

Invoicing and Pricing-to-Market

A Study of Price and Markup Elasticities of UK Exporters

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The question

How do firms set prices for different export markets? Is there a relationship between the currency in which exports are invoiced and the firm's pricing strategy?

- New research seeks to understand puzzles in international pricing by examining the currency in which trade transactions are invoiced.
- Gopinath's (2015) International Pricing System explains the unique role of the US dollar in international transactions as an explanation for puzzling asymmetries across countries in exchange rate pass through (ERPT).

Exchange rate pass through and invoicing currency

In *The International Pricing System*, Gopinath (2015) documents:
Exchange rate pass through into import prices after 2 years:

- US – 44%
- Japan – 90%
- Turkey – 100%

This appears to be related to the high share of trade invoiced in one's own versus a foreign currency:

- 60% of Turkey's imports are invoiced in dollars, but only 6% of its imports from the US.
- 71% of Japan's imports are invoiced in dollars, but only 13% of its imports from the US.
- 93% of the US's imports are invoiced in dollars.

What does this paper do?

We use a unique micro dataset covering the universe of UK trade to countries outside the EU to examine the relationship between pricing strategy by a firm and the currency in which the firm invoices its trade.

What does this paper do?

Documents that aggregates shares of invoicing currencies are stable over time (7 years), but finds substantial heterogeneity and churning in the choices of invoicing currencies across firms, within firms, and over time.

- 99% of UK exports to destinations outside the EU originate from firms that use two or more invoicing currencies.
- Nearly 40% of UK exports to extra-EU destinations are conducted by firms that use two of more invoicing currencies for selling the same product to the same country within the same calendar year.

Analyzes firms' price and markup adjustments to relative changes in economic conditions across markets **conditional on the currency in which the export transaction is invoiced.**

Why does an invoicing currency matter?

- The **pricing currency of a good** is the currency in which the firm strategically sets price to optimize profits.
- The **invoicing currency of a good** is the currency in which the transaction between a buyer and seller is invoiced.

Does pricing currency = invoicing currency ?

Estimating price and markup elasticities to bilateral exchange rates and CPI **conditional on the invoicing currency**, we conclude

- ① invoicing currency is a good proxy for pricing currency and
- ② firms practice different pricing strategies (global pricing vs. local pricing) through the choice of invoicing currency(ies).

Preview of Results

- Export price elasticity to the exchange rate (ERPT):
 - Producer currency (£) invoiced transactions: 0.098 (90.2%)
 - Vehicle currency (\$, €) invoiced transactions: 0.173 (82.7%)
 - Local currency invoiced transactions: 0.529 (47.1%)

Local currency invoiced transactions characterised by **highly incomplete exchange rate pass through**.

- Destination-specific markup elasticity to exchange rate (DSME):
 - Producer currency (£) invoiced transactions: 0.029
 - Vehicle currency (\$, €) invoiced transactions: -0.004
 - Local currency invoiced transactions: 0.453

85% of the incomplete pass through of LCI transactions is due to the exporter **adjusting the markup in the destination**.

Literature

▶ Pricing-to-market and exchange rates

e.g., Knetter (1989); Knetter (1993); Goldberg and Verboven (2001); Gopinath and Rigobon (2008); Gopinath, Itskhoki and Rigobon (2010); Berman, Mayer and Martin (2012); Amit, Itskhoki and Konings (2014); Fitzgerald and Haller (2014); Auer and Schoenle (2016)

▶ Variable markups, trade elasticities, and export dynamics

e.g., Dornbush (1987); Atkeson and Burstein (2008); Corsetti and Dedola (2005), De Blas and Russ (2015); Fitzgerald, Haller and Yedid-Levi (2016)

▶ Welfare gains and the pro-competitive effect of trade

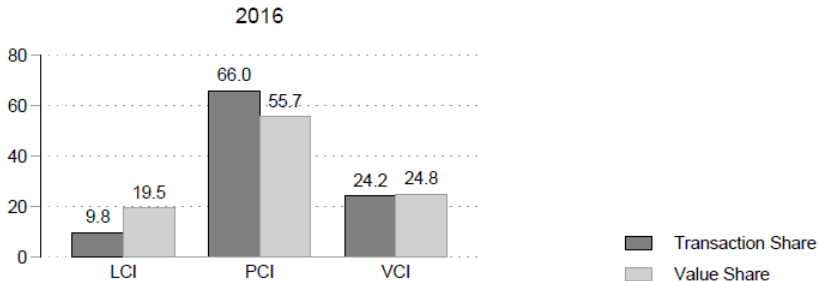
e.g., Feenstra and Weinstein (2017); Arkolakis, et al. (2018)

▶ Exchange rates pass through and macro/stabilization policy

e.g., Corsetti, Dedola and Leduc (2008, 2010 Handbook, 2018), Engel (2011), Gopinath (2015); Casas et al. (2017)

Aggregate Shares of invoicing schemes

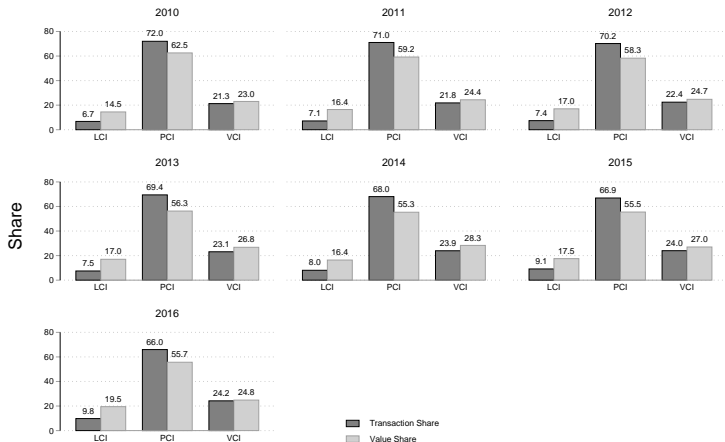
UK exports to countries except the EU (2016)



- 20% of UK exports invoiced in destination (local) currency (LCI)
- 55% of UK exports invoiced in sterling (PCI)
- 25% of UK exports invoiced in vehicle currency (VCI) (\$, €, ¥)

Aggregate composition of invoicing schemes

UK exports to countries except the EU



Aggregate share of each invoicing scheme is stable over 2010-2016

Number of Destinations vs. Invoicing Currencies

UK exports to countries except the EU (2010-2016)

No. of Destinations		No. of Invoicing Currencies				Total
		1	2-5	6-10	10+	
by Share of Firms	1	34.8	6.4	0.0	0.0	41.2
	2-5	7.8	25.6	0.0	0.0	33.5
	6-10	0.3	10.6	0.1	0.0	11.0
	10+	0.1	12.8	1.4	0.2	14.4
	Total	43.1	55.3	1.4	0.2	100.0
by Share of Exports	1	0.4	0.6	0.0	0.0	1.0
	2-5	0.4	3.0	0.0	0.0	3.5
	6-10	0.0	5.1	0.1	0.0	5.2
	10+	0.0	32.9	26.8	30.6	90.3
	Total	0.9	41.6	26.9	30.6	100.0

⇒ **99.1% of export value originates from multi-currency exporters**

Notes: Top panel shows the percentage of obs. in the UK customs data that falls under the relevant description. Bottom panel presents the corresponding value of exports.

Number of Products vs. Invoicing Currencies

UK exports to countries except the EU (2010-2016)

No. of Products		No. of Invoicing Currencies				Total
		1	2-5	6-10	10+	
by Share of Firms	1	29.5	2.1	0.0	0.0	31.6
	2-5	11.9	19.7	0.0	0.0	31.6
	6-10	1.2	11.3	0.0	0.0	12.6
	10+	0.4	22.2	1.4	0.2	24.2
	Total	43.1	55.3	1.4	0.2	100.0
by Share of Exports	1	0.6	0.3	0.0	0.0	0.8
	2-5	0.2	1.9	0.0	0.0	2.2
	6-10	0.1	3.4	0.9	0.3	4.7
	10+	0.0	36.0	26.0	30.2	92.2
	Total	0.9	41.6	26.9	30.6	100.0

⇒ **93.3% of single-product exporters use only one currency.**

⇒ **80.1% of multi-product firms use two or more currencies.**

Notes: Top panel shows the percentage of obs. in the UK customs data that falls under the relevant description. Bottom panel presents corresponding value of exports.

Number of Products vs. Destinations

UK exports to countries except the EU (2010-2016)

	No. of Products	No. of Destinations				Total
		1	2-5	6-10	10+	
by Share of Firms	1	29.5	2.0	0.1	0.0	31.6
	2-5	9.8	20.2	1.3	0.3	31.6
	6-10	1.2	7.0	3.4	0.9	12.6
	10+	0.7	4.3	6.2	13.1	24.2
	Total	41.2	33.5	11.0	14.4	100.0
by Share of Exports	1	0.4	0.4	0.0	0.0	0.8
	2-5	0.5	1.0	0.5	0.3	2.2
	6-10	0.1	0.8	1.9	2.0	4.7
	10+	0.1	1.3	2.9	88.0	92.2
	Total	1.0	3.5	5.2	90.3	100.0

⇒ **Multi-product, multi-destination firms originate 98.7% of UK exports to countries outside the EU.**

Notes: Top panel shows the percentage of obs. in the UK customs data that falls under the relevant description. Bottom panel presents corresponding value of exports.

Invoicing Scheme and No. of Destinations

UK exports to countries except the EU (2010-2016)

		No. of Destinations	Invoicing Scheme			
			LCI	PCI	VCI	Total
by Share of Firms	1		3.9	23.8	4.6	32.4
	2-5		6.4	20.2	8.4	35.1
	6-10		3.6	6.2	4.5	14.3
	10+		5.4	6.6	6.1	18.2
	Total		19.3	56.9	23.7	100.0
by Share of Exports	1		0.3	1.5	0.3	2.1
	2-5		0.7	4.0	0.8	5.5
	6-10		1.0	5.1	2.4	8.4
	10+		17.2	43.8	23.0	84.0
	Total		19.1	54.3	26.5	100.0

⇒ **Producer currency invoicing dominates UK exports**

⇒ **LCI and VCI observed for firms exporting to many destinations**

Notes: Top panel shows the percentage of obs. in the UK customs data that falls under the relevant description. Bottom panel presents corresponding value of exports.

Invoicing Scheme and No. of Products

UK exports to countries except the EU (2010-2016)

	No. of Products	Invoicing Scheme			
		LCI	PCI	VCI	Total
by Share of Firms	1	3.0	19.4	4.3	26.7
	2-5	6.9	22.6	8.5	38.1
	6-10	3.9	7.4	4.6	15.8
	10+	5.5	7.6	6.3	19.5
	Total	19.3	56.9	23.7	100.0
by Share of Exports	1	0.2	1.0	0.3	1.4
	2-5	1.1	4.5	1.3	6.9
	6-10	1.2	5.4	2.1	8.7
	10+	16.7	43.5	22.8	83.0
	Total	19.1	54.3	26.5	100.0

⇒ **LCI and VCI observed for firms exporting many products**

Notes: Top panel shows the percentage of obs. in the UK customs data that falls under the relevant description. Bottom panel presents the corresponding value of exports.

Multi-currency Invoicing

for each firm-product-destination-year quartet

	No. of Currencies	No. of Transactions	Share (%) Transactions	Share (%) Trade
UK Exports	1	4,355,750	84.1	51.6
	2	737,868	14.2	39.0
	3	77,538	1.5	7.9
	4+	8,261	0.2	1.5
	Total	5,179,417	100.0	100.0
UK Imports	1	5,901,697	87.7	67.0
	2	686,228	10.2	21.8
	3	106,545	1.6	5.9
	4+	34,016	0.5	5.3
	Total	6,728,486	100.0	100.0

⇒ **48.4%** of exports by a firm to the same country
with the same product within a year use multiple currencies

⇒ **33.0%** of imports by f-p-d-t use multiple currencies

Transition Matrix of Invoicing Schemes

UK exports to countries except the EU (2010-2016)

	To			
		LCI	PCI	VCI
From	LCI	81.26	17.10	1.63
	PCI	1.99	92.68	5.34
	VCI	0.64	17.34	82.02

Note: This transition matrix is generated conditional on single invoicing currency transactions at the exporter-product-destination level.

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

Transition Matrix of Invoicing Schemes

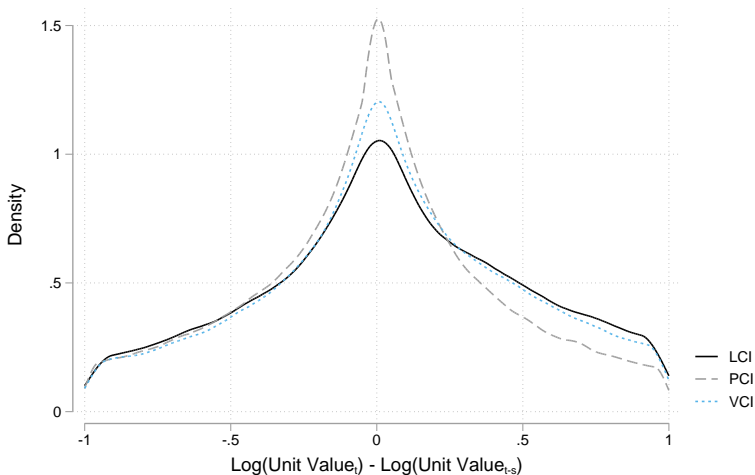
UK imports from non-EU countries

	To			
		LCI	PCI	VCI
From	LCI	92.79	1.68	5.53
	PCI	1.46	97.24	1.30
	VCI	1.81	0.51	97.68

Note: This transition matrix is generated conditional on single invoicing currency transactions at the exporter-product-destination level.

The invoicing scheme choice for UK importers is more persistent than that for UK exporters.

Distribution of Annual Price Changes of UK Exports to countries outside the EU 2010-2016



Note: Density is calculated only if $-1 < \text{Log}(\text{Unit Value}_t) - \text{Log}(\text{Unit Value}_{t-s}) < 1$

Estimating Equation for Export Price Elasticity

Dependent variable is the change in the export price in sterling.

$$\Delta_{s|ifcdt} p_{ifcdt} = \beta_1 \Delta_{s|ifcdt} e_{dt} + \beta_2 \Delta_{s|ifcdt} cpi_{dt} + \Delta_{s|ifcdt} \epsilon_{ifcdt}$$

where

- where $i, f, c, d, & t$ represent product, firm, invoicing currency, destination country, & time
- e_{dt} is the sterling-destination rate – an **increase of e_{dt}** means an **appreciation of the destination country currency**
- cpi is the CPI index in the destination country

β_1 is the export price elasticity

$\beta_1 = 1 - \text{Exchange Rate Pass Through (ERPT) into import prices}$

Destination Specific Markup Elasticity (DSME)

To examine the pricing strategy of the firm and how this relates to the currency of invoicing, we need to understand not only how responsive the export price is to bilateral exchange rate changes, but also the extent to which the firm pursues a policy of pricing to local conditions (local CPI, bilateral exchange rate, local demand conditions) or global conditions.

We use the destination-specific markup elasticity of Corsetti, Crowley, Han and Song (2018) for different invoicing schemes to uncover differences in how firms practice local versus global adjustments of markups.

DSME: Trade Pattern Fixed Effects

Consider a firm exporting a product to four countries, A through D, over 5 time periods. Empty elements in the matrix indicate that there was no trade.

Observed Trade Patterns

$t = 1$	A	B		
$t = 2$	A		C	
$t = 3$	A	B	C	D
$t = 4$	A		C	
$t = 5$	A	B	C	D

To estimate the markup elasticity, we compare price residuals at $t = 2$ with $t = 4$ and $t = 3$ with $t = 5$.

DSME: Trade Pattern Fixed Effects

$$\begin{bmatrix}
 p_{A,1} & p_{B,1} & \cdot & \cdot \\
 p_{A,2} & \cdot & p_{C,2} & \cdot \\
 p_{A,3} & p_{B,3} & p_{C,3} & p_{D,3} \\
 p_{A,4} & \cdot & p_{C,4} & \cdot \\
 p_{A,5} & p_{B,5} & p_{C,5} & p_{D,5}
 \end{bmatrix}
 =
 \begin{bmatrix}
 \tilde{p}_{A,1} + \bar{p}_1 & \tilde{p}_{B,1} + \bar{p}_1 & \cdot & \cdot \\
 \tilde{p}_{A,2} + \bar{p}_2 & \cdot & \tilde{p}_{C,2} + \bar{p}_2 & \cdot \\
 \tilde{p}_{A,3} + \bar{p}_3 & \tilde{p}_{B,3} + \bar{p}_3 & \tilde{p}_{C,3} + \bar{p}_3 & \tilde{p}_{D,3} + \bar{p}_3 \\
 \tilde{p}_{A,4} + \bar{p}_4 & \cdot & \tilde{p}_{C,4} + \bar{p}_4 & \cdot \\
 \tilde{p}_{A,5} + \bar{p}_5 & \tilde{p}_{B,5} + \bar{p}_5 & \tilde{p}_{C,5} + \bar{p}_5 & \tilde{p}_{D,5} + \bar{p}_5
 \end{bmatrix}$$

$$=
 \begin{bmatrix}
 \mu_{A,1} + (\mu + mc)_{AB,1} & \mu_{B,1} + (\mu + mc)_{AB,1} & \cdot & \cdot \\
 \mu_{A,2} + (\mu + mc)_{AC,2} & \cdot & \mu_{C,2} + (\mu + mc)_{AC,2} & \cdot \\
 \mu_{A,3} + (\mu + mc)_{ABCD,3} & \mu_{B,3} + (\mu + mc)_{ABCD,3} & \mu_{C,3} + (\mu + mc)_{ABCD,3} & \mu_{D,3} + (\mu + mc)_{ABCD,3} \\
 \mu_{A,4} + (\mu + mc)_{AC,4} & \cdot & \mu_{C,4} + (\mu + mc)_{AC,4} & \cdot \\
 \mu_{A,5} + (\mu + mc)_{ABCD,5} & \mu_{B,5} + (\mu + mc)_{ABCD,5} & \mu_{C,5} + (\mu + mc)_{ABCD,5} & \mu_{D,5} + (\mu + mc)_{ABCD,5}
 \end{bmatrix}$$

- For each firm-product pair, calculate the average price in each period; then extract destination-specific price residuals.
- The average price in a period is equal to the common markup and the average marginal cost.
- Estimate the markup elasticity by comparing price residuals over time within the same trade pattern.

Estimating Equation for DSME

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

$$\tilde{p}_{ifdt, D_{ift}} = \kappa_0 + \kappa_1 \tilde{e}_{dt, D_{ift}} + \tilde{X}'_{dt, D_{ift}} \kappa_2 + TP_{ifd, D_{ift}} + \tilde{u}_{ifdt, D_{ift}}$$

where

- κ_1 is the DSME
- D_{ift} is an additional dimension of the dataset that denotes the set of destinations, e.g. VN-KR-JP, associated with the firm and product in that time period.
- The trade pattern dummies, $TP_{ifd, D_{ift}}$, capture the observation's destination (JP) and its trade pattern (VN-KR-JP).

Price and Markup Elasticities

by Invoicing Currency Schemes: UK exports 2010-2016

		(1)
		All
Price	Bil. exchange rates	0.141*** (0.0100)
	Dest. CPI	0.232*** (0.0198)
Markup	Bil. exchange rates	0.0611*** (0.0222)
	Dest. CPI	0.0569 (0.0421)
Observations		2,627,778

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

A 1% increase in foreign currency

- \Rightarrow export prices in sterling rise by 0.14%,
- \Rightarrow export prices in foreign currency fall by $1-0.14=0.86\%$.
- \Rightarrow the destination-specific markup (in £) increases by 0.06%.

ERPT is 86%.

- 42.9% ($=0.06/0.14$) of incomplete pass through due to destination specific markup adjustments.

Price and Markup Elasticities: 2010-2016

Variation in ERPT by invoicing currency scheme

		(1) All	(2) PCI	(3) LCI	(4) VCI
Price	Bil. exchange rates	0.141*** (0.0100)	0.0978*** (0.0121)	0.529*** (0.0454)	0.173*** (0.0198)
	Dest. CPI	0.232*** (0.0198)	0.197*** (0.0247)	1.140*** (0.270)	0.237*** (0.0341)
	ERPT	86%	91%	47%	83%
Markup	Bil. exchange rates	0.0611*** (0.0222)	0.0299 (0.0275)	0.453*** (0.0694)	-0.00456 (0.0535)
	Dest. CPI	0.0569 (0.0421)	0.0445 (0.0533)	0.698** (0.275)	-0.101 (0.0909)
	Observations	2,627,778	1,826,450	241,847	559,481

⇒ **ERPT is different - more incomplete - for LCI**

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

Price and Markup Elasticities: 2010-2016

Variation in DSME by invoicing currency scheme

		(1) All	(2) PCI	(3) LCI	(4) VCI
Price	Bil. exchange rates	0.141*** (0.0100)	0.0978*** (0.0121)	0.529*** (0.0454)	0.173*** (0.0198)
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Observations		2,627,778	1,826,450	241,847	559,481

⇒ **DSME is different - larger - for LCI**

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

Price and Markup Elasticities: 2010-2016

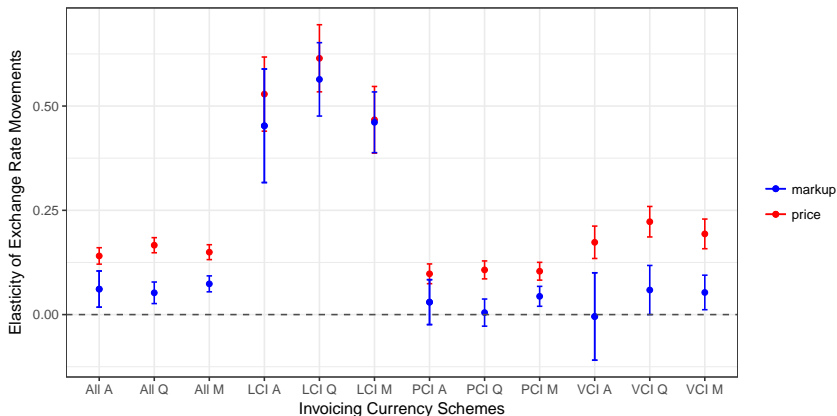
Destination-specific markup adjustments and incomplete ERPT

		(1) All	(2) PCI	(3) LCI	(4) VCI
Price	Bil. exchange rates	0.141*** (0.0100)	0.0978*** (0.0121)	0.529*** (0.0454)	0.173*** (0.0198)
	Dest. CPI	0.232*** (0.0198)	0.197*** (0.0247)	1.140*** (0.270)	0.237*** (0.0341)
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	Dest. CPI	0.0569 (0.0421)	0.0445 (0.0533)	0.698** (0.275)	-0.101 (0.0909)
Observations		2,627,778	1,826,450	241,847	559,481
Percent of incomplete ERPT due to destination-specific markup adjustments					
		43.3	0	85.6	0

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

Price and Markup Elasticities at Different Time Frequencies

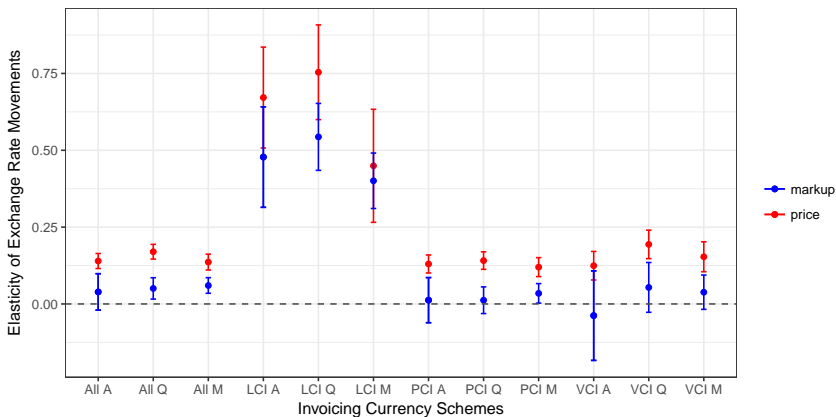
Estimates Not Conditional on a Price Change



- Repeat the analysis at Annual, Quarterly and Monthly frequencies.
- Price and markup elasticities are **large for transactions invoiced in local currency**.

Price and Markup Elasticities at Different Time Frequencies

Estimates Conditional on a Price Change



- Repeat the analysis at all frequencies **conditional on a price change**.
- Estimates are slightly larger when we condition on a price change.

Price and Markup Elasticities

to destinations outside the EU: 2010-2016

Freq.	Invoicing	Price		Markup		n. of obs
		NEX	CPI	NEX	CPI	
Annual	All	0.12***	0.23***	0.06***	0.04	4,012,102
	PCI	0.10***	0.20***	0.03	0.04	1,826,450
	VCI	0.17***	0.24***	-0.01	-0.10	560,647
	LCI	0.53***	1.14***	0.45***	0.70***	241,847
Quarterly	All	0.14***	0.29***	0.05***	0.01	8,027,936
	PCI	0.11***	0.24***	0.00	-0.00	3,630,749
	VCI	0.22***	0.29***	0.06*	0.08*	1,156,735
	LCI	0.61***	0.95***	0.56***	0.69***	530,898
Monthly	All	0.13***	0.28***	0.07***	0.02	11,262,051
	PCI	0.10***	0.23***	0.04***	0.01	5,035,833
	VCI	0.19***	0.28***	0.05***	0.01	1,680,880
	LCI	0.47***	0.85***	0.46***	0.38***	844,708

⇒ Increases in local CPI are fully-passed through into prices for LCI

⇒ Increases in local CPI are passed through to markups only for LCI

Price and Markup Elasticities

to EU destinations 2010-2016

Freq.	Price		Markup		n. of obs
	NEX	CPI	NEX	CPI	
Annual	0.39***	1.01***	-	0.81***	6,337,540
Quarterly	0.39***	1.13***	-	0.83***	15,682,483
Monthly	0.34***	1.13***	-	0.92***	29,256,147

- For exports to EU, we do not know the invoicing currency.
- The pattern for price elasticities on sales to EU are similar to those for LCI exports to countries outside the EU.
- Destination-specific markup elasticity to local CPI in EU countries is high - like LCI for countries outside the EU.

Price and Markup Elasticities

to Non-EU versus All Destinations: 2010-2016

Freq.	Exports	Price		Markup		n. of obs
		NEX	CPI	NEX	CPI	
Annual	Non-EU	0.12***	0.21***	0.04**	0.03	2,452,617
	All countries	0.26***	0.47***	0.01	0.21***	8,790,157
Quarterly	Non-EU	0.15***	0.28***	0.05***	0.02	4,320,523
	All countries	0.27***	0.53***	0.04***	0.31***	20,003,006
Monthly	Non-EU	0.12***	0.28***	0.07***	0.01	5,147,450
	All countries	0.25***	0.60***	0.09***	0.48***	34,403,597

Notes: Estimates conditional on a price change. Statistical significance is based on robust standard errors. ***, **, * stand for 1%, 5%, and 10% significance level respectively.

Conclusions

Using unique data from the UK that reports the invoicing currency of trade transactions, we document three important new facts:

- ① The aggregate shares of invoicing currency schemes – producer currency invoicing, vehicle currency invoicing, and local currency invoicing – are stable over time.
- ② Multi-product, multi-destination firms use local currency invoicing and vehicle invoicing more often than firms with fewer products or destinations.
 - And a large share ($\approx 50\%$ of trade by a firm selling the same product in the same destination uses multiple invoicing currencies.
- ③ Exporting firms switch their invoicing currency scheme over time.

Conclusions

Estimates of price and destination-specific markup elasticities to bilateral exchange rates and CPI suggest that the **invoicing currency is a good proxy for the firm's pricing strategy.**

Firms that invoice in local currency practice extensive pricing to market - changing conditions in the local destination are reflected in substantial destination-specific markup adjustments.

In contrast, firms that choose producer or vehicle currency invoicing do not adjust destination-specific markups \Rightarrow suggests that the firm is pricing to global rather than local factors.