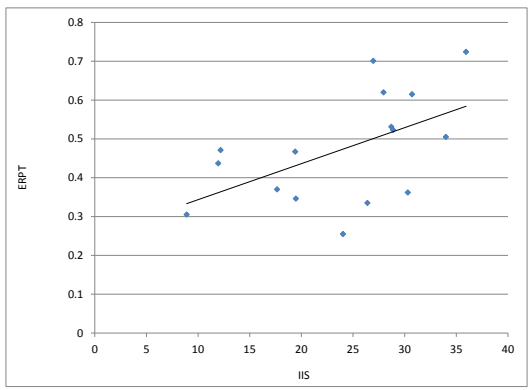
ERPT and IIS: Import Prices



(a) U

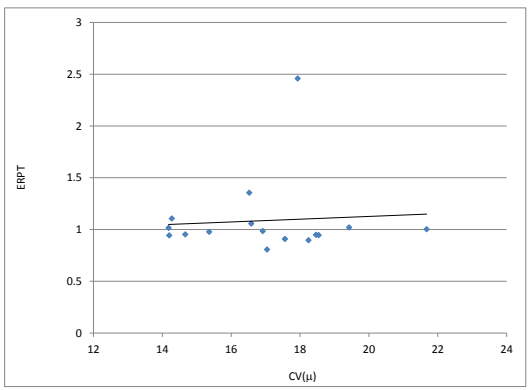


(b) R (LCU)

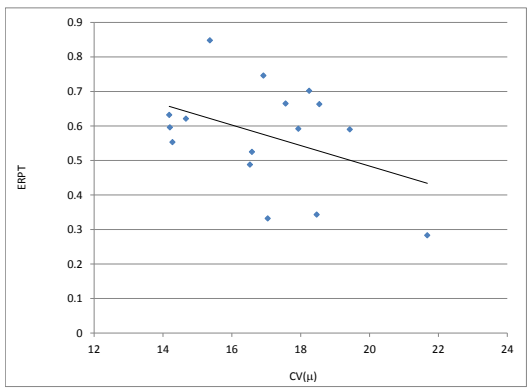


(c) R (USD)

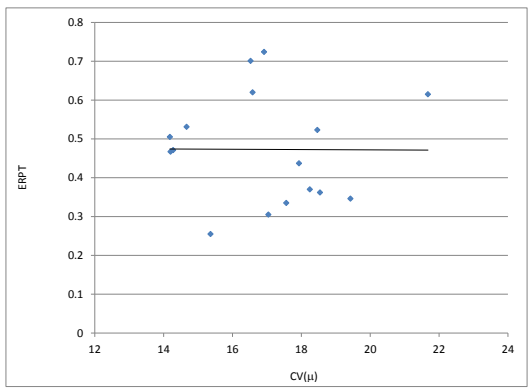
ERPT and CV(μ): Import Prices



(a) U



(b) R (LCU)



(c) R (USD)

Exchange Rate Pass-Through into Quantities

Model predictions for quantity responses to a home currency depreciation, after controlling for demand and competitors' prices:

- ERPT into export quantities:
  1. *Effect on quantities exported to dollar economies around zero*
  2. *Effect on quantities exported to other destinations: around zero if ERs are highly correlated, decline in exports othewise*

- ERPT into import quantities:
  3. *Decline in imports from all partners: response similar to elasticity of demand.*

ERPT: Export Quantities, Dollar Destinations

	(1) Δq	(2) Δq	(3) Δq	(4) Δq	(5) Δq	(6) Δq	(7) Δq	(8) Δq
$\Delta e_{COP/USD}$	-0.859	-0.797	-0.817	-1.299*	-1.012	-1.071	-0.810*	-0.643
	(0.510)	(0.608)	(0.588)	(0.672)	(0.850)	(1.333)	(0.405)	(0.490)
Observations	147,701	9,833	11,429	30,254	6,429	1,065	11,094	20,702
R-squared	0.283	0.282	0.272	0.315	0.310	0.485	0.290	0.228
Industry	M	15	17	18	19	20	21-22	24

	(9) Δq	(10) Δq	(11) Δq	(12) Δq	(13) Δq	(14) Δq	(15) Δq	(16) Δq
$\Delta e_{COP/USD}$	-1.067	-1.623**	-0.491	-0.480*	-0.615	-3.233***	-0.476	-0.352
	(0.631)	(0.723)	(0.664)	(0.261)	(0.550)	(0.897)	(0.531)	(0.441)
Observations	11,204	3,929	8,777	10,227	4,983	1,481	3,089	5,214
R-squared	0.264	0.291	0.273	0.280	0.305	0.409	0.319	0.179
Industry	25	26	28	29	31	32	33	34-35

ERPT: Export Quantities, Other Destinations

	(1) Δq	(2) Δq	(3) Δq	(4) Δq	(5) Δq	(6) Δq	(7) Δq	(8) Δq
$\Delta e_{COP/LCU}$	-0.432	0.213	0.177	0.229	-1.014*	-0.173	-0.253	0.423
	(0.290)	(0.248)	(0.237)	(0.214)	(0.474)	(0.453)	(0.479)	(0.631)
$\Delta e_{COP/USD}$		-0.946**		-0.149		-1.222**		-0.822
		(0.373)		(0.413)		(0.538)		(0.551)
Observations	131,194	131,194	14,723	14,723	34,683	34,683	10,176	10,176
R-squared	0.314	0.315	0.271	0.271	0.330	0.331	0.300	0.300
Industry	M	M	15	15	18	18	21-22	21-22

	(9) Δq	(10) Δq	(11) Δq	(12) Δq	(13) Δq	(14) Δq	(15) Δq	(16) Δq
$\Delta e_{COP/LCU}$	-0.487	0.620	-0.495	0.286	-0.0790	0.0172	1.319	3.612*
	(0.378)	(0.394)	(0.423)	(0.705)	(0.340)	(0.502)	(1.219)	(1.683)
$\Delta e_{COP/USD}$		-1.363**		-0.944		-0.118		-2.729**
		(0.485)		(0.627)		(0.573)		(0.961)
Observations	14,336	14,336	8,950	8,950	5,781	5,781	996	996
R-squared	0.266	0.269	0.305	0.306	0.327	0.327	0.319	0.325
Industry	24	24	25	25	28	28	32	32

ERPT: Import Quantities, Dollar Origins

	(1) Δq	(2) Δq	(3) Δq	(4) Δq	(5) Δq	(6) Δq	(7) Δq	(8) Δq
$\Delta e_{COP/USD}$	-0.891**	-0.637	-1.142*	-3.843**	-0.450	-0.672	-1.287***	-0.865*
	(0.355)	(0.621)	(0.620)	(1.455)	(0.850)	(0.822)	(0.418)	(0.402)
Observations	596,299	16,002	12,399	9,494	2,194	1,676	21,370	82,406
R-squared	0.167	0.246	0.267	0.307	0.316	0.297	0.247	0.169
Industry	M	15	17	18	19	20	21-22	24

	(9) Δq	(10) Δq	(11) Δq	(12) Δq	(13) Δq	(14) Δq	(15) Δq	(16) Δq
$\Delta e_{COP/USD}$	-0.830*	-0.493	-1.008**	-0.888***	-0.573	-0.922**	-0.749**	-1.295***
	(0.464)	(0.433)	(0.446)	(0.287)	(0.351)	(0.400)	(0.321)	(0.213)
Observations	51,837	10,367	61,091	137,848	59,367	22,899	51,836	32,668
R-squared	0.182	0.210	0.175	0.131	0.141	0.197	0.152	0.102
Industry	25	26	28	29	31	32	33	34-35

ERPT: Import Quantities, Other Origins

	(1) Δq	(2) Δq	(3) Δq	(4) Δq	(5) Δq	(6) Δq	(7) Δq	(8) Δq
$\Delta e_{COP/LCU}$	-0.500**	-0.248	-0.859**	-0.220	-0.644**	-0.265	-0.530**	-0.165
	(0.208)	(0.159)	(0.286)	(0.270)	(0.233)	(0.417)	(0.208)	(0.117)
$\Delta e_{COP/USD}$		-0.495		-0.781*		-0.452		-0.698*
		(0.327)		(0.379)		(0.459)		(0.346)
Observations	644,563	644,563	23,378	23,378	102,945	102,945	55,061	55,061
R-squared	0.202	0.202	0.240	0.241	0.188	0.189	0.228	0.228
Industry	M	M	17	17	24	24	25	25

	(9) Δq	(10) Δq	(11) Δq	(12) Δq	(13) Δq	(14) Δq	(15) Δq	(16) Δq
$\Delta e_{COP/LCU}$	-0.674**	-0.511*	-0.473**	-0.324**	-0.378	-0.184	-0.672**	-0.530**
	(0.222)	(0.260)	(0.182)	(0.142)	(0.249)	(0.160)	(0.248)	(0.243)
$\Delta e_{COP/USD}$		-0.223		-0.311		-0.689*		-0.261
		(0.532)		(0.261)		(0.318)		(0.234)
Observations	61,608	61,608	127,417	127,417	55,795	55,795	58,531	58,531
R-squared	0.215	0.215	0.177	0.177	0.180	0.181	0.080	0.080
Industry	28	28	29	29	31	31	34-35	34-35

Concluding Remarks

- I document differences across industries in two features that affect the ERPT: the share of imported inputs used in production and markup variation
- I find that the ERPT into import and export prices also varies greatly across 2-digit manufacturing sectors
- I find some evidence of the effect of the marginal cost channel on the ERPT on prices but no evidence of the effect of markup variability
- I find that, for most industries, the most relevant exchange rate for trade prices is the peso/dollar rate regardless of the destination or origin of trade
- In general, a peso depreciation is associated with a fairly small change in exports and a decline in imports