Invoicing and Pricing-to-Market

Evidence on the "International Price System" from UK Exporters

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Introduction

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  1st Gen: Producer Currency Pricing – prices remain stable at the producer's currency

  2nd Gen: Local Currency Pricing – prices remain stable at the destination country's currency

  3rd Gen: Vehicle Currency Pricing – prices remain stable at a third country's currency, e.g., dollar

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- The open macro literature has proposed models based on three types of pricing strategies, each suggesting a distinct adjustment of cross border demand and therefore different optimal policy:
  - **1st Gen: Producer Currency Pricing** – prices remain stable at the producer's currency
  - **2nd Gen: Local Currency Pricing** – prices remain stable at the destination country's currency
  - **3rd Gen: Vehicle Currency Pricing** – prices remain stable at a third country's currency, e.g., dollar
- While direct evidence on how firms price exports is scarce, recent studies suggest that the **currency of invoice** in trade transactions seems to be a good indicator of the degree of price adjustments to exchange rates (exchange rate pass through ERPT).

Invoicing currencies and exchange rate pass through

An important recent instance is the *International Price System* by Gopinath (2015)—stressing that asymmetries in pass through are an indicator of the dominant role of the dollar in goods trade. Key to the argument is evidence on invoicing.

Differences in ERPT into import prices after 2 years

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

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reflect the share of imports invoiced in dollar, which are:

- **93%** of the US's imports are invoiced in dollars (**local currency**).
- **71%** of Japan's imports are invoiced in dollars (**vehicle currency**) but only 13% of its imports from the US.
- **60%** of Turkey's imports are invoiced in dollars (**vehicle currency**) but only 6% of its imports from the US.

The question

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?

- What do we know about firms' invoicing currency usages? How many currencies does each firm use and does the firm switch currencies over time?
- Do we find a close relationship between price adjustments and the invoicing currency in British data?
- Price adjustments incorporate both markup and marginal cost changes. Is the invoicing choice related to firms' strategic markup adjustments?

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- Price adjustments incorporate both markup and marginal cost changes. Is the invoicing choice related to firms' strategic markup adjustments?
  ⇒ **Estimate destination-specific markup elasticity using the TPSFE estimator developed in previous work 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 may narrow identification of shocks.
2. **Pricing to market captures (b)**
   - ⇒ To deals with potential bias due to endogenous selection of destination markets, we use the Trade Pattern Sequential Fixed Effect (TPSFE) estimator developed in previous work CCHS (2019).
   - ⇒ The TPSFE estimator exploits destination variation in export prices to control for changes in the unobserved marginal cost (c) and common markup (a)

Stylized facts

1. The pattern of invoicing currencies is different for exports and imports, but stable over time. In value:
   - $\Rightarrow$ 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

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3. UK exporters invoice in multiple currencies in the same destination for the same product in the same year
   - $\Rightarrow$ Nearly 50% of UK exports to extra-EU destinations are conducted by such firms
4. UK exporters switch currency of invoicing

Brexit event study

Against the large depreciation following Brexit-referendum:

- Export prices in sterling rise immediately in VCI and LCI transactions.
- For PCI transactions, prices are initially unresponsive, then they rise steadily.
- Differences across VCI LCI and PCI narrow over 6 quarters from the referendum.

Fixed effect approach

- Export price elasticity to the exchange rate=1-ERPT:
  - ⇒ Producer currency (£) invoiced transactions: 0.24*** (ERPT: 76%)
  - ⇒ Vehicle currency ($) invoiced transactions: 0.41*** (ERPT: 59%)
  - ⇒ Local currency invoiced transactions: 0.58*** (ERPT: 42%)

  Local currency invoice → lower ERPT.

- Destination-specific markup elasticity to exchange rate (DSME):
  - ⇒ Producer currency (£) invoiced transactions: 0.04
  - ⇒ Vehicle currency ($) invoiced transactions: 0.06
  - ⇒ Local currency invoiced transactions: 0.48***

  Only LCI implies pricing to market: Most (.48/.58=84%) of the incomplete pass through of LCI transactions is due to the exporter adjusting the markup in the destination markets.

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A Scottish firm sells whisky to Canada and Mexico. The **sterling** depreciates by 10% against all other currencies. Assuming that the conditional response coincides with the average estimates above:

- For PCI transactions, the sterling price of the whisky **rises by 2.4%**: the peso (Canadian dollar) price drops by 7.6%.
- If transactions are VCI, say, invoiced in US dollars, the sterling price **rises by 4.1%**: the peso (Canadian dollar) price drops by 5.9%.
- If transactions are LCI, the sterling price **rises by 5.8%**: the peso (Canadian dollar) price drops by 4.2%.

An illustration of our result

A Scottish firm sells whisky to Canada and Mexico. The **Mexican peso** depreciates by 10% against all other currencies. Assuming that the conditional response coincides with the average estimates above:

- For PCI transactions, the sterling price of the whisky **does not change**. There is no pricing to market: The peso price rises by 10% in Mexico and there is no change in price in Canada.
- If transactions are VCI, say, invoiced in US dollars, the sterling price **does not change**. There is no pricing to market: The peso price rises by 10% in Mexico and there is no change in price in Canada.
- If transactions are LCI, the sterling price **drops by 4.8% in Mexico**. The firm does price-to-market: The peso price rises by 5.2% (= 10% - 4.8%) in Mexico and there is no change in price in Canada.

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); Casas et al. (2017); Chen, Chung and Novy (2018); Amiti, Itskhoki and Konings (2018)

- **Pricing-to-market**

  e.g., 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 (2018)

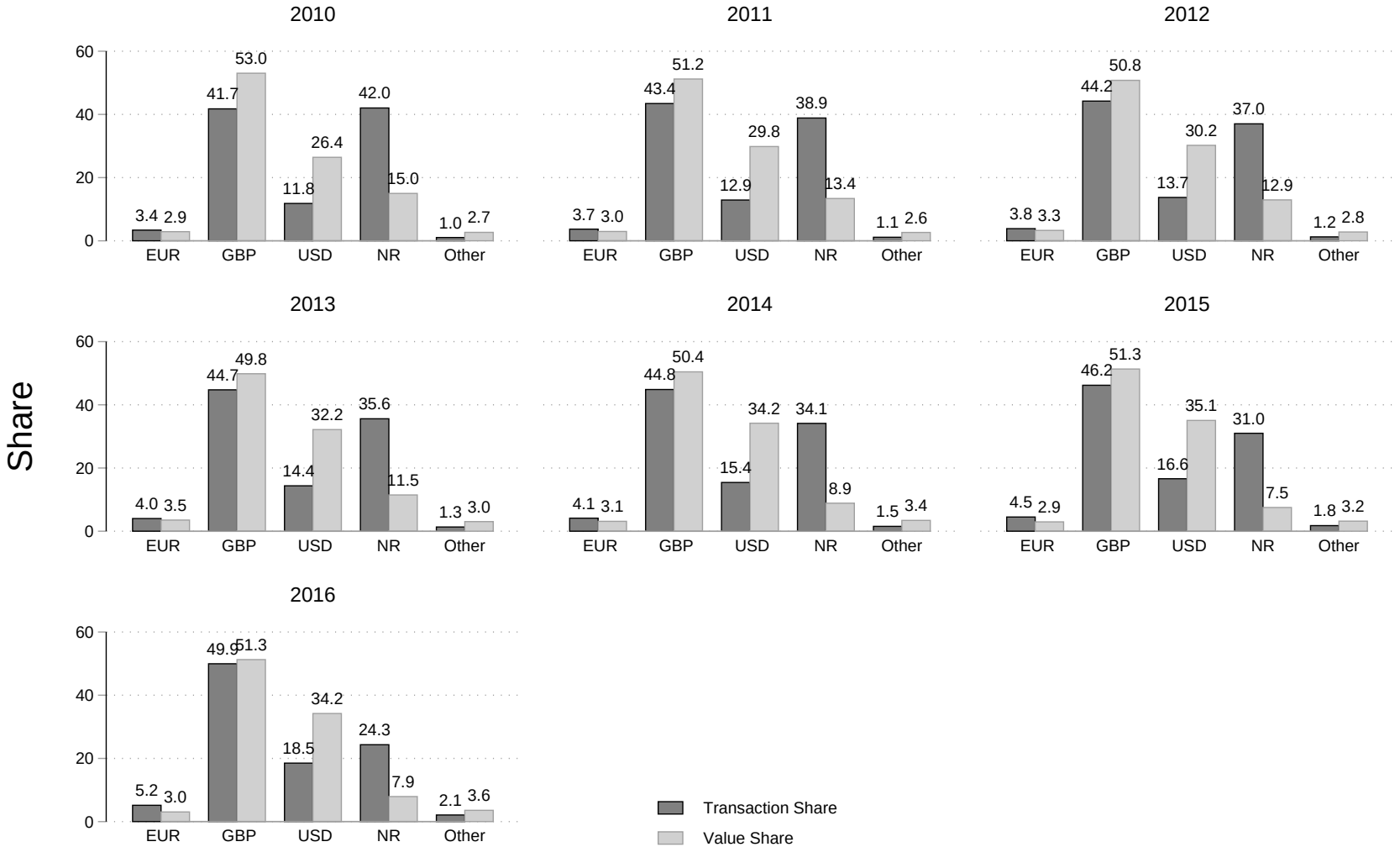
Outline

- 4 stylized facts
- Brexit event study
- Pricing-to-market and invoicing currency (TPSFE approach)

Stylized facts about invoicing currencies

1. The pattern of invoicing currencies is different for exports and imports, but stable over time.
2. UK's trade is dominated by firms invoicing in more than one currency
3. UK exporters invoice in multiple currencies in the same destination for the same product
4. UK exporters switch currency of invoicing

Fact 1: Share of invoicing currencies in UK exports



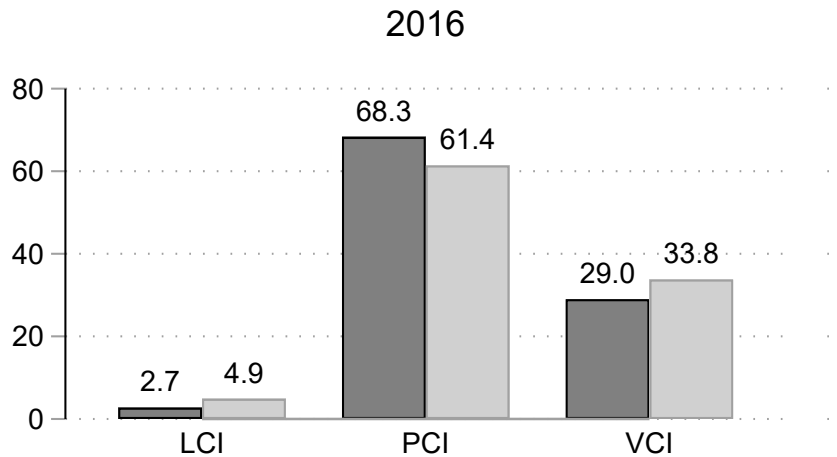
Top invoicing currencies for extra-EU exports

NR: Not Reported

Fact 1: Share of invoicing currencies in UK exports

Excluding US destinations (to rule out confusion VCI LCI):

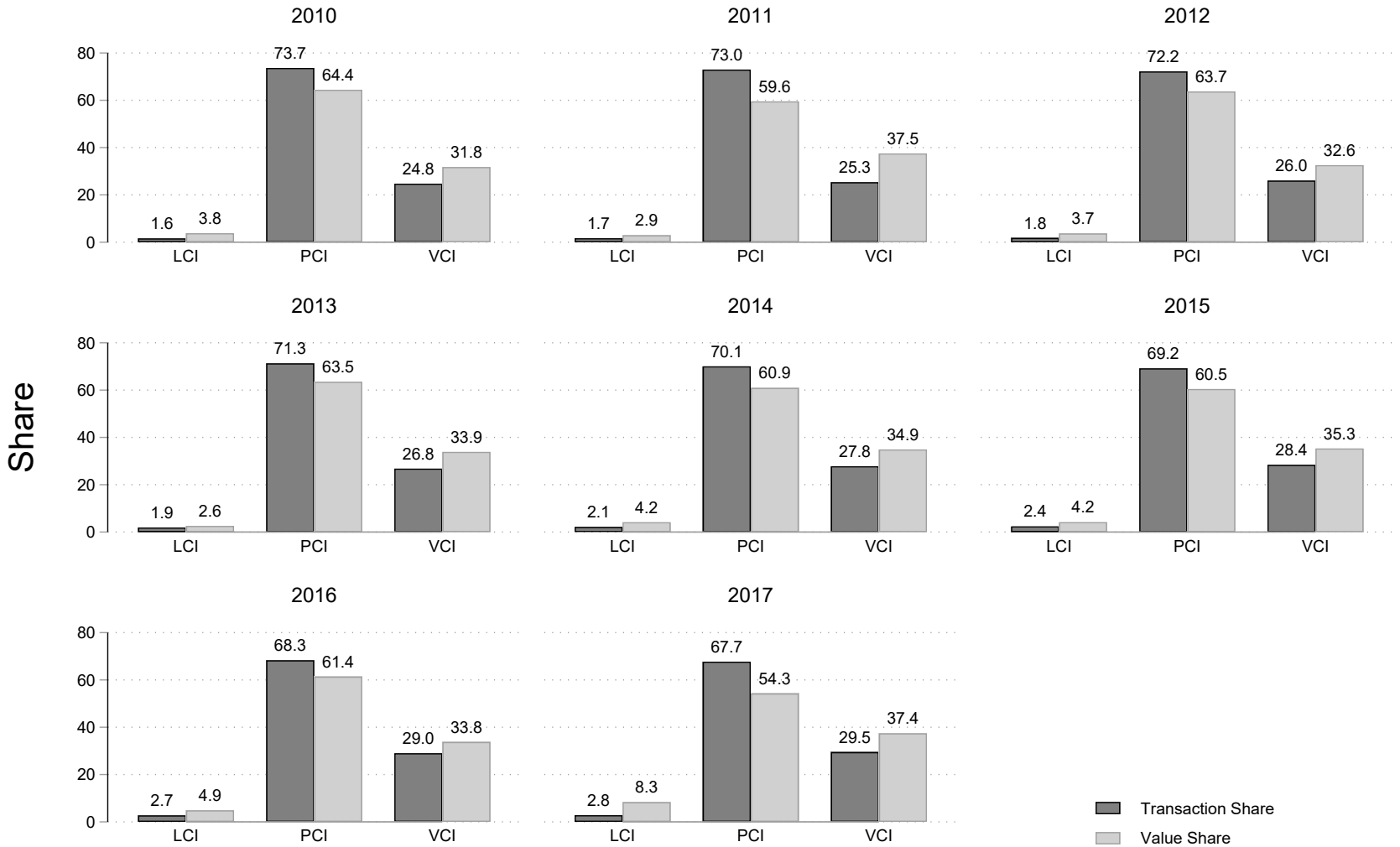
- sterling (PCI): 61%
- vehicle currency (VCI) ($, €, ¥): 34%
- destination (local) currency (LCI): 5%



Dark: transaction share; Light: value share

Fact 1: Aggregate composition of invoicing schemes

UK exports, excluding the EU and the US



Fact 2: Number of destinations vs. invoicing currencies

UK exports, excluding the EU and the US, 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

⇒ **99.3% of export value originates from multi-currency exporters**

⇒ **only .7% of export value (43% of transactions) uses one currency.**

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

Fact 2: Number of products vs. invoicing currencies

UK exports, excluding the EU and the US, 2010-2017

	No. of Products	No. of Invoicing Currencies 1	2-5	6-10	10+	Total
by Share of Firms	1	**29.7**	2.1	0.0	0.0	**31.8**
	2-5	12.0	**19.4**	0.0	0.0	**31.4**
	6-10	1.3	**11.0**	0.0	0.0	**12.3**
	10+	0.5	**22.4**	**1.5**	**0.2**	**24.5**
	Total	43.4	54.8	1.5	0.2	100.0
by Share of Exports	1	0.4	0.7	0.0	0.0	1.0
	2-5	0.2	1.7	0.0	0.0	1.9
	6-10	0.0	2.3	0.8	0.1	3.3
	10+	0.0	33.4	26.0	34.4	93.8
	Total	0.7	38.0	26.9	34.5	100.0

⇒ **93.4% of single-product exporters use only one currency.**
⇒ **80.0% of multi-product exporters use two or more currencies.**

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

Fact 3: Multi-currency invoicing

for same product-firm-destination-year (ifdt) quartet

	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

⇒ **50.6% of exports of the same "ifdt" invoiced in multiple currencies**

⇒ **33.9% of imports by the same "ifdt" invoiced in multiple currencies**

Fact 4: Transition matrix of invoicing schemes

UK exports, excluding EU and US, 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.

ERPT after the Brexit referendum

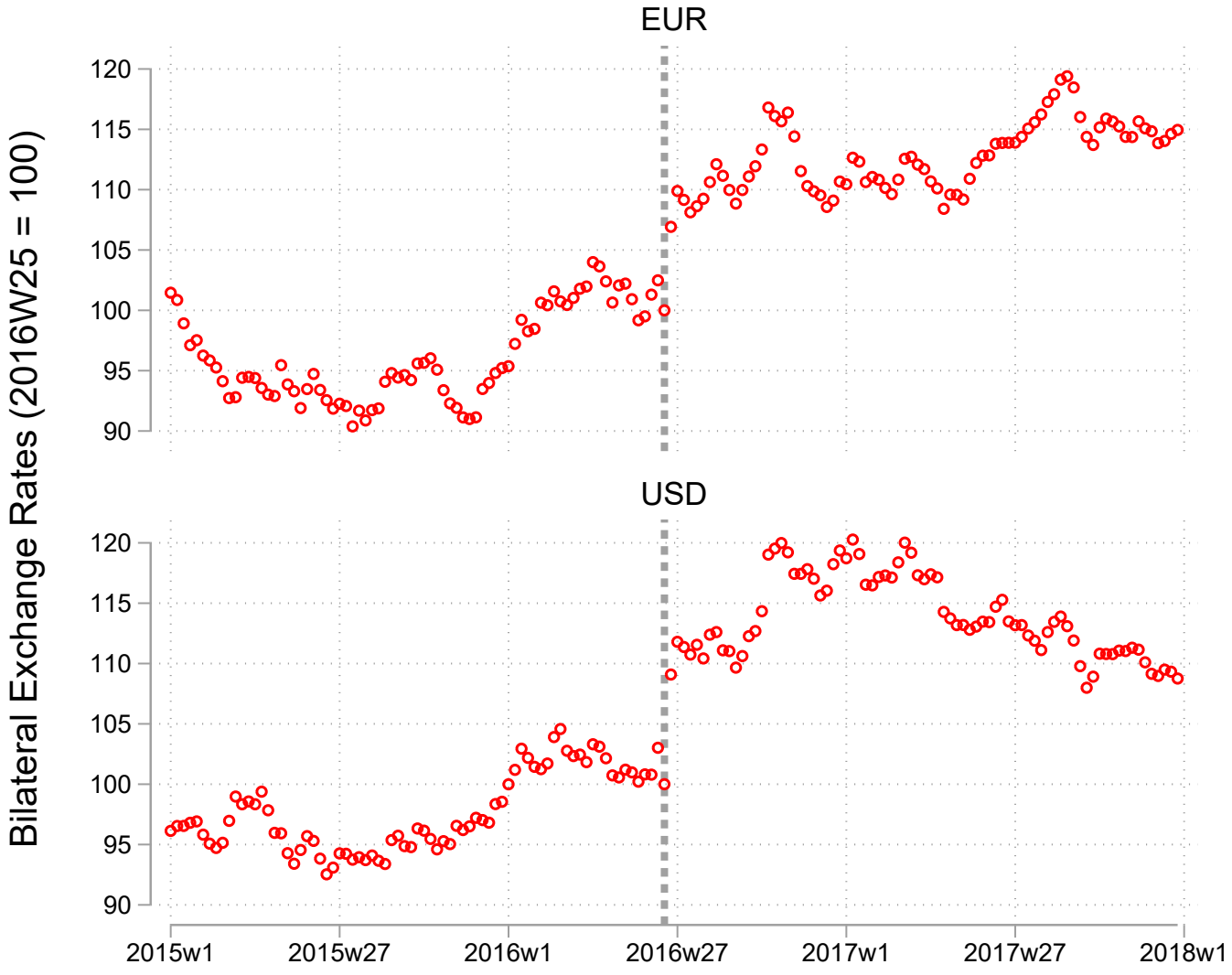
Recall

$$\text{Price changes} = \text{(a) global markup adjustments} + \text{(b) destination-specific markup adjustments} + \text{(c) changes in marginal costs}$$

- Event study: Captures (a), (b) and (c) in response to a specific (although) complex shocks.
- However, if one thinks that marginal costs remain temporary unresponsive to Brexit depreciation in the very short run (evidence on import prices...), one may consider the event study informative about (a) and (b) as well.

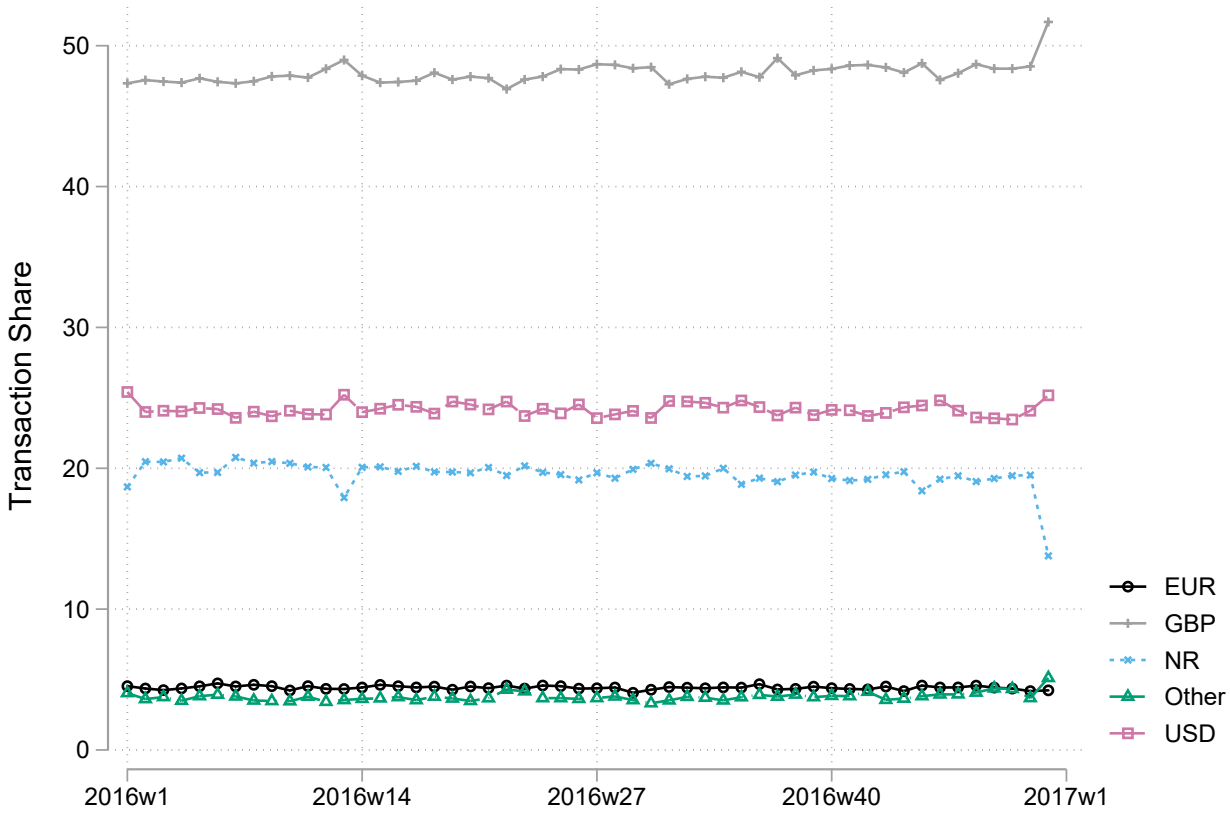
Brexit Event Study

The pound around the Brexit referendum



Brexit event study

Aggregate shares of invoicing currencies in 2016



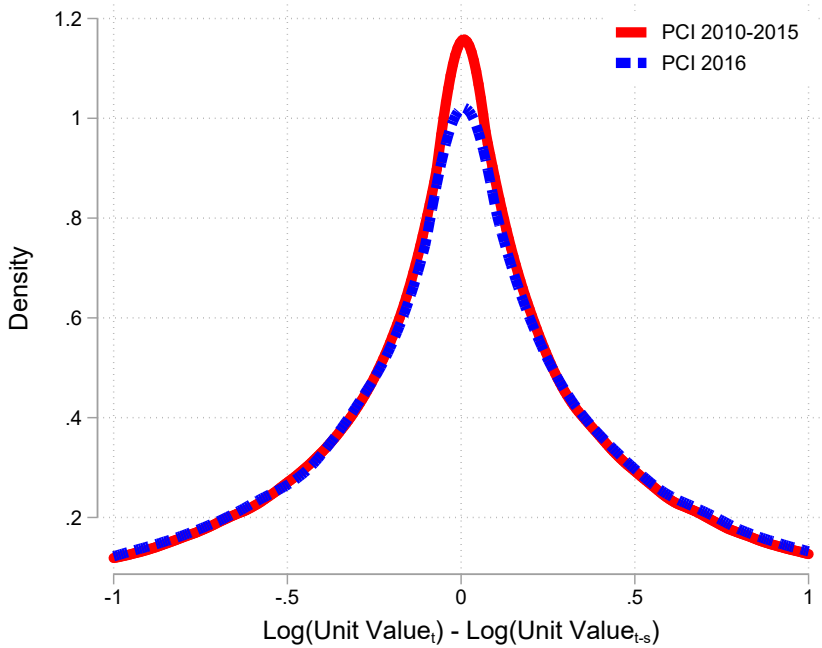
Transaction share of different invoicing currencies for extra-EU exports did not respond to the Brexit depreciation.

Note: "NR" stands for not reported.

Brexit event study

Distribution of export price changes: 2016 vs 2010-2015
Prices measured in sterling

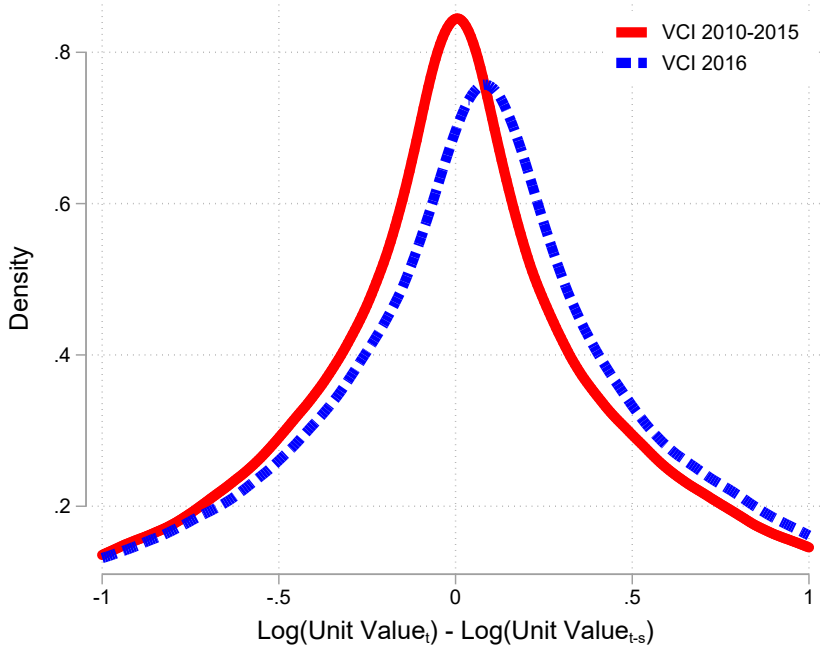
Producer Currency Invoiced (PCI) Transactions



Note: Density is calculated based on all unit value changes including those > 1 or < -1.

No Shift $\Rightarrow$ High ERPT

Vehicle Currency Invoiced (VCI) Transactions



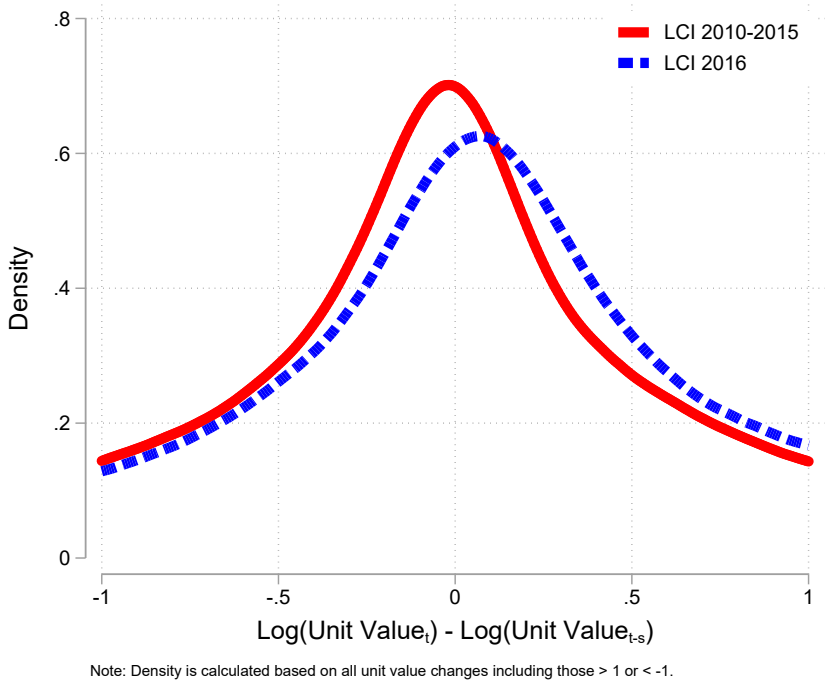
Note: Density is calculated based on all unit value changes including those > 1 or < -1.

Shift to the right $\Rightarrow$ Low ERPT

Brexit event study

Distribution of export price changes: 2016 vs 2010-2015
Prices measured in sterling

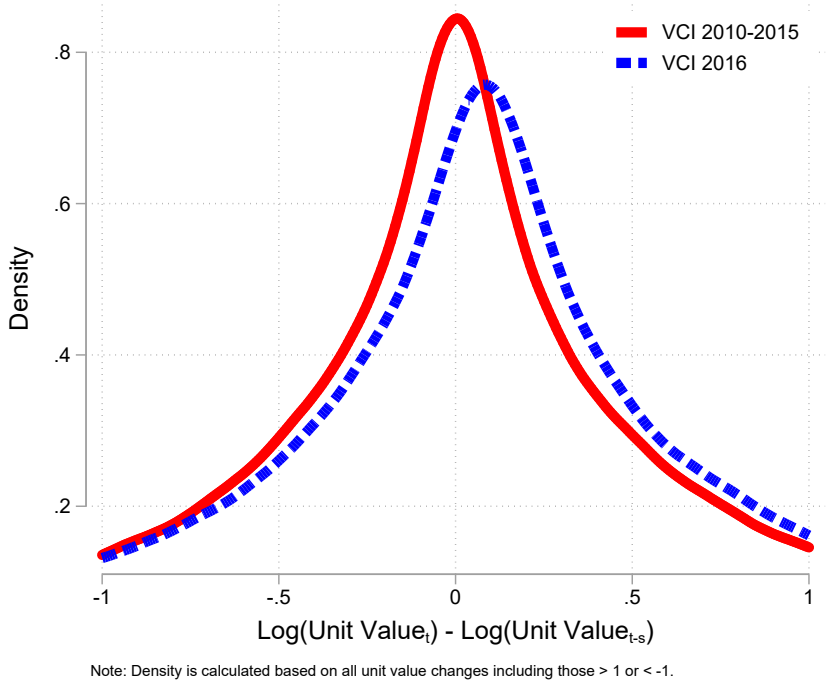
Local Currency Invoiced (LCI) Transactions



Note: Density is calculated based on all unit value changes including those > 1 or < -1.

Shift to the right $\Rightarrow$ Low ERPT

Vehicle Currency Invoiced (VCI) Transactions



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Shift to the right $\Rightarrow$ Low ERPT

Brexit event study

Estimation equation

Econometric analysis of weekly ERPT (see e.g. Bonadio Fisher and Saure 2019):

$$y_{ifdt} = \sum_{\tau=1}^{156} \lambda_\tau + \delta_{ifd} + u_{ifdt} \quad y \in \{p_{ifdct}, q_{ifdt}, e_{dt}\} \tag{1}$$

where

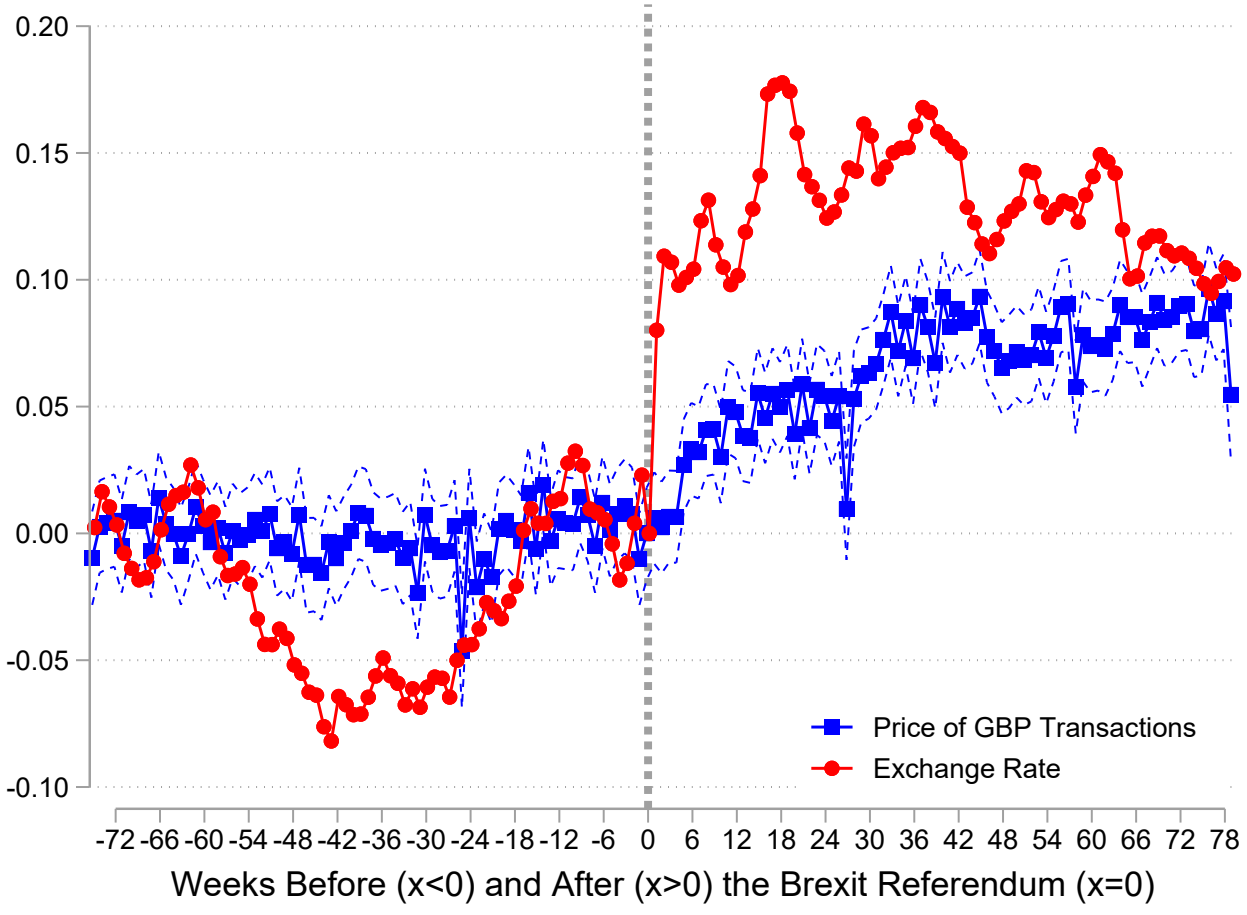
- i, f, d, t represent product, firm, destination country, and *week* respectively.
- $\sum_{\tau=1}^{156} \lambda_\tau$ is a bunch of week dummies capturing the average price/quantity/exchange rate changes
- δ_{ifd}: firm-product-destination fixed effects

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

Brexit event study

Weekly pass through after the Brexit referendum

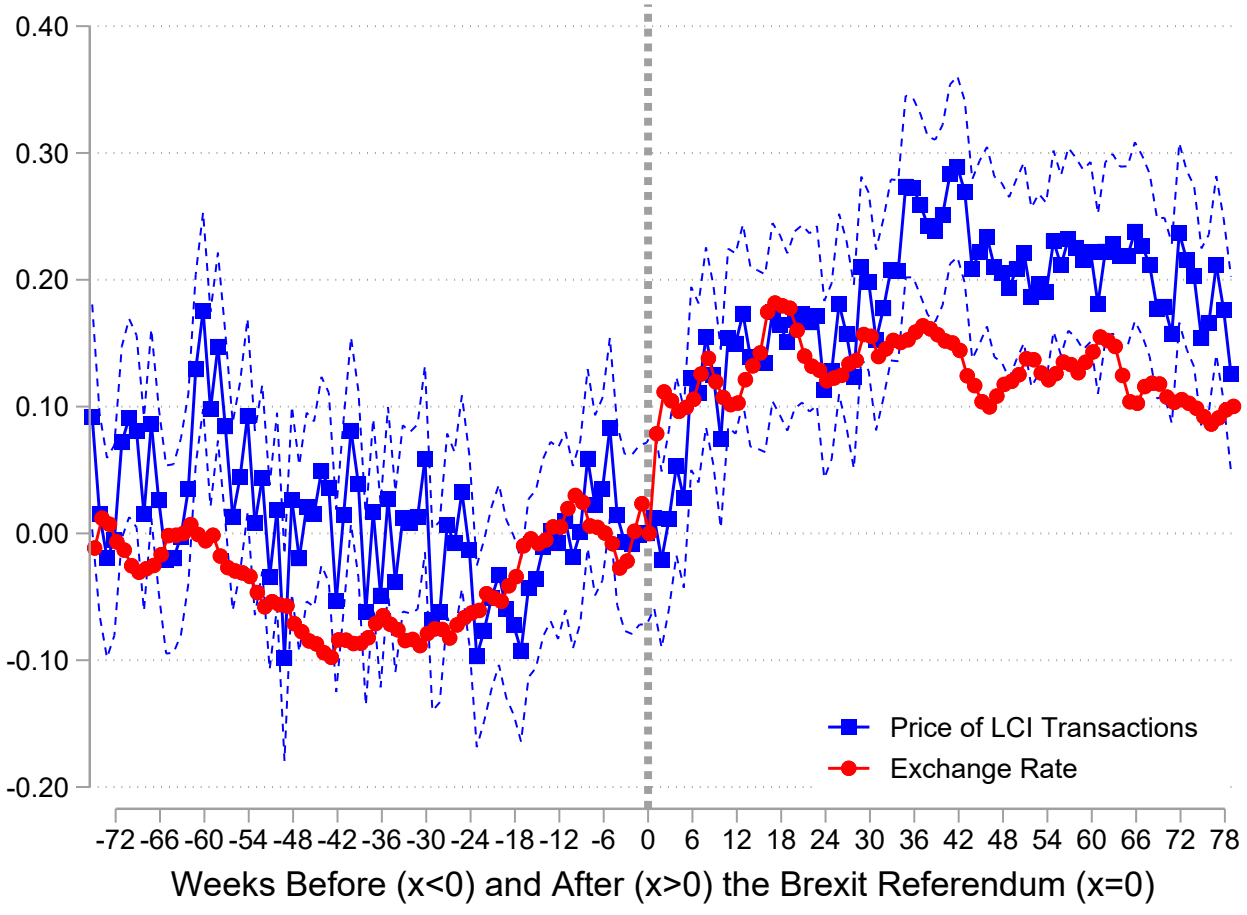
Weekly Price Changes of **Sterling** Invoiced Transactions **2015-2017**



Brexit event study

Weekly pass through after the Brexit referendum

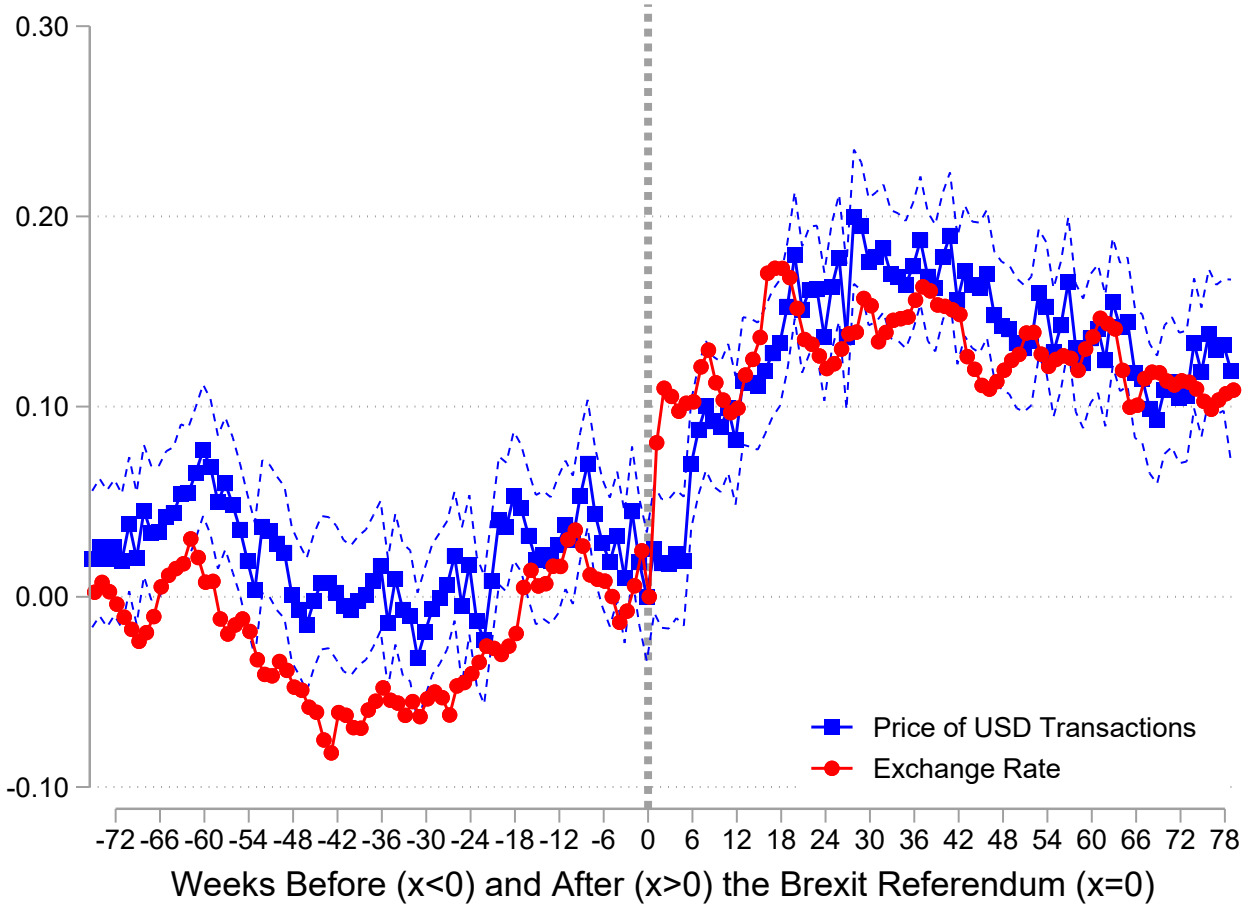
Weekly Price Changes of **Local Currency** Invoiced Transactions **2015-2017**



Brexit event study

Weekly pass through after the Brexit referendum

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



Fixed effect approach

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

1. Similar to the event study, ERPT regressions: Capture (a), (b) and (c).

2. Fixed effects approach: Captures (b), i.e., pricing-to-market

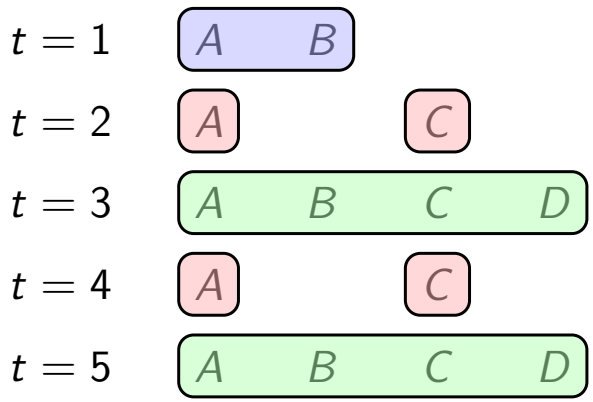
Analysis of Price elasticity (1-ERPT) vs Destination-Specific Markup Elasticity (DSME) with respect to the exchange rate.
Model developed in previous work, "Markets and Markups".

Trade Pattern Sequential Fixed Effects

Destination Specific Markup Elasticity (DSME)

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.

To estimate the markup elasticity addressing selection bias, the TPSFE estimator compares changes in destination-specific price deviations from mean at $\mathbf{t = 2}$ with $\mathbf{t = 4}$ and $\mathbf{t = 3}$ with $\mathbf{t = 5}$.

DSME: Trade Pattern Sequential Fixed Effects

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

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

- 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 for the same trade pattern.

Estimating equation for DSME

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

$$\widetilde{p}_{ifdt,D_{ift}} = \kappa \widetilde{e}_{dt,D_{ift}} + TP_{ifd,D_{ift}} + \widetilde{u}_{ifdt,D_{ift}}$$

where

- κ 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).

Estimating equation for price elasticity (1-ERPT)

We also regress prices (not price residuals) on exchange rates and the trade pattern fixed effects.

$$p_{ifdt} = \beta e_{dt} + TP_{ifd,D_{ift}} + \widetilde{u}_{ifdt}$$

where

- β is the price elasticity $\equiv 1 - ERPT$.
- 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

UK extra-EU exports 2015-2017, weekly frequency

	(1) All
Price	0.333*** (0.0118)
Markup	0.0733*** (0.0267)
Observations	4,854,264

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 0.33%

export prices in foreign currency fall by 1-0.33 = 0.67%

ERPT is incomplete = 67%

⇒ the destination-specific markup (in £) increases by 0.07%

22% (=0.073/0.33) due to destination specific markup adjustments.

Price and markup elasticities: 2015-2017

UK extra-EU exports by invoicing currency, weekly frequency

ERPT

	(1) All	(2) PCI	(3) LCI	(4) VCI (Dollar)	(5) VCI (Euro)
Price	0.333***	0.241***	0.577***	0.406***	0.520***
	(0.0118)	(0.0177)	(0.0453)	(0.0365)	(0.0448)
Implied ERPT	**67%**	**76%**	**42%**	**59%**	**48%**
Markup	0.0733***	0.0435	0.482***	0.0591	0.0506
	(0.0267)	(0.0384)	(0.0778)	(0.0779)	(0.106)
Observations	4,854,264	2,438,368	258,970	765,993	277,611

⇒ **Higher ERPT for PCI compared to LCI and VCI**

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

Price and markup elasticities: 2015-2017

UK extra-EU exports by invoicing currency, weekly frequency

Destination Specific Markup Elasticity (DSME)

	(1) All	(2) PCI	(3) LCI	(4) VCI (Dollar)	(5) VCI (Euro)
Price	0.333***	0.241***	0.577***	0.406***	0.520***
	(0.0118)	(0.0177)	(0.0453)	(0.0365)	(0.0448)
Implied ERPT	**67%**	**76%**	**42%**	**59%**	**48%**
Markup	0.0733***	0.0435	0.482***	0.0591	0.0506
	(0.0267)	(0.0384)	(0.0778)	(0.0779)	(0.106)
Observations	4,854,264	2,438,368	258,970	765,993	277,611

⇒ **No destination specific markup adjustments for PCI and VCI**

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

Price and markup elasticities: 2015-2017

UK extra-EU exports by invoicing currency, weekly frequency

DSME and incomplete ERPT

	(1) All	(2) PCI	(3) LCI	(4) VCI (Dollar)	(5) VCI (Euro)
Price	0.333***	0.241***	0.577***	0.406***	0.520***
	(0.0118)	(0.0177)	(0.0453)	(0.0365)	(0.0448)
Markup	0.0733***	0.0435	0.482***	0.0591	0.0506
	(0.0267)	(0.0384)	(0.0778)	(0.0779)	(0.106)
Observations	4,854,264	2,438,368	258,970	765,993	277,611
Percent of incomplete ERPT due to destination-specific markup adjustments					
	22	**0**	**84**	**0**	**0**

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:

1. The lion's share (99%) of trade is conducted by firms invoicing in multiple currencies.

2. In response to the large sterling depreciation after the Brexit referendum, local and vehicle currency invoiced transactions demonstrate faster markup adjustments than producer currency invoiced transactions.

3. Only local currency invoiced transactions demonstrate destination-specific markup adjustments $\Rightarrow$ Firms price discriminate by invoicing their products in local currencies.

Appendix

Number of Products vs. Destinations

UK exports to countries except the EU (2010-2017)

	No. of Products	No. of Destinations 1	2-5	6-10	10+	Total
by Share of Firms	1	29.7	2.0	0.1	0.0	31.8
	2-5	9.9	19.9	1.3	0.3	31.4
	6-10	1.2	6.9	3.2	0.9	12.3
	10+	0.7	4.3	6.2	13.2	24.5
	Total	41.6	33.1	10.9	14.4	100.0
by Share of Exports	1	0.5	0.5	0.0	0.0	1.0
	2-5	0.3	1.0	0.4	0.3	1.9
	6-10	0.1	0.6	1.0	1.6	3.3
	10+	0.1	1.2	2.7	89.8	93.8
	Total	1.0	3.2	4.1	91.7	100.0

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

Notes: Top panel shows the share of UK exporters that falls under the relevant description. Bottom panel presents corresponding value of exports.

Price and Markup Elasticities

to destinations outside the EU and the US: 2010-2017

		Price		Markup		
Freq.	Invoicing	NEX	CPI	NEX	CPI	n. of obs
Annual	PCI	0.13***	0.34***	-0.04	0.11	1,529,583
	VCI	0.26***	0.45***	-0.05	0.01	559,184
	LCI	0.51***	0.81***	0.22	1.05	49,873
Quarterly	PCI	0.16***	0.36***	0.03	-0.05	3,106,318
	VCI	0.34***	0.55***	-0.08	-0.10	1,177,315
	LCI	0.61***	1.08***	0.40***	0.76*	121,045
Monthly	PCI	0.18***	0.35***	0.04	0.03	4,167,771
	VCI	0.35***	0.53***	0.05	-0.03	1,693,494
	LCI	0.53***	0.71***	0.30***	-0.07	164,595

Price and Markup Elasticities

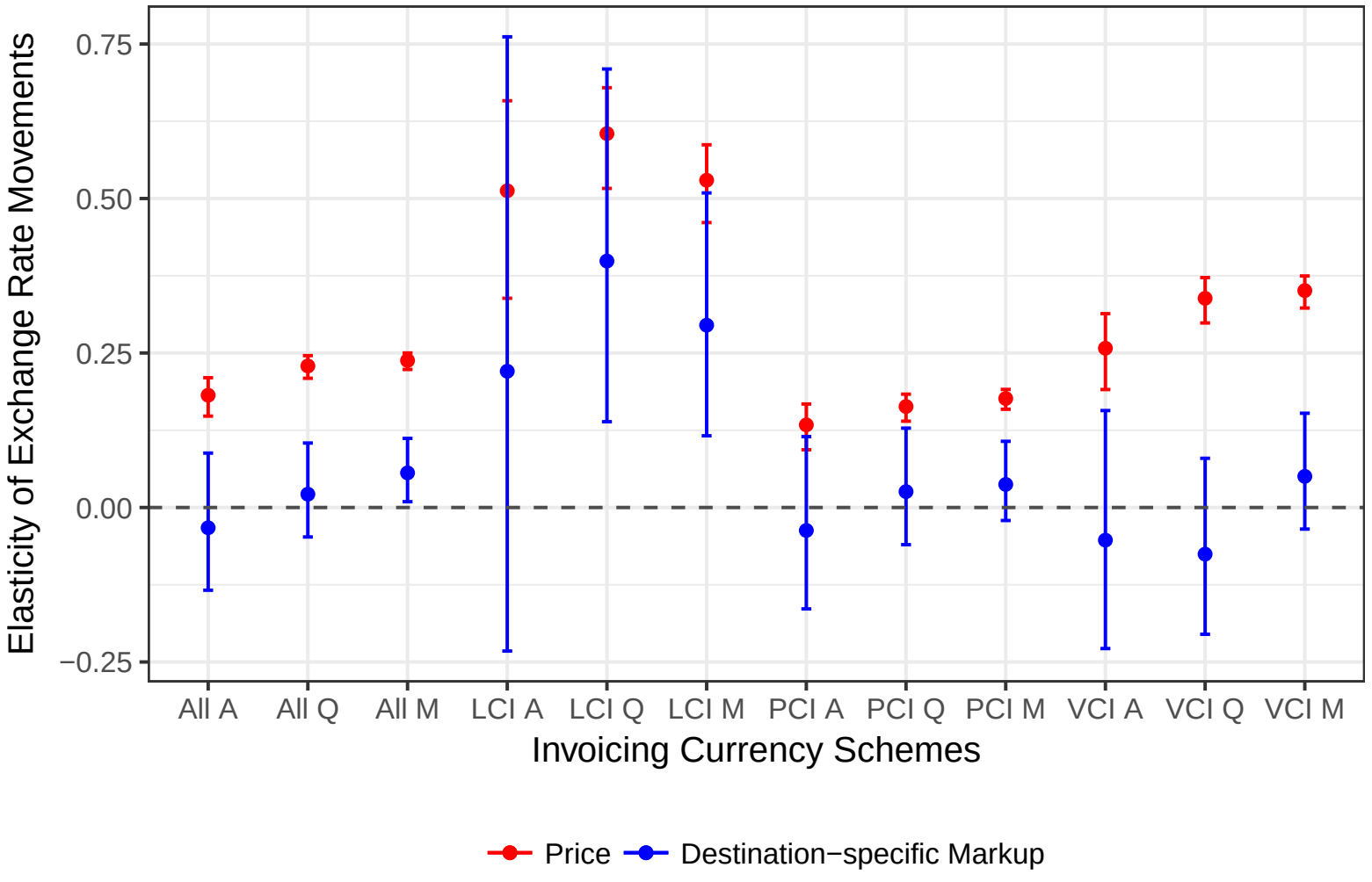
to Non-EU versus All Destinations: 2010-2017

Freq.	Exports	Price		Markup		n. of obs
		NEX	CPI	NEX	CPI	
Annual	Non-EU	0.32***	0.55***	0.10*	0.15	2,936,692
	All countries	0.28***	0.65***	-0.02	-0.04	11,502,814
Quarterly	Non-EU	0.34***	0.56***	0.09***	0.00	5,635,328
	All countries	0.31***	0.71***	0.24***	0.29***	27,397,833
Monthly	Non-EU	0.35***	0.54***	0.09***	-0.02	7,808,005
	All countries	0.34***	0.79***	0.23***	0.21***	50,129,917

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

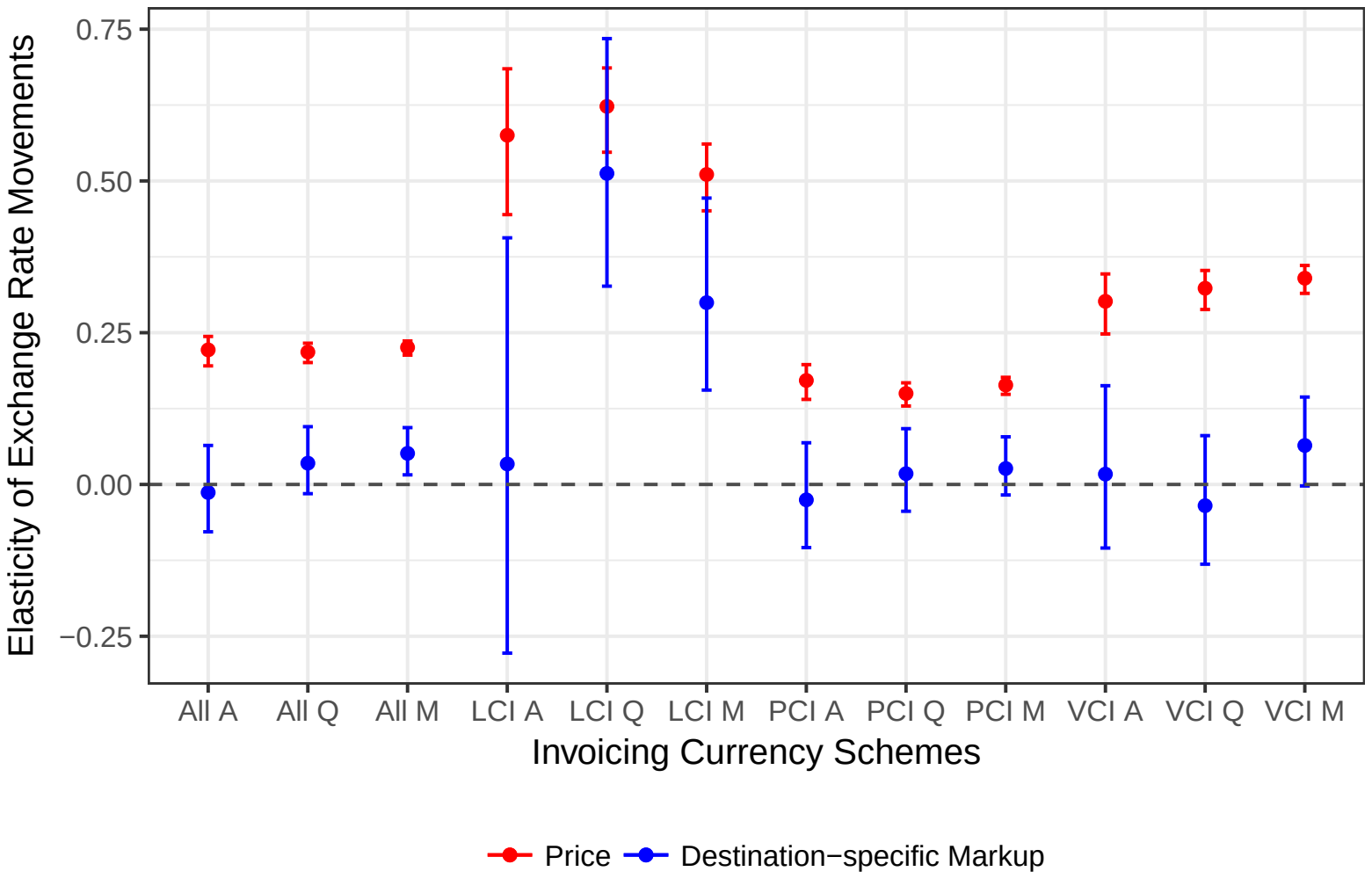
Different Time Frequencies, longer sample

Estimates of Price and Markup Elasticities Conditional on a Price Change 2010-2017



Different Time Frequencies, longer sample

Not Conditional on a Price Change 2010-2017



UK Exports to all extra-EU destinations, 2010-2017

Conditional on a price change, Monthly frequency

US transactions invoiced in dollars classified as LCI

	Price		Markup		
Freq.	NEX	CPI	NEX	CPI	n. of obs
All	0.35***	0.54***	0.09***	-0.02	7,808,005
PCI	0.24***	0.43***	0.03	-0.06	5,132,214
VCI	0.35***	0.52***	0.06	-0.05	1,759,815
LCI	0.63***	0.99***	0.43***	-0.20	915,976

Price and markup elasticities larger for LCI.
ERPT into dollar low, more pricing to market.

UK exports to the EU

EU destinations only, 2010-2017

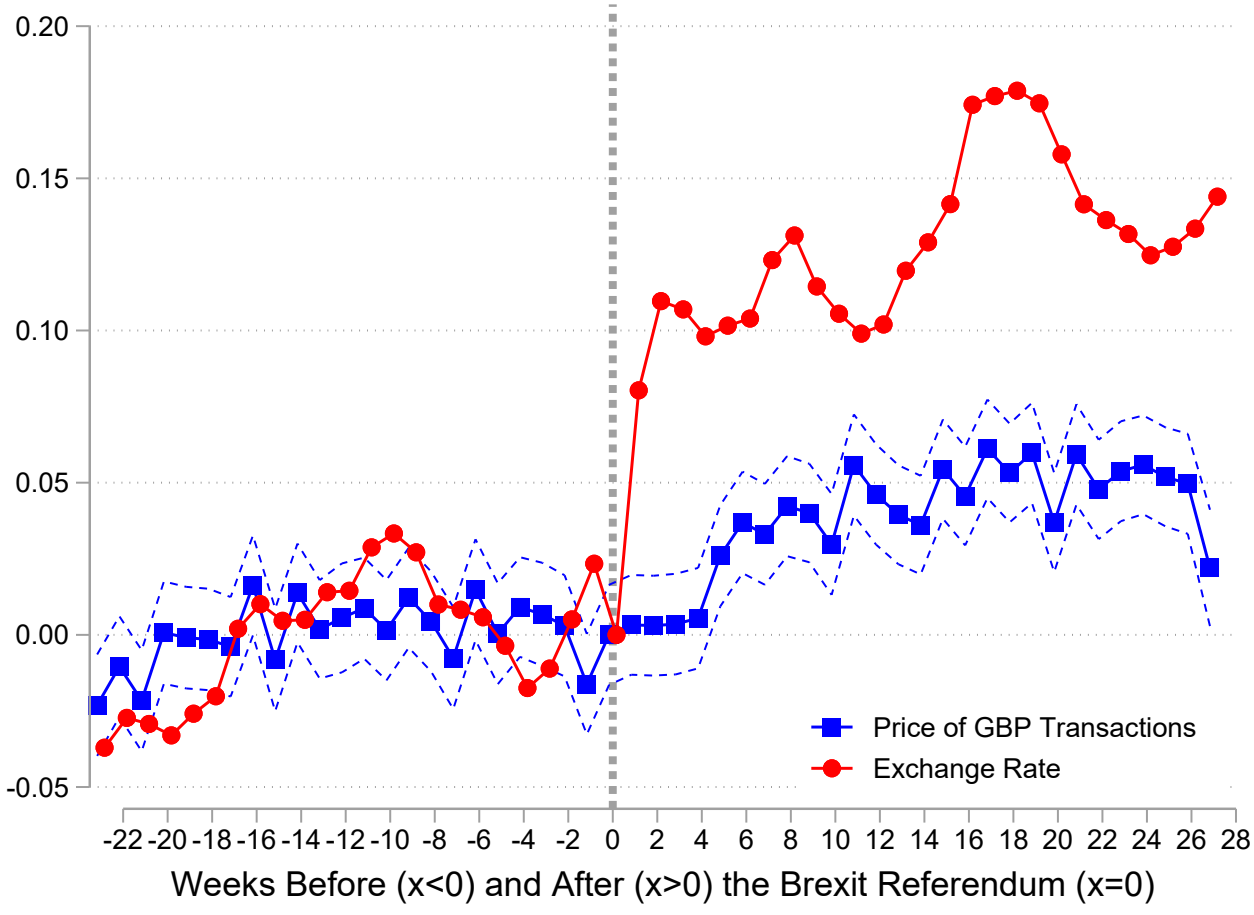
	Price		Markup		
Freq.	NEX	CPI	NEX	CPI	n. of obs
Annual	0.37***	1.46***	-	0.51***	8,566,122
Quarterly	0.34***	1.44***	-	0.60***	21,762,505
Monthly	0.35***	1.42***	-	0.56***	42,321,912

- For exports to EU, we do not know the invoicing currency.
- The pattern for price elasticities similar as for LCI exports to countries outside the EU.
- High Destination-specific Markup Elasticity to local CPI in EU countries.

Brexit Event Study

Weekly pass through after the Brexit referendum

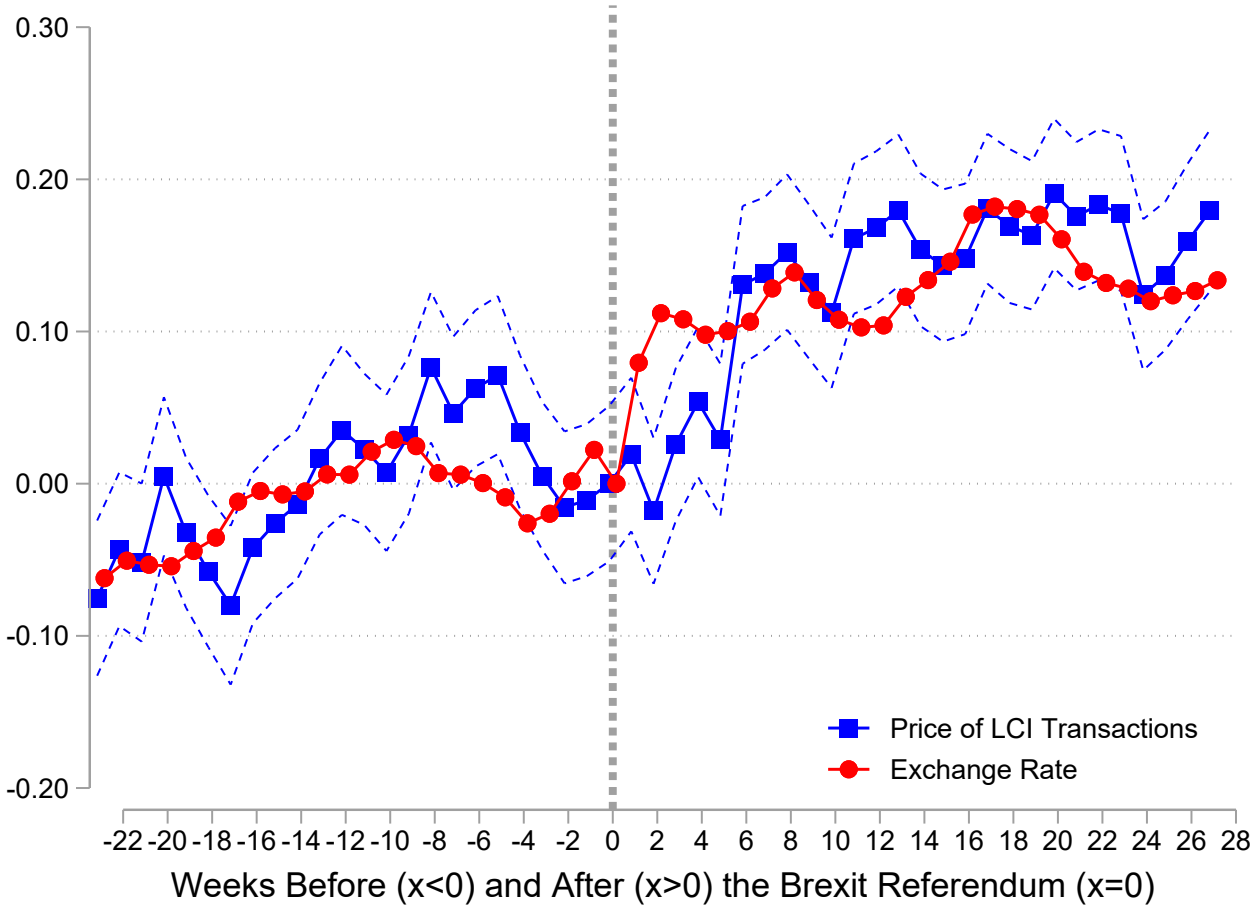
Weekly Price Changes of **Sterling** Invoiced Transactions



Brexit Event Study

Weekly pass through after the Brexit referendum

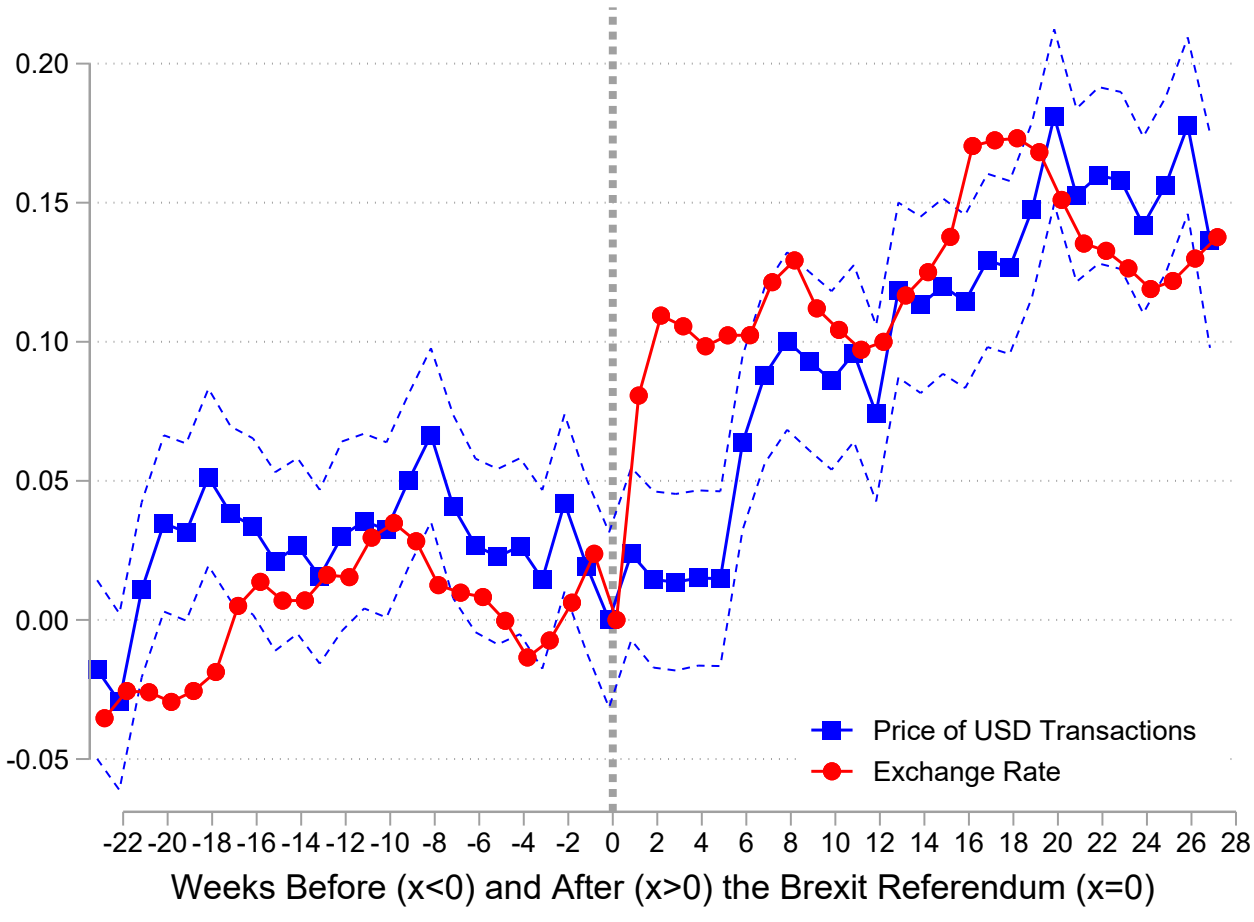
Weekly Price Changes of **Local Currency** Invoiced Transactions



Brexit Event Study

Weekly pass through after the Brexit referendum

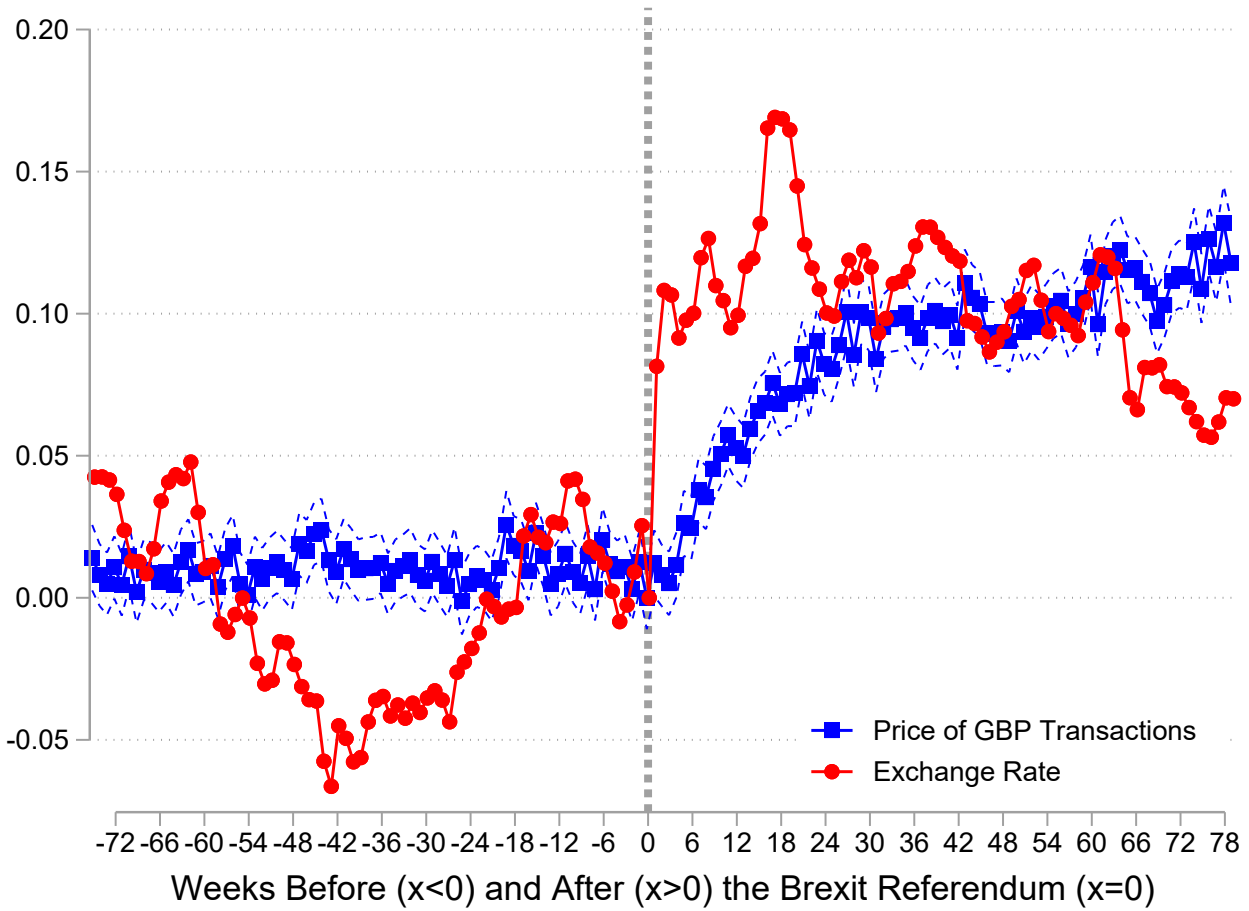
Weekly Price Changes of **Dollar** Invoiced Transactions



Brexit Event Study: Import

Weekly pass through after the Brexit referendum

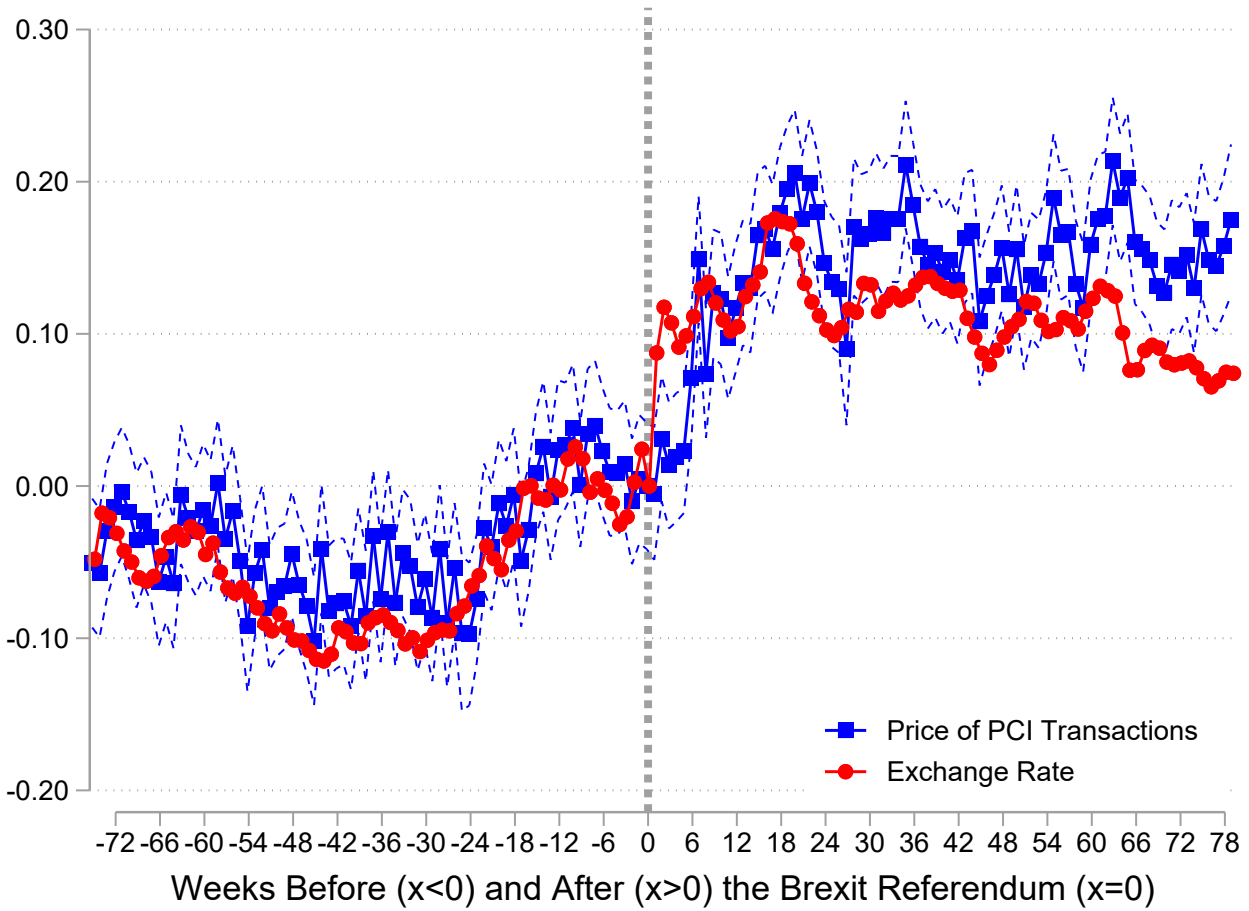
Figure: Price responses of **sterling** invoiced transactions (**extra-EU imports**, 2015-2017)



Brexit Event Study: Import

Weekly pass through after the Brexit referendum

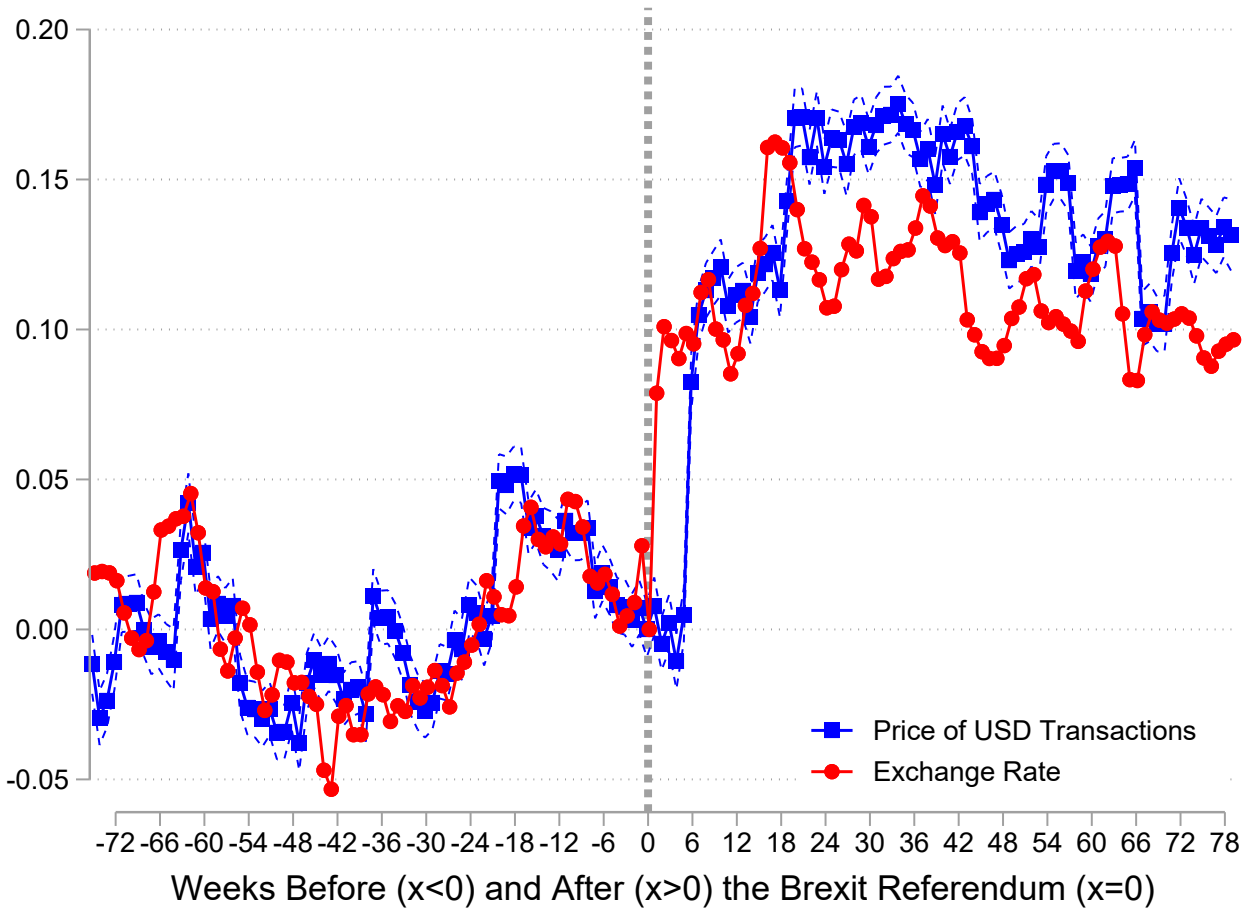
Figure: Price responses of **producer currency** invoiced transactions (**extra-EU imports**, 2015-2017)



Brexit Event Study: Import

Weekly pass through after the Brexit referendum

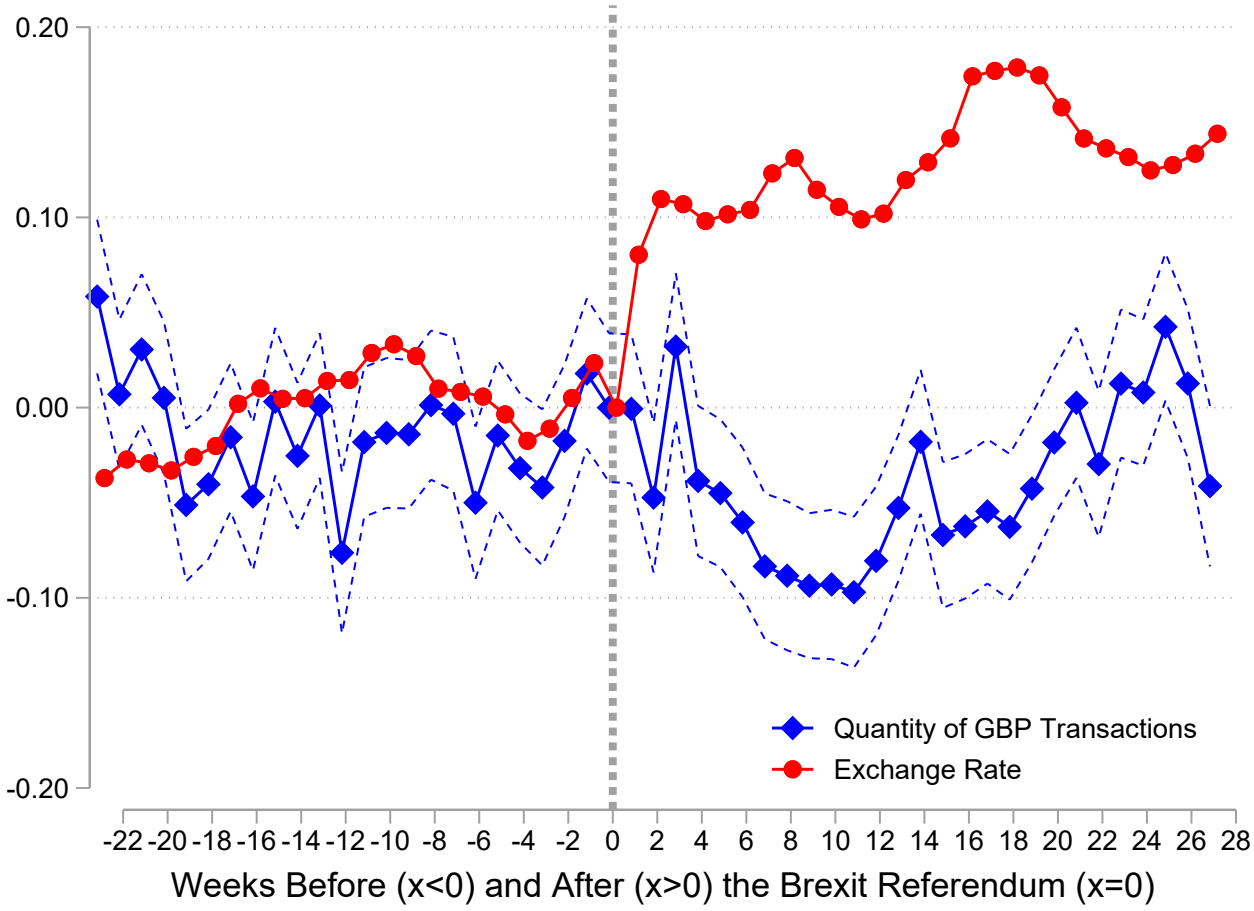
Figure: Price responses of **dollar** invoiced transactions (**extra-EU imports**, 2015-2017)



Brexit Event Study

Weekly pass through after the Brexit referendum

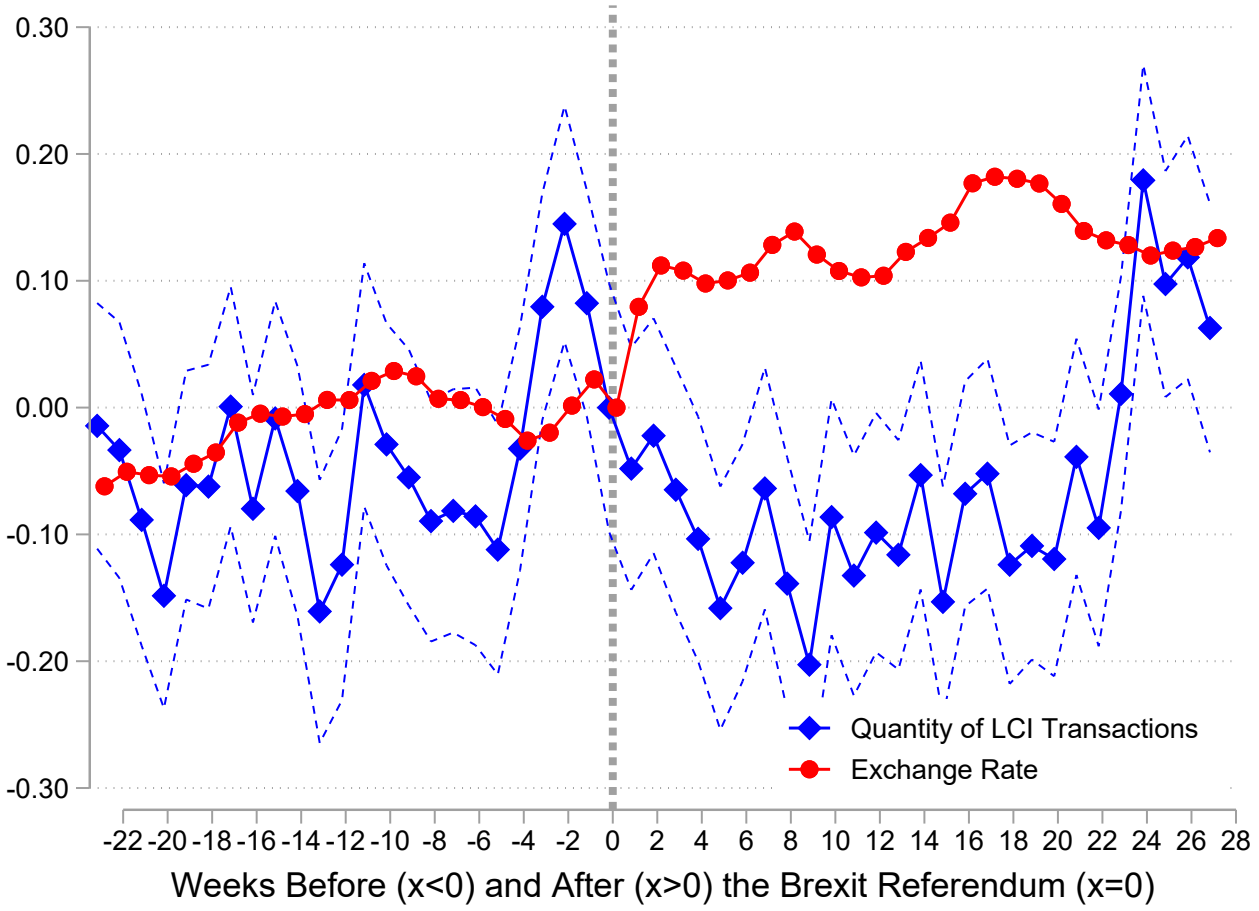
Weekly **Quantity** Changes of **Sterling** Invoiced Transactions



Brexit Event Study

Weekly pass through after the Brexit referendum

Weekly **Quantity** Changes of **Local Currency** Invoiced Transactions



Brexit Event Study

Weekly pass through after the Brexit referendum

Weekly **Quantity** Changes of **Dollar** Invoiced Transactions