Invoicing and the Dynamics of Pricing-to-market

Evidence from UK Export Prices around the Brexit Referendum

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Introduction

- The extent to which import and export prices respond to exchange rate movements plays a key role in the international transmission of shocks and the design of the stabilization policy.
- In aggregate data, the **currency of invoicing** seems to be correlated with Exchange Rate Pass Through (ERPT).
- Notably, in *The International Price System* Gopinath (2015) stresses that widespread dollar-invoicing proves the dominant role of the dollar in goods trade and explains significant asymmetries in pass through.

This paper: What can we learn about the structure of the *International Price System* from detailed and granular analyses of invoicing currencies using transaction level data on British exporters?

Three questions

1. How do firms manage invoicing currencies? Do they use one or multiple currencies? Do they switch currencies over time?

2. Are invoicing currencies correlated with ERPT at the level of individual transactions? If yes, over which time frame?

3. Price adjustments incorporate both markup and marginal cost changes. Is the invoicing choice related to firms' strategic markup adjustments, i.e., pricing to market?

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   $\Rightarrow$ **Estimate destination-specific markup elasticities using the trade pattern fixed effects estimator (CCHS, 2019)**

Key definitions: Pass through vs. pricing to market

Price changes = (a) global markup adjustments +
(b) destination-specific markup adjustments +
(c) changes in marginal costs

1. **ERPT captures combination of (a), (b) and (c)**
   - ⇒ Event study of price responses to a large unilateral depreciation
2. **Pricing to market captures (b)**
   - ⇒ Our *trade pattern sequential fixed effects* (TPSFE) estimator exploits destination variation in export prices to control for changes in unobserved marginal cost (c) and global markup (a)
   - ⇒ It also reduces potential bias due to endogenous selection of destinations.

Data and key definitions: PCI, LCI and VCI

Unique dataset: Overseas Trade in Good Statistics from Her Majesty's Revenue and Customs (HMRC) covering the universe of UK trade (exports and imports). Since 2010, it includes info on the invoicing currency of a transaction (exception: no info for EU).

For each firm-product-destination-time observation, we categorize its invoicing currency scheme as:

- **Producer Currency Invoicing (PCI)** – transaction is invoiced using the producer's currency, e.g., sterling
- **Local Currency Invoicing (LCI)** – ...using the destination country's currency, e.g., yen or Canadian dollar
- **Vehicle Currency Invoicing (VCI)** – ...using a third country's currency, e.g., dollar

Literature

- **Invoicing currency and pass through**

  Goldberg and Tille (2008, 2016); Gopinath and Rigobon (2008); Gopinath, Itskhoki and Rigobon (2010); Fitzgerald and Haller (2014); Gopinath (2015); Chung (2016); Chen, Chung and Novy (2019); Bonadio, Fisher and Saure (2020); Amiti, Itskhoki and Konings (2020); Gopinath et al. (2020);

- **Pricing-to-market**

  Knetter (1989); Knetter (1993); Goldberg and Verboven (2001); Berman, Mayer and Martin (2012); Amit, Itskhoki and Konings (2014); Auer and Schoenle (2016); Fitzgerald and Haller (2018); Corsetti, Crowley, Han, and Song (2019)

Roadmap

1. New facts on granular invoicing currency choices
2. Invoicing and ERPT dynamics around the Brexit referendum
3. Invoicing and pricing-to-market

Stylized facts on invoicing: Summary

1. UK trade is dominated by firms with $>$ one invoicing currency
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3. Some UK exporters switch currency of invoicing year-to-year
   $\Rightarrow$ Among single-currency VC invoicers, 20% switch from VCI to PCI
4. The aggregate shares of invoicing currencies are different for exports and imports, but stable over time.
   $\Rightarrow$ UK extra-EU exports: 60% PCI, 1/3 VCI, $\approx$ 5% LCI
   $\Rightarrow$ UK extra-EU imports: 2/3 VCI, $\approx$ 1/3 LCI, small PCI

Fact 1: Firms invoice in more than one currency

UK exports, excluding the EU, 2010-2017

	No. of Destinations	No. of Invoicing Currencies: 1	2-5	6-10	10+	Total
by Share of Firms	1	35.2	6.4	0.0	0.0	41.6
	2-5	7.8	25.3	0.0	0.0	33.1
	6-10	0.4	10.4	0.1	0.0	10.9
	10+	0.1	12.7	1.5	0.2	14.4
	Total	43.4	54.8	1.5	0.2	100.0
by Share of Exports	1	0.4	0.6	0.0	0.0	1.0
	2-5	0.2	3.0	0.0	0.0	3.2
	6-10	0.0	3.9	0.1	0.0	4.1
	10+	0.0	30.4	26.7	34.5	91.7
	Total	0.7	38.0	26.9	34.5	100.0

$\Rightarrow$ **99.3% of export value originates from multi-currency exporters**

$\Rightarrow$ **only .7% of export value (43% of exporters) uses one currency.**

Top panel: share of UK exporters. Bottom panel: share of export value.

Fact 2: Firms use multiple currency for same product-firm-destination-year (ifdt)

	No. of Currencies	No. of Transactions	Share (%) Transactions	Share (%) Trade
UK Exports	1	5,134,053	84.0	49.4
	2	872,124	14.3	41.1
	3	92,631	1.5	8.0
	4 plus	9,833	0.2	1.5
	Total	6,108,641	100.0	100.0
UK Imports	1	6,804,261	87.7	66.1
	2	793,630	10.2	22.8
	3	122,946	1.6	6.0
	4 plus	40,464	0.5	5.1
	Total	7,761,301	100.0	100.0

$\Rightarrow$ **50.6% of exports of the same "ifdt" invoiced in multiple currencies**

$\Rightarrow$ **33.9% of imports by the same "ifdt" invoiced in multiple currencies**

Fact 3: Firms switch invoicing currency

Transition matrix of invoicing schemes
UK exports, excluding EU, annual, 2010-2017

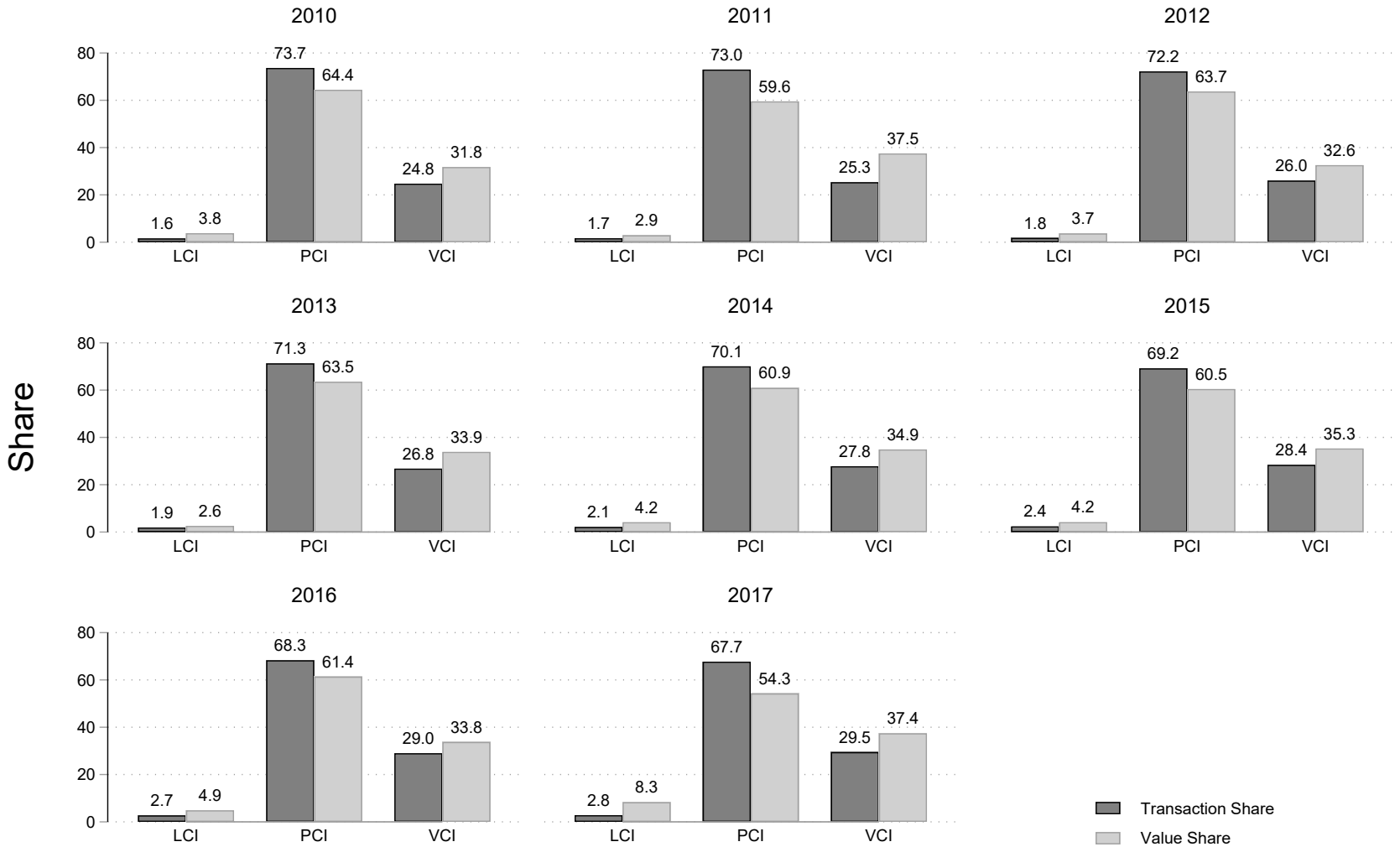
Matrix calculated based on single invoicing currency transactions at the exporter-product-destination level:

		To		
		LCI	PCI	VCI
From	LCI	76.44	18.11	5.45
	PCI	0.53	93.32	6.14
	VCI	0.52	17.07	82.41

A substantial share of UK exporters switch their invoicing scheme from year to year.

Fact 4: Agg. shares of invoicing currencies stable

UK exports, excluding the EU and the US



ERPT Dynamics after a Large Devaluation

Main findings from the Brexit Event Study

Against the large depreciation following the Brexit referendum:

- In the short run, sterling prices remained stable for PCI transactions, they rose quickly for VCI and LCI transactions.

- Over 18 months, differences across currency schemes narrowed as prices tended toward alignment with the weaker pound.

  $\Rightarrow$ The alignment to higher sterling export prices likely reflects increases in the cost of imported inputs

  $\Rightarrow$ Sterling prices of imports fully adjusted to the weaker pound by week 36 after the referendum.

ERPT dynamics around Brexit

Estimation equation

Econometric analysis of weekly ERPT (see e.g. Bonadio Fisher and Saure 2020):

$$y_{ifdct} = \delta_{ifd} + \lambda_{ct} + u_{ifdct} \quad y \in \{p_{ifdct}, e_{dt}\} \tag{1}$$

where

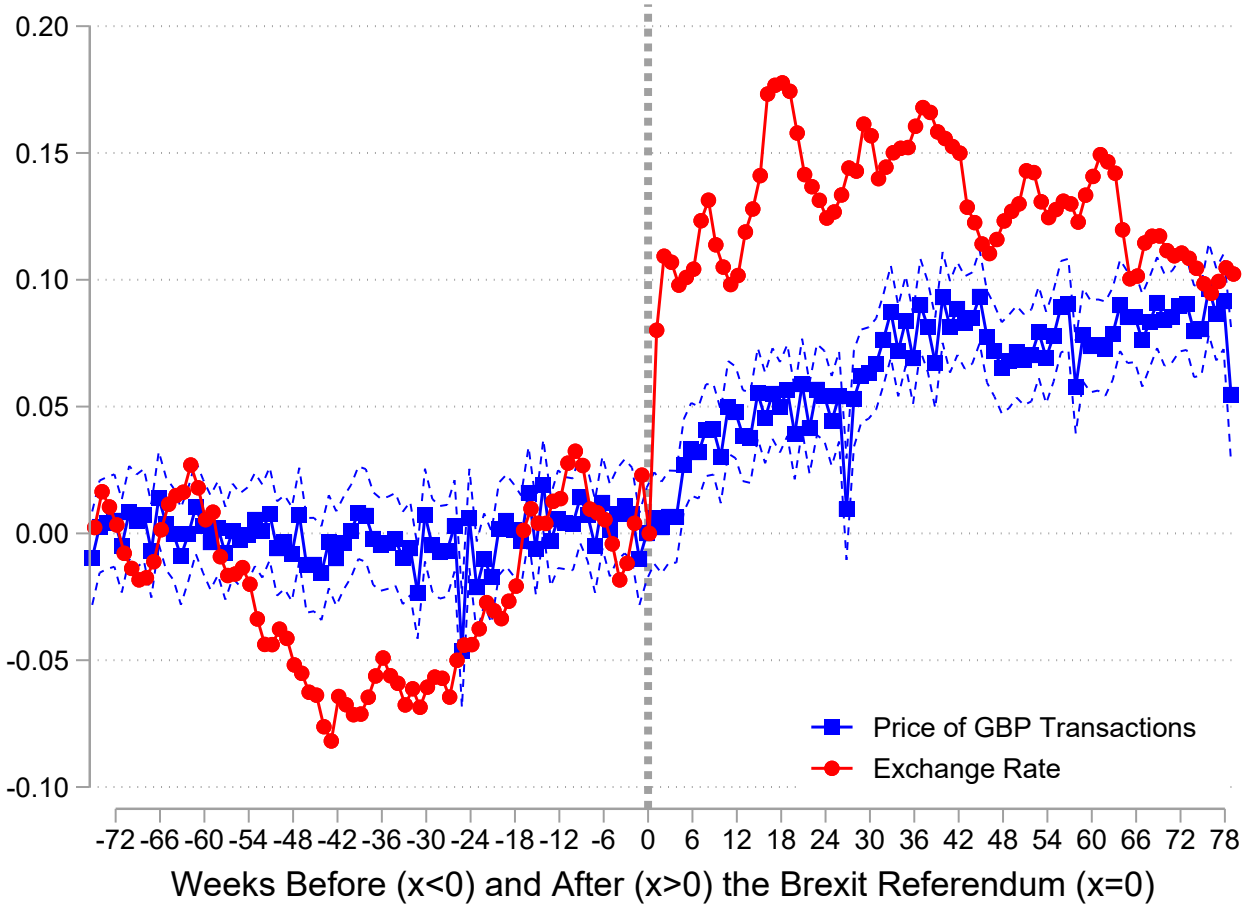
- i, f, d, c, t represent product, firm, destination country, currency and *week* respectively.
- δ_{ifd}: firm-product-destination fixed effects
- $\lambda_{c\tau}$ is a bunch of week dummies capturing the average price/exchange rate changes

$\Rightarrow$ Equation (1) is estimated for each invoicing currency scheme.

ERPT dynamics around Brexit

Weekly pass through after the Brexit referendum

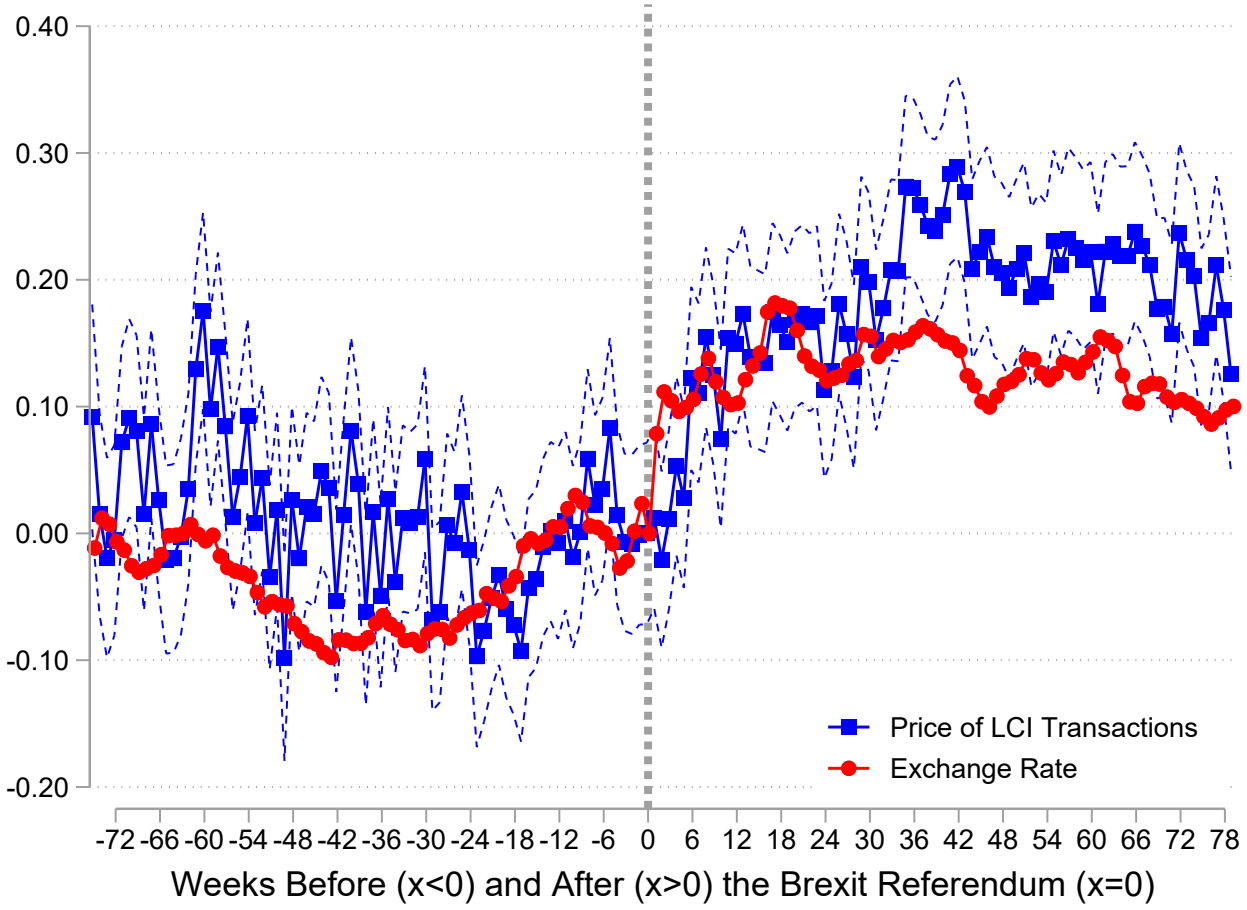
Weekly Price Changes of **Sterling** Invoiced Transactions **2015-2017**



ERPT dynamics around Brexit

Weekly pass through after the Brexit referendum

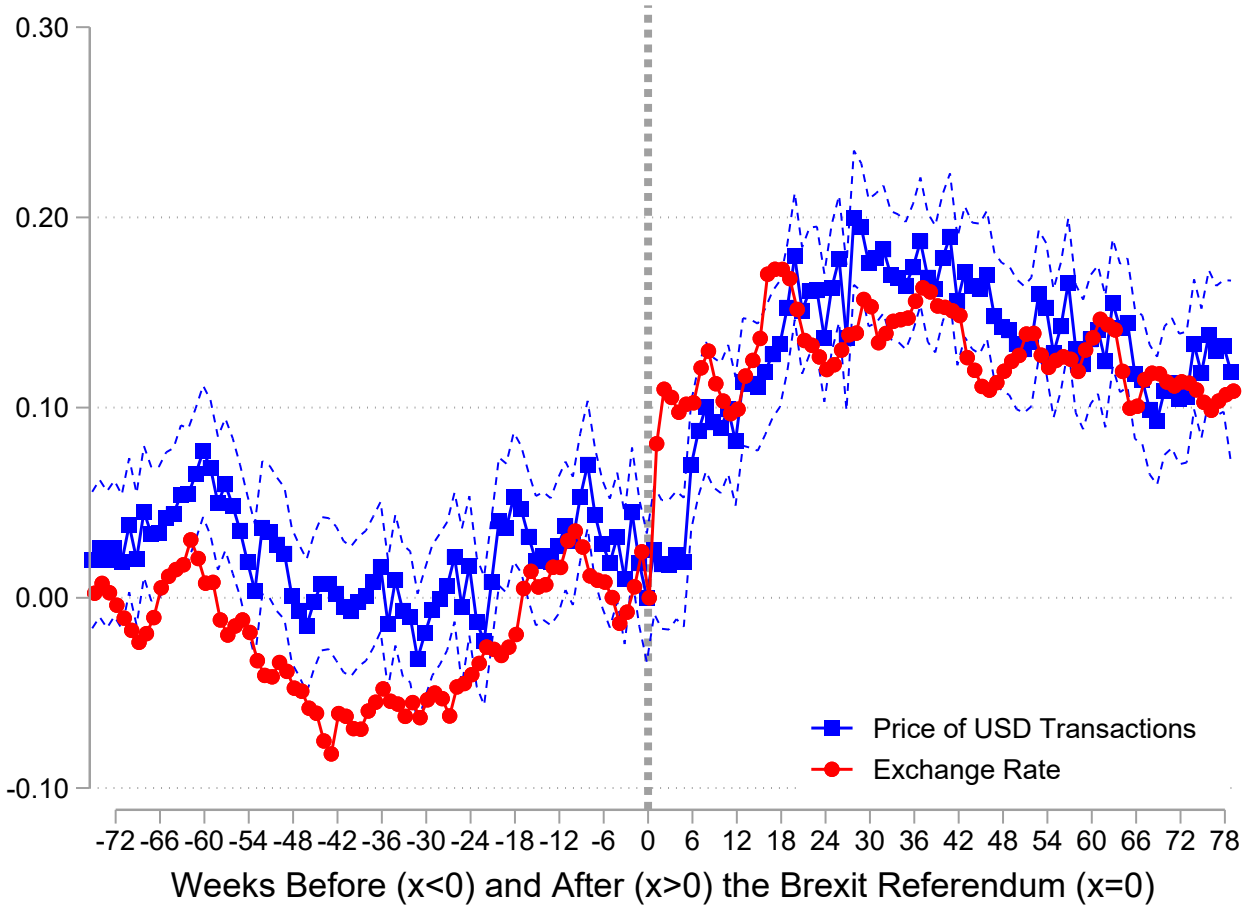
Weekly Price Changes of **Local Currency** Invoiced Transactions **2015-2017**



ERPT dynamics around Brexit

Weekly pass through after the Brexit referendum

Weekly Price Changes of **Dollar** Invoiced Transactions **2015-2017**



ERPT vs pricing to market

Recall again

Price changes = (a) global markup adjustments +
(b) destination-specific markup adjustments+
(c) changes in marginal costs

1. ERPT regressions capture (a), (b) and (c).
2. DSME Captures (b), i.e., pricing-to-market

ERPT and Pricing to Market: Main findings

Trade Pattern Fixed Effects Approach 2010-2017

- Export price elasticity to the exchange rate=1-ERPT:
  - $\Rightarrow$ PCI (£) transactions: 0.24*** $\Rightarrow$ ERPT: 76%
  - $\Rightarrow$ VCI ($) transactions: 0.35*** $\Rightarrow$ ERPT: 65%
  - $\Rightarrow$ LCI transactions: 0.63*** $\Rightarrow$ ERPT: 37%

  Local currency invoicing $\rightarrow$ lower ERPT.

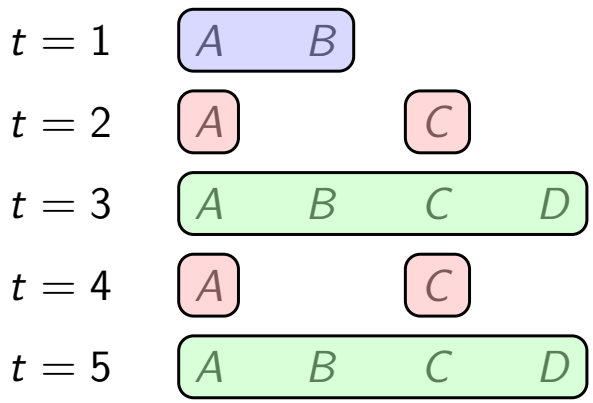
- Destination-specific markup elasticity to exchange rate (DSME):
  - $\Rightarrow$ Producer currency (£) invoiced transactions: 0.03
  - $\Rightarrow$ Vehicle currency ($) invoiced transactions: 0.06
  - $\Rightarrow$ Local currency invoiced transactions: 0.43***

  Only LCI implies pricing to market

Trade Pattern Fixed Effects

Consider a firm exporting a product to four countries, A through D, over 5 time periods, according to the following (typical) pattern:

Observed Trade Patterns



where empty elements in the matrix indicate that there was no trade. Trade patterns: AC at t=2 and 4; ABCD at t=3 and 5.

If the factors that determine a firm's selection of a set of destinations are relatively stable, then controlling for the firm's trade pattern helps address selection bias (see CCHS 2019).

Estimating equation for DSME

Using Trade Patterns sequentially

For each firm-product pair, calculate the average price in each period; then extract destination-specific price residuals.

Regress price residuals on destination-demeaned exchange rates and the trade pattern fixed effects.

$$\widetilde{p}_{ifdt,D_{ift}} = \kappa_0 + \kappa_1 \widetilde{e}_{dt,D_{ift}} + \kappa_2 \widetilde{cpi}_{dt,D_{ift}} + TP_{d,D_{ift}} + \widetilde{u}_{ifdt,D_{ift}}$$

- κ_1 is the DSME
- The trade pattern dummies, $TP_{d,D_{ift}}$, capture the observation's destination (JP) and its trade pattern (VN-KR-IND-JP).
- D_{ift} is an **additional panel dimension** that captures the trade pattern for a firm, product and time period.
- Thus, the price and the exchange rate are now expressed in deviations from trade pattern means, i.e., $\widetilde{e}_{dt,D_{ift}}$ instead of e_{dt}

Estimating equation of price elasticity (1-ERPT)

Including Trade Pattern FEs

Regress prices on exchange rates and the trade pattern fixed effects.

$$p_{ifdt} = \gamma_0 + \gamma_1 e_{dt} + \gamma_2 cpi_{dt} + TP_{d,D_{ift}} + u_{ifdt}$$

where

- γ_1 is the price elasticity $\equiv 1 - ERPT$.
- The trade pattern dummies, $TP_{d,D_{ift}}$, capture the observation's destination (say, JP) and its trade pattern (say, VN-KR-IND-JP).

Price and markup elasticities

UK extra-EU exports 2010-2017, monthly frequency

	(1) All
Price	0.35***
Markup	0.09***
Observations	7,808,005

Notes: Export prices denominated in £. Exchange rates in pounds per foreign currency; increase ⇒ foreign currency appreciation.

Against a 1% increase in foreign currency

⇒ export prices in sterling rise by 0.35%

export prices in foreign currency fall by 1-0.35 = 0.65%

ERPT is incomplete = 65%

⇒ the destination-specific markup (in £) increases by 0.09%

26% (=0.09/0.35) due to destination specific markup adjustments.

Price and markup elasticities: 2010-2017

UK extra-EU exports by invoicing currency, monthly frequency

ERPT

	(1) All	(2) PCI	(3) VCI	(4) LCI
Price	0.35***	0.24***	0.35***	0.63***
Implied ERPT	**65%**	**76%**	**65%**	**37%**
Markup	0.09***	0.03	0.06	0.43***
Observations	7,808,005	5,132,214	1,759,815	915,976

$\Rightarrow$ **ERPT is high for PCI and VCI transactions**

Export prices denominated in £. Exchange rates in pounds per foreign currency: increase $\Rightarrow$ foreign currency appreciation.

Price and markup elasticities: 2010-2017

UK extra-EU exports by invoicing currency, monthly frequency

Destination Specific Markup Elasticity (DSME)

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Implied ERPT	65%	76%	65%	37%
Markup	0.09***	**0.03**	**0.06**	**0.43*** **
Observations	7,808,005	5,132,214	1,759,815	915,976

$\Rightarrow$ **No destination specific markup adjustments for PCI and VCI**

Export prices denominated in £. Exchange rates in pounds per foreign currency: increase $\Rightarrow$ foreign currency appreciation.

Price and markup elasticities: 2010-2017

UK extra-EU exports by invoicing currency, monthly frequency

DSME and incomplete ERPT

	(1) All	(2) PCI	(3) VCI	(4) LCI
Price	0.35***	0.24***	0.35***	0.63***
Markup	0.09***	0.03	0.06	0.43***
Observations	7,808,005	5,132,214	1,759,815	915,976
Incomplete ERPT due to destination-specific markup adjustments				
	26%	**0**	**0**	**68%**

Export prices denominated in £. Exchange rates in pounds per foreign currency: increase ⇒ foreign currency appreciation.

Conclusions

We find supporting evidence on International Price System and that firms use invoice currencies as an instrument to implement their pricing strategies:

- The lion's share (99%) of trade is conducted by firms invoicing in multiple currencies.
- In response to the large sterling depreciation after the Brexit referendum, local and vehicle currency invoiced transactions demonstrate faster price adjustments than producer currency invoiced transactions.
- Only local currency invoiced transactions demonstrate destination specific markup adjustments; vehicle and producer currency invoiced transactions do not response to destination specific shocks $\Rightarrow$ Firms price discriminate by invoicing their products in local currencies.

Invoicing currencies around Brexit

Aggregate level invoicing currency decomposition remains unchanged

Transaction share of invoicing currencies (Extra-EU exports)