Dominant currency dynamics:

Evidence on dollar-invoicing from UK exporters

Meredith Crowley
Cambridge and CEPR

Lu Han
Liverpool and CEPR

Minkyu Son
Bank of Korea

SEM, Calgary
13 August 2022

Disclaimer

This work contains statistical data from HMRC which is Crown Copyright. The research datasets used may not exactly reproduce HMRC aggregates. The use of HMRC statistical data in this work does not imply the endorsement of HMRC in relation to the interpretation or analysis of the information.

Motivation

- A stunning feature in the data is the abnormally high dollar usage in global trade (Gopinath 2015):
  - world exports: dollar share 40% $\gg$ US share 12%
  - world imports: dollar share 43% $\gg$ US share 9%

- Questions:
  - Which factors drive the invoicing choices of individual firms?
  - How do these factors contribute to the dollar's global dominance?

- Why important?
  - Recent literature documents firms' invoicing currencies to be a key predictor of exchange rate pass through.
  - Dollar dominance creates asymmetries in shock transmissions and monetary policies (Gopinath et al 2020; Mukhin 2021)

Motivation

- A stunning feature in the data is the abnormally high dollar usage in global trade (Gopinath 2015):
  - world exports: dollar share 40% $\gg$ US share 12%
  - world imports: dollar share 43% $\gg$ US share 9%

- Questions:
  - Which factors drive the invoicing choices of individual firms?
  - How do these factors contribute to the dollar's global dominance?

- Why important?
  - Recent literature documents firms' invoicing currencies to be a key predictor of exchange rate pass through.
  - Dollar dominance creates asymmetries in shock transmissions and monetary policies (Gopinath et al 2020; Mukhin 2021)

Motivation

- A stunning feature in the data is the abnormally high dollar usage in global trade (Gopinath 2015):
  - world exports: dollar share 40% $\gg$ US share 12%
  - world imports: dollar share 43% $\gg$ US share 9%

- Questions:
  - Which factors drive the invoicing choices of individual firms?
  - How do these factors contribute to the dollar's global dominance?

- Why important?
  - Recent literature documents firms' invoicing currencies to be a key predictor of exchange rate pass through.
  - Dollar dominance creates asymmetries in shock transmissions and monetary policies (Gopinath et al 2020; Mukhin 2021)

What explains the extensive use of US dollars today?

A simple hypothesis:

- the US dominated world trade for most of the post-WWII era

$\Rightarrow$ a firm using dollars in the past may want to use dollars again

Empirical evidence is scarce:

- transactional level data with invoicing currency is difficult to obtain
- existing studies focused on countries that were dominated by dollar use or used relatively short panels

UK data present a unique opportunity to study this question:

- diverse invoicing choices: 90% of UK firms invoice in more than one currency
- a long panel of invoicing choices at the transaction level (2010-2016)
- significant rise of UK's dollar-invoiced export share over time
  (For non-EU destinations: 32% in 2010 $\rightarrow$ 48% in 2019)

What explains the extensive use of US dollars today?

A simple hypothesis:

- the US dominated world trade for most of the post-WWII era

$\Rightarrow$ a firm using dollars in the past may want to use dollars again

Empirical evidence is scarce:

- transactional level data with invoicing currency is difficult to obtain
- existing studies focused on countries that were dominated by dollar use or used relatively short panels

UK data present a unique opportunity to study this question:

- diverse invoicing choices: 90% of UK firms invoice in more than one currency
- a long panel of invoicing choices at the transaction level (2010-2016)
- significant rise of UK's dollar-invoiced export share over time (For non-EU destinations: 32% in 2010 $\rightarrow$ 48% in 2019)

What explains the extensive use of US dollars today?

A simple hypothesis:

- the US dominated world trade for most of the post-WWII era

$\Rightarrow$ a firm using dollars in the past may want to use dollars again

Empirical evidence is scarce:

- transactional level data with invoicing currency is difficult to obtain
- existing studies focused on countries that were dominated by dollar use or used relatively short panels

UK data present a unique opportunity to study this question:

- diverse invoicing choices: 90% of UK firms invoice in more than one currency
- a long panel of invoicing choices at the transaction level (2010-2016)
- significant rise of UK's dollar-invoiced export share over time
  (For non-EU destinations: 32% in 2010 $\rightarrow$ 48% in 2019)

This paper

Empirically, using UK trade transactions data (2010-2016), we document

- within-firm spillovers of dollar usage **over time** and **across markets**

$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

This paper

Empirically, using UK trade transactions data (2010-2016), we document

- within-firm spillovers of dollar usage **over time** and **across markets**

$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

Theoretically, we introduce a fixed cost of currency use at the firm level to explain the newly documented spillover effects:

This paper

Empirically, using UK trade transactions data (2010-2016), we document

- within-firm spillovers of dollar usage **over time** and **across markets**

$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

Theoretically, we introduce a fixed cost of currency use at the firm level to explain the newly documented spillover effects:

- **scale effect**: the more destinations using a currency, the lower the cost

Contribution to literature

This paper

Empirically, using UK trade transactions data (2010-2016), we document

- within-firm spillovers of dollar usage **over time** and **across markets**

$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

Theoretically, we introduce a fixed cost of currency use at the firm level to explain the newly documented spillover effects:

- **scale effect**: the more destinations using a currency, the lower the cost
- **joint market decisions**: the pricing and invoicing choices are inter-dependent across markets due to the firm-level cost of currency usage

Contribution to literature

This paper

Empirically, using UK trade transactions data (2010-2016), we document

- within-firm spillovers of dollar usage **over time** and **across markets**

$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

Theoretically, we introduce a fixed cost of currency use at the firm level to explain the newly documented spillover effects:

- **scale effect**: the more destinations using a currency, the lower the cost
- **joint market decisions**: the pricing and invoicing choices are inter-dependent across markets due to the firm-level cost of currency usage
- **path dependence**: a firm's invoicing choice in a new market depends on its past invoicing choices in existing markets

Contribution to literature

This paper

Empirically, using UK trade transactions data (2010-2016), we document

- within-firm spillovers of dollar usage **over time** and **across markets**

$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

Theoretically, we introduce a fixed cost of currency use at the firm level to explain the newly documented spillover effects:

- **scale effect**: the more destinations using a currency, the lower the cost
- **joint market decisions**: the pricing and invoicing choices are inter-dependent across markets due to the firm-level cost of currency usage
- **path dependence**: a firm's invoicing choice in a new market depends on its past invoicing choices in existing markets

$\Rightarrow$ We estimate that the spillover effects explain $\approx 40\%$ of the recent increase in the aggregate dollar share of UK's non-EU exports.

Contribution to literature

Roadmap

- Basic model and its key predictions
- Empirical results
- Full model with joint invoicing decisions across markets to explain invoicing dynamics
- Implications on aggregate invoicing dynamics

Model outline

We propose a model that incorporates:

1. Key elements of invoicing currency choice from the literature
   - Oligopolistic competition à la Atkeson and Burstein (2008)
   - Cobb-Douglas production technology with multiple imported inputs
   - Preset price and invoicing choice à la Engel (2006) and Amiti, Itskhoki and Konings (2020)

2. New dynamic features observed among UK exporters
   - Introduce a (fixed) cost of using a foreign invoicing currency, which generates invoicing dynamics

Model outline

We propose a model that incorporates:

1. Key elements of invoicing currency choice from the literature
   - Oligopolistic competition à la Atkeson and Burstein (2008)
   - Cobb-Douglas production technology with multiple imported inputs
   - Preset price and invoicing choice à la Engel (2006) and Amiti, Itskhoki and Konings (2020)

2. New dynamic features observed among UK exporters
   - Introduce a (fixed) cost of using a foreign invoicing currency, which generates invoicing dynamics

Model outline

We propose a model that incorporates:

1. Key elements of invoicing currency choice from the literature
   - Oligopolistic competition à la Atkeson and Burstein (2008)
   - Cobb-Douglas production technology with multiple imported inputs
   - Preset price and invoicing choice à la Engel (2006) and Amiti, Itskhoki and Konings (2020)

2. New dynamic features observed among UK exporters
   - Introduce a (fixed) cost of using a foreign invoicing currency, which generates invoicing dynamics

Optimal invoicing currency choice

The expected profit difference of choosing dollars relative to currency c is:

$$\mathbb{E}[\Pi_{fd}^{\text{USD}}] - \mathbb{E}[\Pi_{fd}^{c}] \propto \lambda_{fd} \Bigg[\underbrace{\frac{\Gamma_{fd}}{1+\Gamma_{fd}} (\zeta_{(-f)d}^{\text{USD}} - \zeta_{(-f)d}^{c})}_{\text{Strategic complementarity}} + \underbrace{\frac{1}{1+\Gamma_{fd}} (\psi_{f}^{\text{USD}} - \psi_{f}^{c})}_{\text{Operational hedging}} \Bigg] - \underbrace{(F_{fd}^{\text{USD}} - F_{fd}^{c})}_{\text{Invoicing cost}}$$

where

- $\mathbb{E}[\Pi_{fd}^{c}]$: expected profit from invoicing in currency c
- $\zeta_{(-f)d}^{c}$: firm f's competitors' invoicing share of currency c
- ψ_{f}^{c}: the firm's share of imports invoiced in currency c
- F_{fd}^{c}: the cost of invoicing in a foreign currency c
- Γ_{fd}: markup elasticity

The firm is more likely to use dollars if

(1) more competitors use dollars - to keep its relative prices stable

(2) it has a larger dollar-invoiced import share - to hedge the exchange rate risk

(3) the cost of using dollars is low relative to alternatives

Data

We use the universe of extra-EU trade transactions of British firms from Her Majesty's Revenue and Customs (HMRC) over 2010-2016.

- Records at the level of firm, product (CN08), country and date
- Invoicing currency is reported for extra-EU trade
  - All importers
  - Exporters whose annual exports exceed £100k
- We aggregate to fpdc annually for our analysis

Statistics

Empirical specification

Using a sample of entrants into new destinations, we estimate a linear prob. model:

$$\mathbb{1}^{\text{USD}}_{fhdt} = \beta_1 \zeta^{\text{USD}}_{(-f)idt} + \beta_2 \psi^{\text{USD}}_{ft} + \beta_3 \psi^{\text{Euro}}_{ft} + \beta_4 \psi^{\text{LCI}}_{ft} + \delta \omega^{\text{USD}}_{ft-1} + \gamma \text{size}_{ft} + \text{FEs} + \nu_{fhdt}$$

- f (firm), h (product), i (industry), d (destination), t (year)
- $\mathbb{1}^{\text{USD}}_{fhdt}$: equals one if dollar-invoicing and zero otherwise
- $\zeta^{\text{USD}}_{(-f)idt}$: competitors' dollar-invoicing share instrument
- ψ^{USD}_{ft}, ψ^{Euro}_{ft}, ψ^{LCI}_{ft}: dollar-, euro- and destination- currency invoiced import shares
- $\omega^{\text{USD}}_{ft-1}$: dollar share in the firm's total exports prior to entry
- size_{ft}: total export value (in logs) to proxy for firm size

Impact of prior dollar invoicing on new markets (1)

Dep. Var. $\mathbb{1}_{fhdt}^{USD}$	
Competitors' dollar inv. share	0.069***
	(0.007)
Dollar import share	0.093***
	(0.001)
Euro import share	-0.014***
	(0.002)
Destination cur. import share	0.022***
	(0.002)
Firm size	0.013***
	(0.000)
Dollar share in total exports (t-1)	**0.292*** **
	(0.002)
Observations	1,181,074
Country-Year FE	✓
Product-Year FE	✓
Weak IV F-stat	15,143

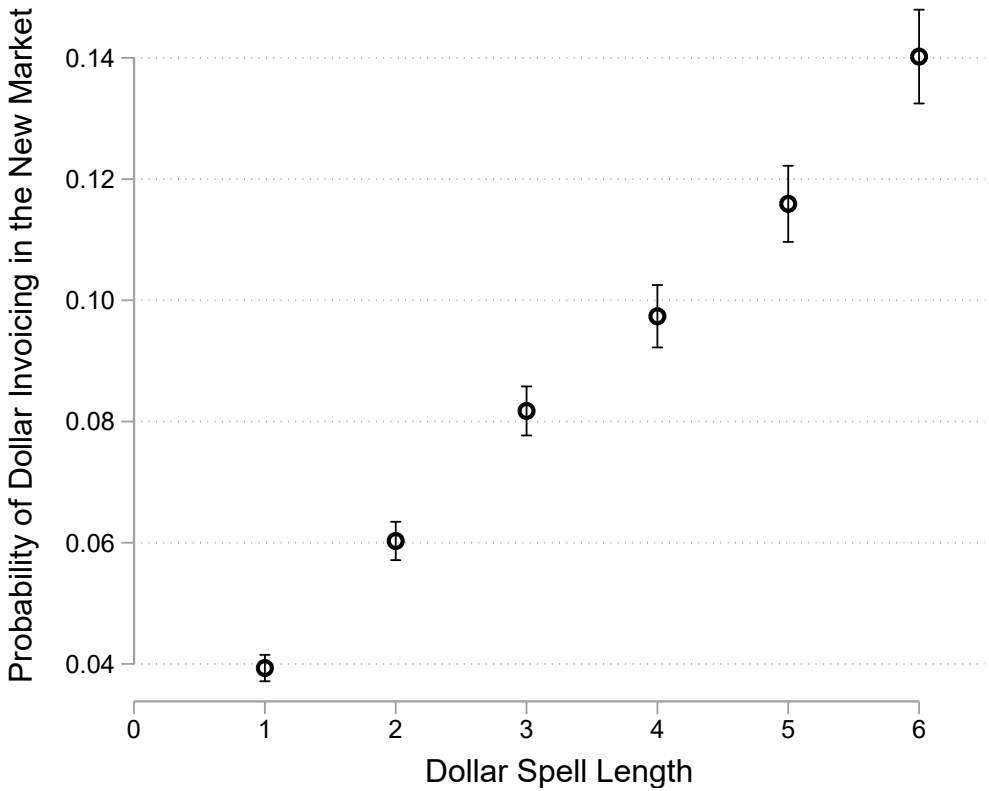
Note: Observations are of the first-year of exporting in each firm-destination pair. All results are based on 2SLS. Competitors' dollar invoicing export share is instrumented using competitors' dollar-invoiced import shares.

Prob. of dollar invoicing in a new market:

- Strategic complementarity: increases in its competitors' dollar share
- Operational hedging: increases in its own dollar-invoiced import share
- Prior usage: increases in the dollar invoicing share in the firm's total exports prior entry

Impact of prior dollar invoicing on new markets (2)

$$\mathbb{1}^{\text{USD}}_{fhdt} = \sum_{l=0}^{6} \eta_l \, Spell^{\text{USD},l}_{ft-1} + \beta_1 \zeta^{\text{USD}}_{(-f)idt} + \beta_2 \psi^{\text{USD}}_{ft} + \beta_3 \psi^{\text{Euro}}_{ft} + \beta_4 \psi^{\text{LCI}}_{ft} + \gamma \text{size}_{ft} + \text{FEs} + \nu_{fhdt}$$

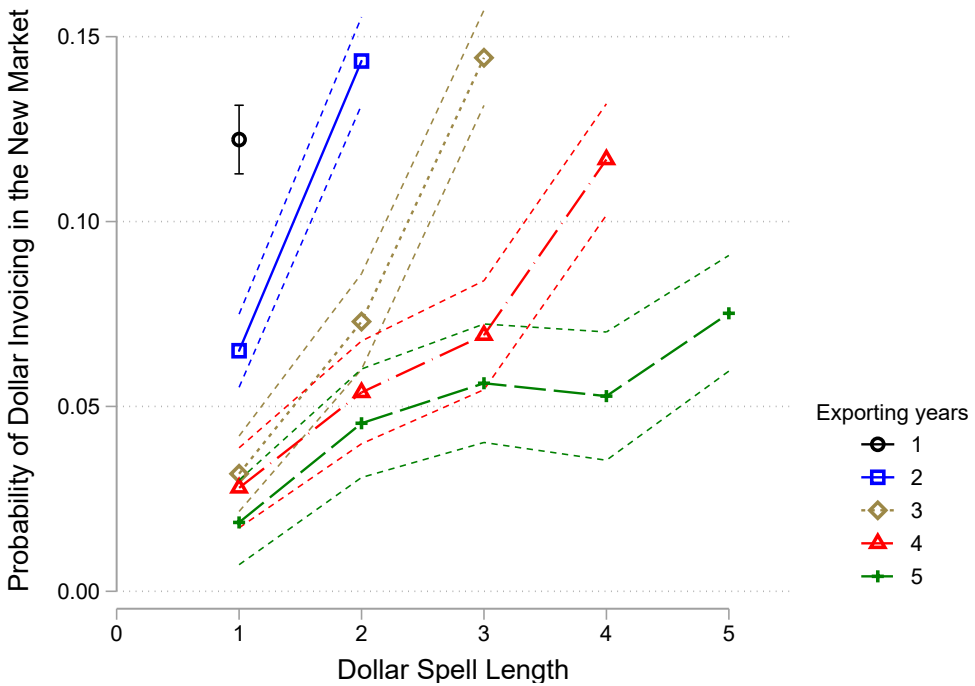


- Dollar spell length is the number of years the firm has invoiced any foreign sales in dollars prior to its entry into the new market
- Dollar invoicing probability in a new market is increasing in the dollar spell length

Estimation Tables

Impact of prior dollar invoicing on new markets (3)

$$\mathbb{1}^{\text{USD}}_{fhdt} = \sum_{k=1}^{5}\sum_{l=0}^{k} \eta_{k,l} \, ExportTenure^{k}_{ft-1} * Spell^{\text{USD},l}_{ft-1}$$
$$+ \beta_1 \zeta^{\text{USD}}_{(-f)idt} + \beta_2 \psi^{\text{USD}}_{ft} + \beta_3 \psi^{\text{Euro}}_{ft} + \beta_4 \psi^{\text{LCI}}_{ft} + \gamma \text{size}_{ft} + \text{FEs} + \nu_{fhdt}$$



- Estimates obtained by interacting the dollar spell length dummies $Spell^{\text{USD},l}_{ft-1}$ with export tenure dummies $ExportTenure^{k}_{ft-1}$.
- Dollar invoicing probability is increasing in dollar spell length within each export tenure.

Roadmap

How can we build a model that explains the dynamic patterns?

$\Rightarrow$ Full model with joint invoicing decisions across markets

$\Rightarrow$ Implications on aggregate invoicing dynamics

Shared fixed cost and joint decisions

- Shared global fixed cost of using each currency c

$$F_{ft}^{c} = \begin{cases} \frac{\kappa_0^c}{\sum_d \mathbb{1}_{fdt}^c} & \text{if } \sum_d \mathbb{1}_{fdt}^c > 0 \\ 0 & \text{if } \sum_d \mathbb{1}_{fdt}^c = 0 \end{cases}$$

where $\sum_d \mathbb{1}_{fdt}^c$ = number of markets where the firm uses invoicing currency c. $\Rightarrow$ The cost of using dollars F_{ft}^{USD} decreases as the firm adds more dollar markets.

- Joint market decisions

$$\max_{c_{1t},\ldots,c_{dt},\ldots,c_{Dt}} \left\{ \sum_{d \in \mathcal{D}_{ft}} \left[\max_{\bar{p}_{fdt}^{c_{dt}}} \mathbb{E}\pi_{fdt}(\bar{p}_{fdt}^{c_{dt}}) - F_{ft}^{c_{dt}}(c_{1t}, \ldots, c_{dt}, \ldots, c_{Dt}) \right] \right\}$$

$\Rightarrow$ Invoicing and pricing choices are inter-dependent across markets.

- Deterministic entry for simplicity: Assume firms expand globally by adding one foreign market in each period.

More details

Shared fixed cost and joint decisions

- Shared global fixed cost of using each currency c

$$F_{ft}^{c} = \begin{cases} \frac{\kappa_0^c}{\sum_d \mathbb{1}_{fdt}^c} & \text{if } \sum_d \mathbb{1}_{fdt}^c > 0 \\ 0 & \text{if } \sum_d \mathbb{1}_{fdt}^c = 0 \end{cases}$$

where $\sum_d \mathbb{1}_{fdt}^c$ = number of markets where the firm uses invoicing currency c. $\Rightarrow$ The cost of using dollars F_{ft}^{USD} decreases as the firm adds more dollar markets.

- Joint market decisions

$$\max_{c_{1t},\ldots,c_{dt},\ldots,c_{Dt}} \left\{ \sum_{d \in \mathcal{D}_{ft}} \left[\max_{\bar{p}_{fdt}^{c_{dt}}} \mathbb{E}\pi_{fdt}(\bar{p}_{fdt}^{c_{dt}}) - F_{ft}^{c_{dt}}(c_{1t}, \ldots, c_{dt}, \ldots, c_{Dt}) \right] \right\}$$

$\Rightarrow$ Invoicing and pricing choices are inter-dependent across markets.

- Deterministic entry for simplicity: Assume firms expand globally by adding one foreign market in each period.

More details

Shared fixed cost and joint decisions

- Shared global fixed cost of using each currency c

$$F_{ft}^{c} = \begin{cases} \frac{\kappa_0^c}{\sum_d \mathbb{1}_{fdt}^c} & \text{if } \sum_d \mathbb{1}_{fdt}^c > 0 \\ 0 & \text{if } \sum_d \mathbb{1}_{fdt}^c = 0 \end{cases}$$

where $\sum_d \mathbb{1}_{fdt}^c$ = number of markets where the firm uses invoicing currency c. $\Rightarrow$ The cost of using dollars F_{ft}^{USD} decreases as the firm adds more dollar markets.

- Joint market decisions

$$\max_{c_{1t},\ldots,c_{dt},\ldots,c_{Dt}} \left\{ \sum_{d \in \mathcal{D}_{ft}} \left[\max_{\bar{p}_{fdt}^{c_{dt}}} \mathbb{E}\pi_{fdt}(\bar{p}_{fdt}^{c_{dt}}) - F_{ft}^{c_{dt}}(c_{1t}, \ldots, c_{dt}, \ldots, c_{Dt}) \right] \right\}$$

$\Rightarrow$ Invoicing and pricing choices are inter-dependent across markets.

- Deterministic entry for simplicity: Assume firms expand globally by adding one foreign market in each period.

More details

Shared fixed cost and joint decisions

- Shared global fixed cost of using each currency c

$$F_{ft}^{c} = \begin{cases} \frac{\kappa_0^c}{\sum_d \mathbb{1}_{fdt}^c} & \text{if } \sum_d \mathbb{1}_{fdt}^c > 0 \\ 0 & \text{if } \sum_d \mathbb{1}_{fdt}^c = 0 \end{cases}$$

where $\sum_d \mathbb{1}_{fdt}^c$ = number of markets where the firm uses invoicing currency c. $\Rightarrow$ The cost of using dollars F_{ft}^{USD} decreases as the firm adds more dollar markets.

- Joint market decisions

$$\max_{c_{1t},\ldots,c_{dt},\ldots,c_{Dt}} \left\{ \sum_{d \in \mathcal{D}_{ft}} \left[\max_{\bar{p}_{fdt}^{c_{dt}}} \mathbb{E}\pi_{fdt}(\bar{p}_{fdt}^{c_{dt}}) - F_{ft}^{c_{dt}}(c_{1t}, \ldots, c_{dt}, \ldots, c_{Dt}) \right] \right\}$$

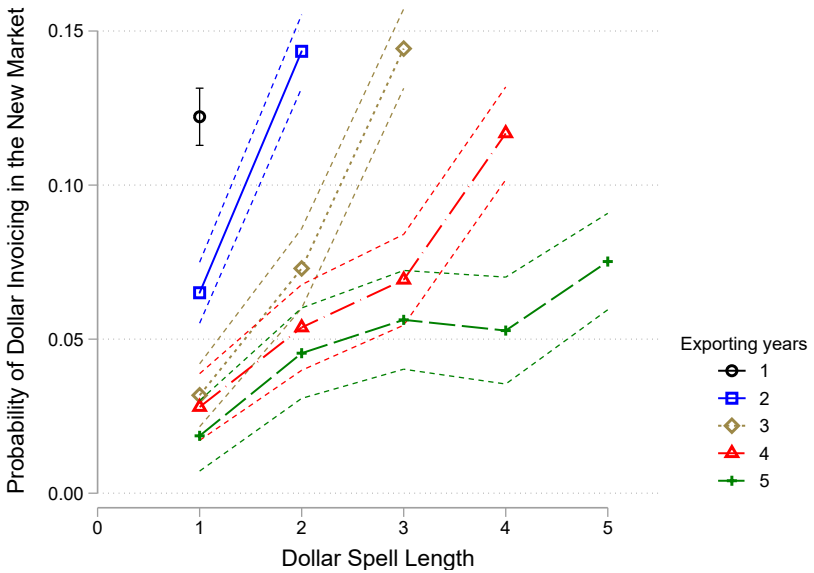
$\Rightarrow$ Invoicing and pricing choices are inter-dependent across markets.

- Deterministic entry for simplicity: Assume firms expand globally by adding one foreign market in each period.

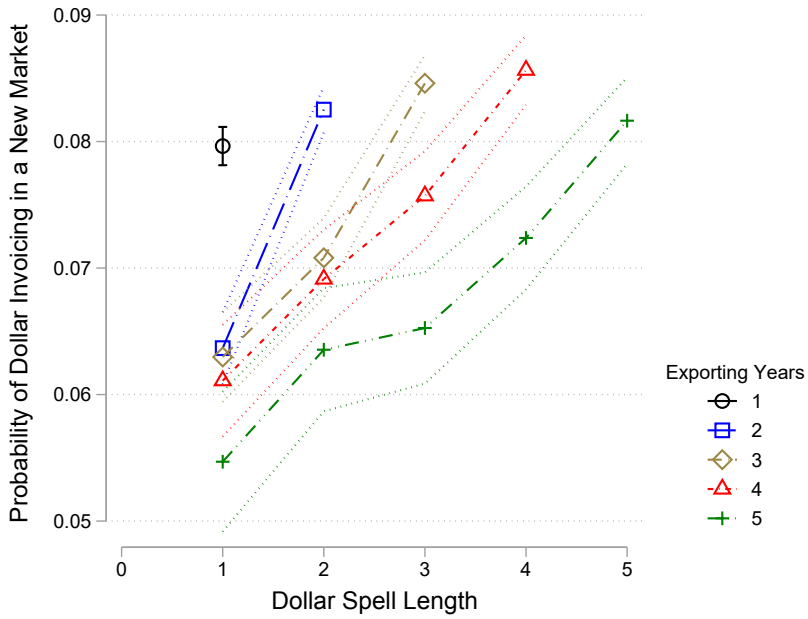
More details

Empirical vs model: dollar invoicing by export tenure

(a) Empirical Estimates



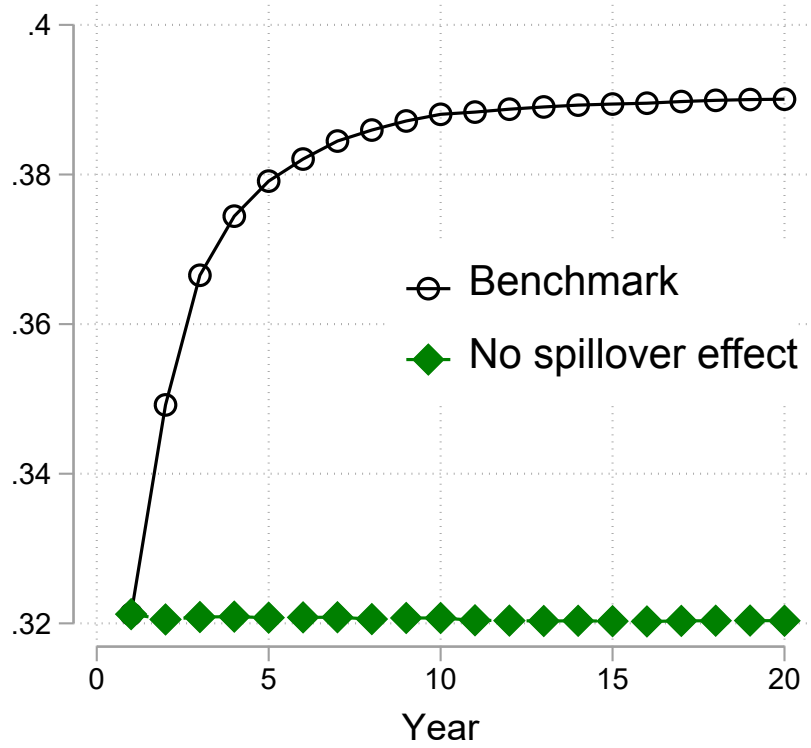
(b) Model Estimates



The shared global cost does a reasonably good job in replicating the patterns:

- The dollar spell length within an export tenure is indicative of the profitability of dollar usage in the firm's existing markets
- The higher the profitability of using dollars in other markets
  $\rightarrow$ the higher the probability the cost of using dollars can be shared
  $\rightarrow$ the higher the probability of using dollars in a new market

Counterfactual: Evolution of aggregate dollar invoicing share in absence of any external shock



- Recall in data: Aggregate dollar invoicing share of non-EU British exports increased from 0.32 in 2010 to 0.48 in 2019
- Dynamic spillovers explain $\approx 44\%$ $(= \frac{0.39-0.32}{0.48-0.32})$ of the increase

Conclusions

Using transaction-level data for UK exporters over 2010-2016, we uncover a new dynamic channel for dollar-invoicing choices:

- Firms entering a new destination are more likely to adopt dollars if they used dollars more intensively and persistently in their existing markets

  $\Rightarrow$ Strong spillovers of a firm's invo. choices across mkts and over time

- Propose a model that introduces a fixed cost of currency use at the firm level and features joint invoicing decisions across markets

  $\Rightarrow$ Dynamic spillovers explain more than 40% of the recent increase in the aggregate dollar invoicing share of UK exporters

Conclusions

Using transaction-level data for UK exporters over 2010-2016, we uncover a new dynamic channel for dollar-invoicing choices:

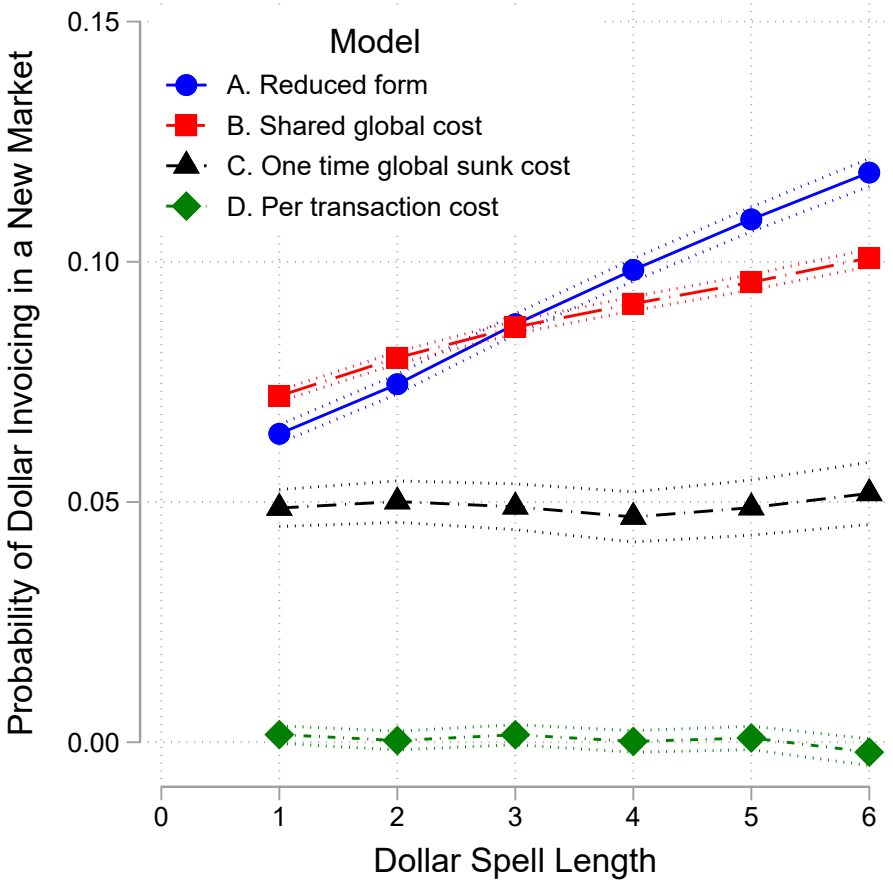
- Firms entering a new destination are more likely to adopt dollars if they used dollars more intensively and persistently in their existing markets

  $\Rightarrow$ Strong spillovers of a firm's invo. choices across mkts and over time

- Propose a model that introduces a fixed cost of currency use at the firm level and features joint invoicing decisions across markets

  $\Rightarrow$ Dynamic spillovers explain more than 40% of the recent increase in the aggregate dollar invoicing share of UK exporters

Functional forms of the cost of currency use



Dollar invoicing probability is increasing in Dollar Spell Length when fixed cost modelled as

- Reduced form: $F(\omega^c_{ft-1}) = \kappa_1 - \kappa_2 \cdot \omega^c_{ft-1}$
- Shared global cost: $F^c_{ft} = \frac{\kappa^c_0}{\sum_d \mathbb{1}^c_{fdt}}$

One-time sunk and per period fixed costs cannot replicate the empirical pattern.

Notes: Estimates based on simulated data of 200,000 firms with 10 destinations over 10 periods.

Summary statistics of the main estimation sample

	Obs	Un-weighted Mean	Un-weighted Std	Weighted Mean	Weighted Std
Dollar invoicing probability	4,719,628	0.229	0.420	0.362	0.480
Dollar import share	4,719,628	0.571	0.391	0.603	0.365
Euro import share	4,719,628	0.055	0.158	0.054	0.159
Destination currency import share	4,719,628	0.113	0.287	0.199	0.346
UK competitors' dollar invoicing share	4,719,628	0.254	0.285	0.359	0.336
UK competitor's dollar import share	4,719,628	0.578	0.246	0.594	0.272

Notes: 'Weighted' indicates that the variables are weighted by export values at the firm-product-destination-year level. Data source: HMRC Overseas Trade in Goods Statistics, UK's non-EU export transactions, 2010-2016.

Back

Dollar invoicing probability at entry year

Dep. Var.: $\mathbb{1}_{fhdt}^{USD}$	(1)	(2)	(3)
UK competitors' dollar invoicing share	0.069***	0.071***	0.071***
	(0.007)	(0.007)	(0.007)
Dollar import share	0.093***	0.103***	0.103***
	(0.001)	(0.001)	(0.001)
Euro import share	-0.014***	-0.017***	-0.017***
	(0.002)	(0.002)	(0.002)
Destination currency import share	0.022***	0.014***	0.015***
	(0.002)	(0.002)	(0.002)
Firm size	0.013***	0.013***	0.013***
	(0.000)	(0.000)	(0.000)
Dollar share in total export (t-1)	**0.292*** **		
	(0.002)		
Dollar invoicing years (t-1)		0.025***	
		(0.000)	
Dollar invoicing years (t-1) = 1			0.039***
			(0.001)
Dollar invoicing years (t-1) = 2			0.060***
			(0.002)
Dollar invoicing years (t-1) = 3			0.082***
			(0.002)
Dollar invoicing years (t-1) = 4			0.097***
			(0.003)
Dollar invoicing years (t-1) = 5			0.116***
			(0.004)
Dollar invoicing years (t-1) = 6			0.140***
			(0.005)
Observations	1,181,074	1,181,074	1,181,074
Country-Year FE	✓	✓	✓
Product-Year FE	✓	✓	✓
Hansen J-stat [p-value]	0.0204 [0.886]	0.009 [0.922]	0.008 [0.926]
Weak IV F-stat	15,143	15,143	15,142

Back

Note: Observations are of the first-year of exporting in each firm-destination pair. All results are based on 2SLS. Robust standard errors in parentheses. Data source: HMRC Overseas Trade in Goods Statistics, UK's non-EU export transactions, 2010-2016.

Variable construction

- (Strategic complementarity) $\zeta^{\text{USD}}_{(-f)idt}$ is the average dollar invoicing share in exports of UK firms excluding firm f at 6-digit HS industry i to destination d in year t:

$$\zeta^{\text{USD}}_{(-f)idt} = \frac{\sum_{k \neq f} \text{Export}^{\text{USD}}_{kidt}}{\sum_c \sum_{k \neq f} \text{Export}^{c}_{kidt}}$$

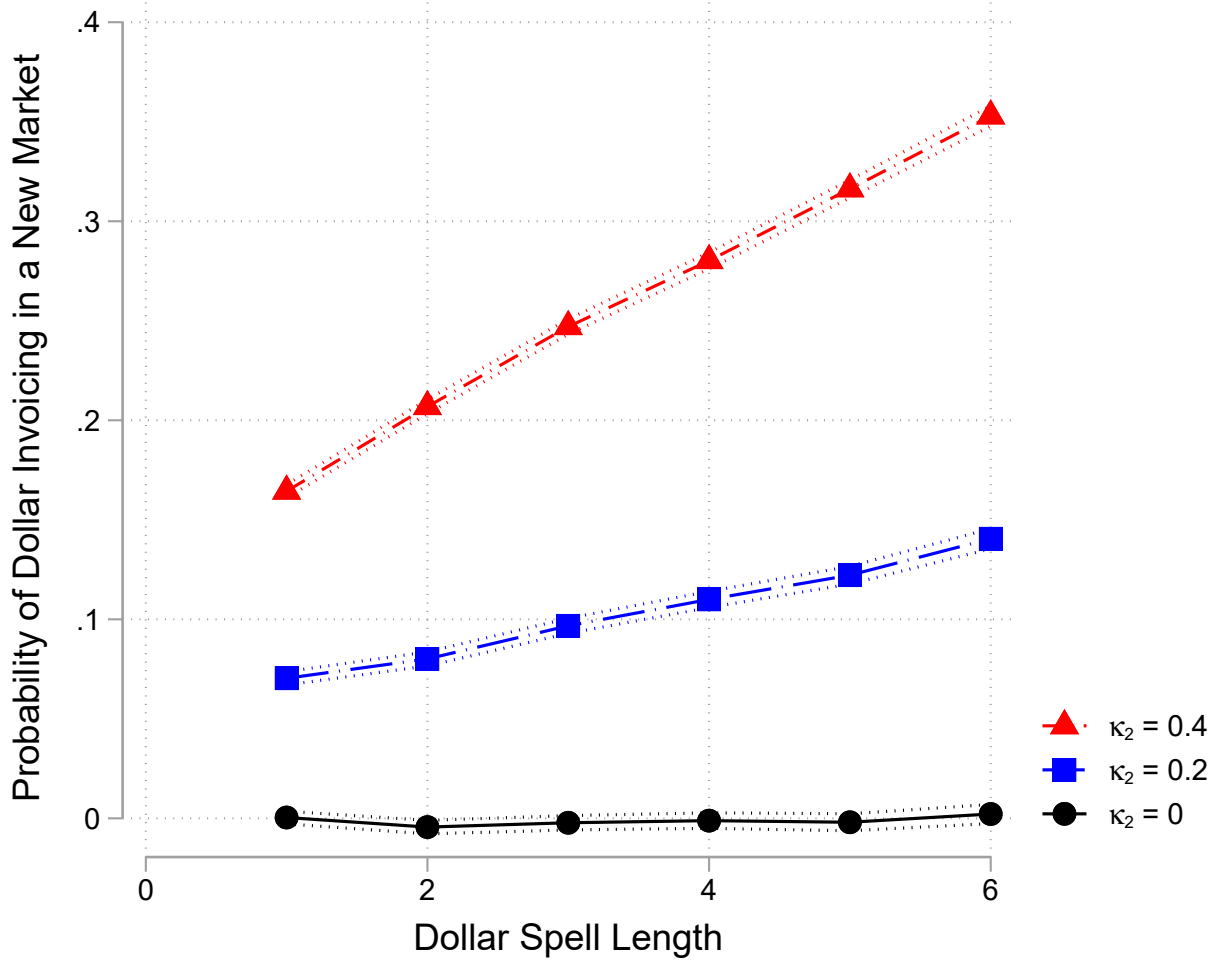
  where Export^{c}_{fidt} denotes firm f's export value invoiced in currency c at 6-digit HS industry i to country d in year t.

- (Operational hedging) ψ^{c}_{ft} is the share of currency c in firm f's total import in year t and $c \in \{\text{USD}, \text{Euro}, \text{LCI}\}$:

$$\psi^{c}_{ft} = \frac{\text{Import}^{c}_{ft}}{\sum_c \text{Import}^{c}_{ft}}$$

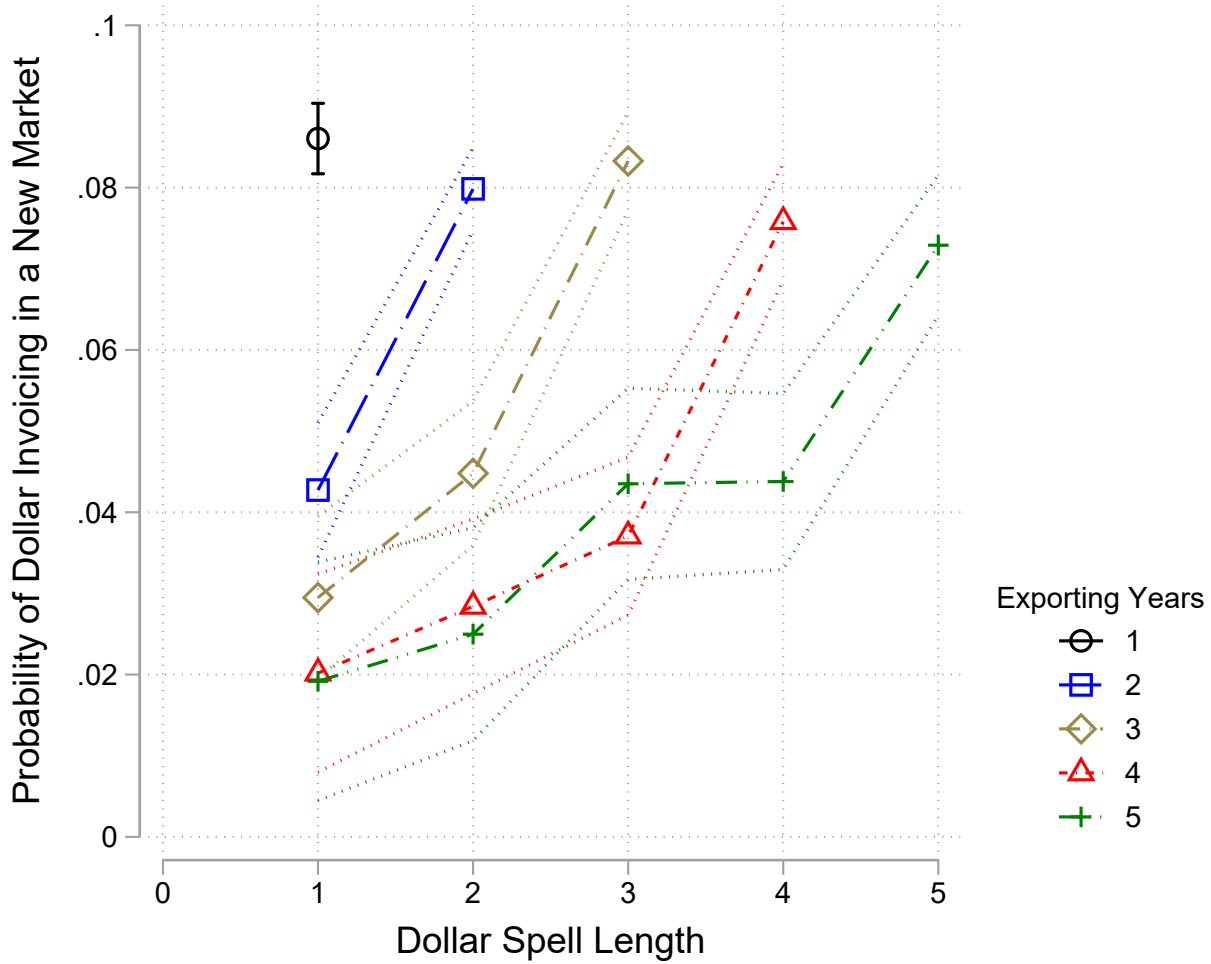
Back

Comparison of Dynamic Predictions



Notes: Estimates based on simulated data of 200,000 firms with 10 destinations over 10 periods. Dollar Spell Length = the number of dollar invoicing years prior to entry.

Reduced form setting



Notes: Estimates based on simulated data of 200,000 firms with 10 destinations over 10 periods. We calibrate $\kappa_1 = 0.6$ and $\kappa_2 = 0.18$.

Back

Heterogeneity over market power

	(1) Baseline	(2) Large	(3) Small
UK competitors' dollar invoicing share	0.076***	0.100***	0.046***
	(0.004)	(0.005)	(0.006)
Dollar import share	0.164***	0.163***	0.160***
	(0.000)	(0.001)	(0.001)
Euro import share	-0.009***	-0.012***	-0.012***
	(0.001)	(0.001)	(0.002)
Destination curr. import share	-0.018***	-0.042***	-0.010***
	(0.001)	(0.002)	(0.001)
Firm size	0.016***	0.013***	0.018***
	(0.000)	(0.000)	(0.000)
Observations	4,719,628	2,359,085	2,354,927
Country-Year FE	✓	✓	✓
Product-Year FE	✓	✓	✓
Hansen J-stat	0.156	0.003	2.389
[P-value]	[0.693]	[0.956]	[0.122]
Weak IV F-stat	69,591	36,632	39,551

⇒ Larger firms (based on median export value in a destination) exhibit a stronger tendency to align their currency with their competitors.

Back

Heterogeneity over product differentiation

	(1) Homog. (Rauch)	(2) Diff. (Rauch)	(3) Low diff. (CCHS)	(4) High diff. (CCHS)
UK competitors' dollar invoicing share	0.198**	0.075***	0.091***	0.043***
	(0.092)	(0.004)	(0.005)	(0.006)
Dollar import share	0.102***	0.164***	0.150***	0.182***
	(0.011)	(0.000)	(0.001)	(0.001)
Euro import share	-0.015	-0.009***	-0.010***	-0.010***
	(0.035)	(0.001)	(0.001)	(0.002)
Destination currency import share	0.081***	-0.019***	-0.011***	-0.029***
	(0.030)	(0.001)	(0.002)	(0.002)
Firm size	0.007***	0.016***	0.017***	0.015***
	(0.001)	(0.000)	(0.000)	(0.000)
Observations	10,663	4,708,964	2,611,076	1,883,102
Country-Year FE	✓	✓	✓	✓
Product-Year FE	✓	✓	✓	✓
Hansen J-stat	0.179	0.154	0.245	0.0368
[p-value]	[0.672]	[0.695]	[0.621]	[0.848]
Weak IV F-stat	89	69,553	35,952	29,562

⇒ The motive is stronger for less differentiated/more substitutable goods based on both Rauch (1999) and Corsetti, Crowley, Han and Song (2018).

Back

Addressing endogeneity of competitors' currency choice

- We build two instruments for the UK competitors' dollar invoicing export share $\zeta^{\text{USD}}_{(-f)idt}$:

(1) UK competitors' average dollar import share

$$\psi^{\text{USD}}_{(-f)idt} = \sum_{k \neq f} \frac{S_{kidt}}{1 - S_{fidt}} \times \psi^{\text{USD}}_{kt}$$

(2) UK competitor's average firm size

$$\text{Size}_{(-f)idt} = \sum_{k \neq f} \frac{S_{kidt}}{1 - S_{fidt}} \times \text{Size}_{kt}$$

where S_{fidt} denotes the firm f's export share in 6-digit HS industry i to destination d in year t among all UK firms ($S_{fidt} = \frac{\text{Export}_{fidt}}{\sum_i \text{Export}_{fidt}}$)

Currency choice in new markets

- Assume firms expand globally by adding one foreign market in each period.
- We assume, after controlling for the observable factors of strategic complementarity $\zeta_{(-f)d}$ and operational hedging ψ_{fd}, the expected *operational* profit differences are uniformly distributed for each destination:

$$\mathbb{E}[\pi_{fd}^{\text{USD}} - \pi_{fd}^{\text{PCI}} | \zeta_{(-f)d}, \psi_{fd}] \sim U(0,1);$$
$$\mathbb{E}[\pi_{fd}^{\text{LCI}} - \pi_{fd}^{\text{PCI}} | \zeta_{(-f)d}, \psi_{fd}] \sim U(0,1)$$

- Firm f chooses dollars in a new destination d if

$$\mathbb{E}[\pi_{fd}^{\text{USD}} - \pi_{fd}^{\text{PCI}} | \zeta_{(-f)d}, \psi_{fd}] > F_f^{\text{USD}}(c_1, ..., c_d) - 0 \quad \text{and}$$
$$\mathbb{E}[\pi_{fd}^{\text{USD}} - \pi_{fd}^{\text{LCI}} | \zeta_{(-f)d}, \psi_{fd}] > F_f^{\text{USD}}(c_1, ..., c_d) - F_f^{\text{LCI}}(c_1, ..., c_d)$$

Back

Analytical approximation to characterize the evolution of aggregate invoicing shares

- Joint decisions and shared global fixed cost

$$\max_{c_{1t},\ldots,c_{dt},\ldots,c_{Dt}} \left\{ \sum_{d \in \mathcal{D}_{ft}} \left[\max_{\bar{p}_{fdt}^{c_{dt}}} \mathbb{E}\pi_{fdt}(\bar{p}_{fdt}^{c_{dt}} - e_{dt}^{c_{dt}}) - F_{ft}^{c_{dt}}(c_{1t}, \ldots, c_{dt}, \ldots, c_{Dt}) \right] \right\}$$

$\rightarrow$ No closed form solution $\rightarrow$ can only be solved numerically

- Analytically, we approximate the desired dynamics with:

$$F(\omega_{ft-1}^{c}) = \kappa_1 - \kappa_2 \cdot \omega_{ft-1}^{c}$$

  - κ_1 initial cost of invoicing in c $(0 < \kappa_1 < 1)$
  - κ_2 degree of cost reduction due to prior usage $(0 < \kappa_2 < \kappa_1)$
  - ω_{ft-1}^{c} invoicing share of currency c in firm f's global exports at $t-1$

Pattern generated by the reduced form setting

Analytical approximation to characterize the evolution of aggregate invoicing shares

- Joint decisions and shared global fixed cost

$$\max_{c_{1t},\ldots,c_{dt},\ldots,c_{Dt}} \left\{ \sum_{d \in \mathcal{D}_{ft}} \left[\max_{\bar{p}_{fdt}^{c_{dt}}} \mathbb{E}\pi_{fdt}(\bar{p}_{fdt}^{c_{dt}} - e_{dt}^{c_{dt}}) - F_{ft}^{c_{dt}}(c_{1t}, \ldots, c_{dt}, \ldots, c_{Dt}) \right] \right\}$$

  $\rightarrow$ No closed form solution $\rightarrow$ can only be solved numerically

- Analytically, we approximate the desired dynamics with:

$$F(\omega_{ft-1}^{c}) = \kappa_1 - \kappa_2 \cdot \omega_{ft-1}^{c}$$

  - κ_1 initial cost of invoicing in c $(0 < \kappa_1 < 1)$
  - κ_2 degree of cost reduction due to prior usage $(0 < \kappa_2 < \kappa_1)$
  - ω_{ft-1}^{c} invoicing share of currency c in firm f's global exports at $t-1$

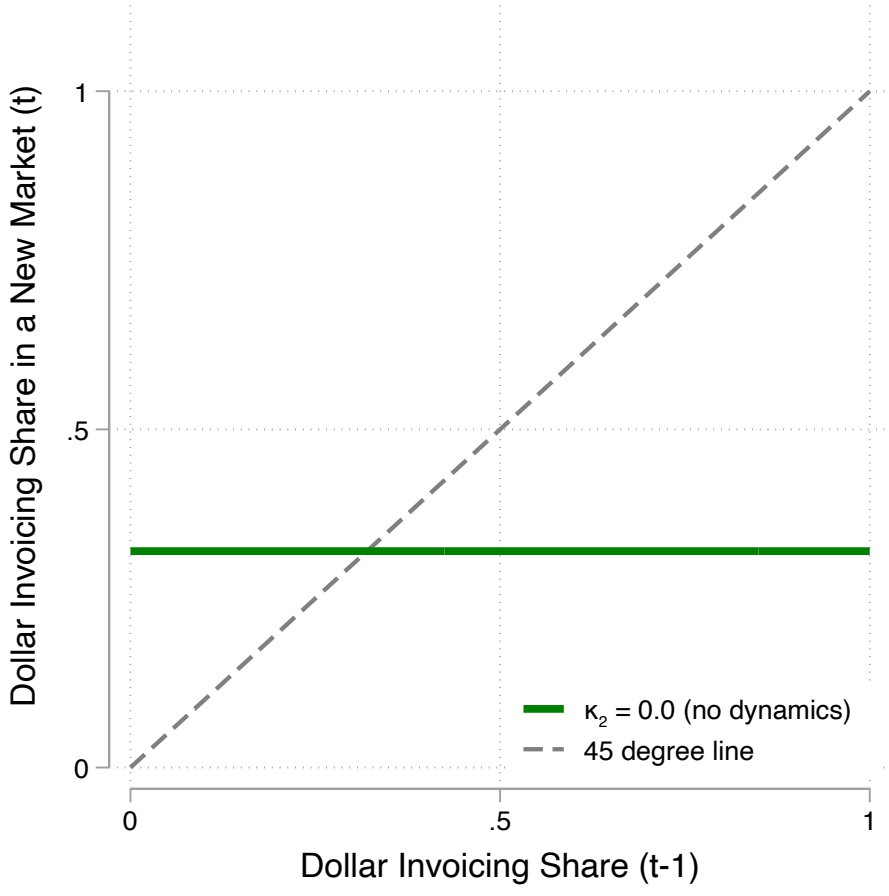
Pattern generated by the reduced form setting

Dollar transition function

The probability of dollar-invoicing in a new market can be derived as:

$$T(\omega_{ft-1}^{\text{USD}}) = \frac{1}{2}(1+\kappa_2\omega_{ft-1}^{\text{USD}})^2 - \frac{1}{2}(\kappa_1)^2$$

- $\Rightarrow$ No dynamics if $\kappa_2 = 0$
- $\Rightarrow$ Rising share if $\kappa_2 > 0$
- $\Rightarrow$ Dollar-only eqm if κ_2 is too big



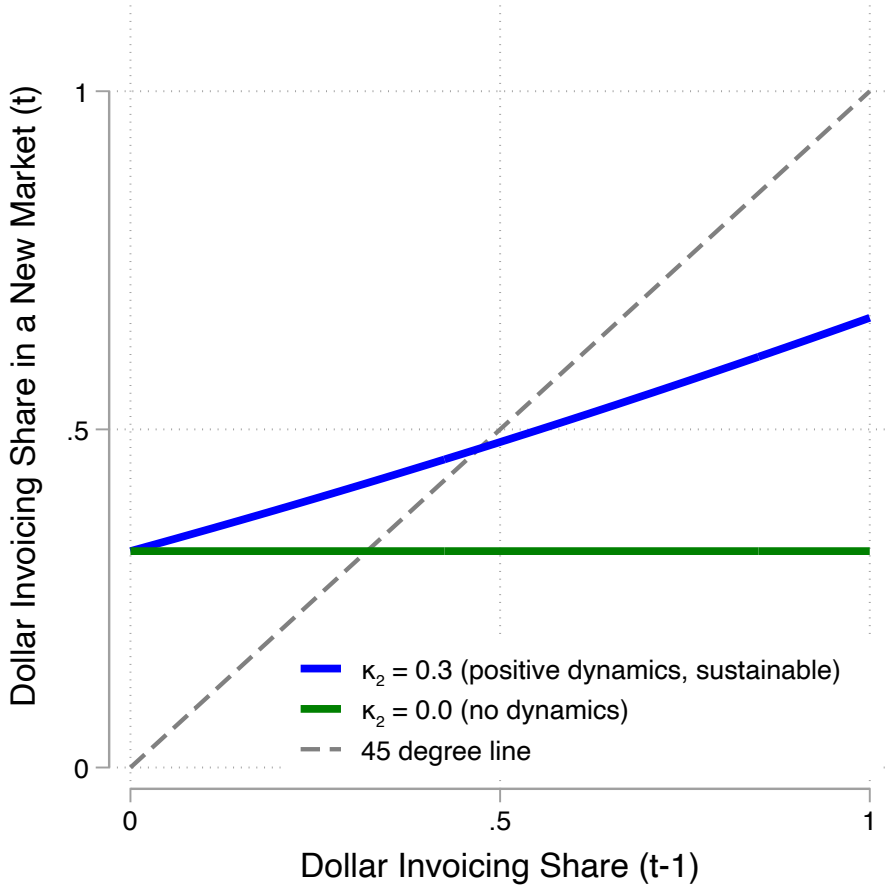
Note: $\kappa_1 = 0.6$.

Dollar transition function

The probability of dollar-invoicing in a new market can be derived as:

$$T(\omega_{ft-1}^{\text{USD}}) = \frac{1}{2}(1+\kappa_2\omega_{ft-1}^{\text{USD}})^2 - \frac{1}{2}(\kappa_1)^2$$

- $\Rightarrow$ No dynamics if $\kappa_2 = 0$
- $\Rightarrow$ Rising share if $\kappa_2 > 0$
- $\Rightarrow$ Dollar-only eqm if κ_2 is too big



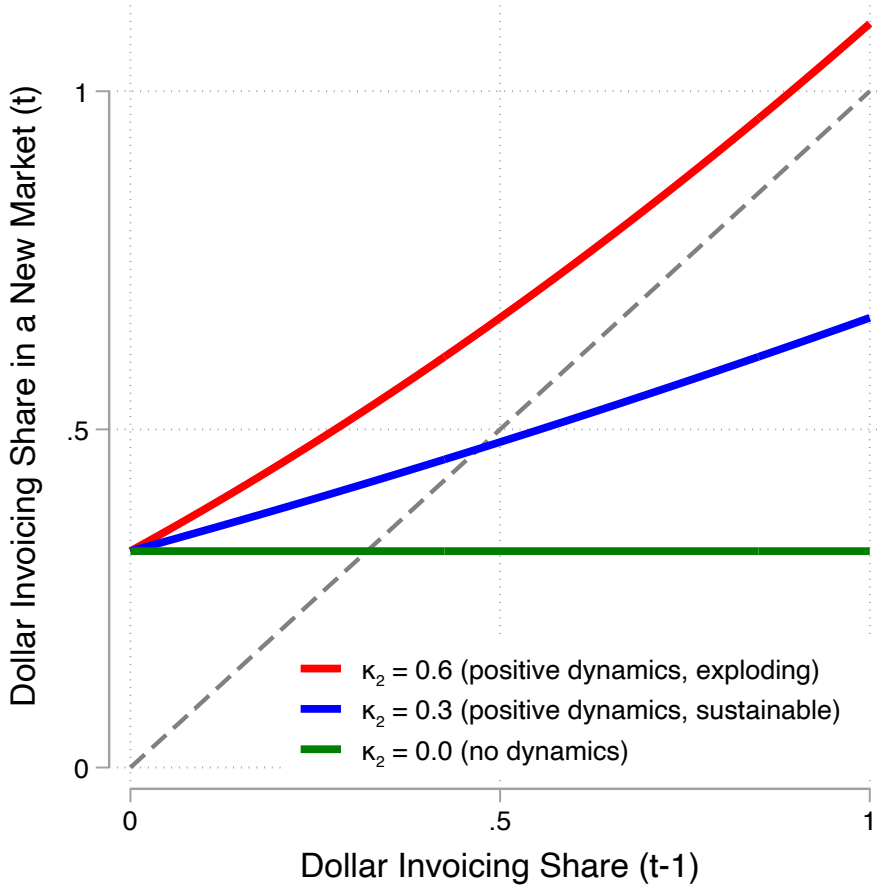
Note: $\kappa_1 = 0.6$.

Dollar transition function

The probability of dollar-invoicing in a new market can be derived as:

$$T(\omega_{ft-1}^{\text{USD}}) = \frac{1}{2}(1+\kappa_2\omega_{ft-1}^{\text{USD}})^2 - \frac{1}{2}(\kappa_1)^2$$

- $\Rightarrow$ No dynamics if $\kappa_2 = 0$
- $\Rightarrow$ Rising share if $\kappa_2 > 0$
- $\Rightarrow$ Dollar-only eqm if κ_2 is too big



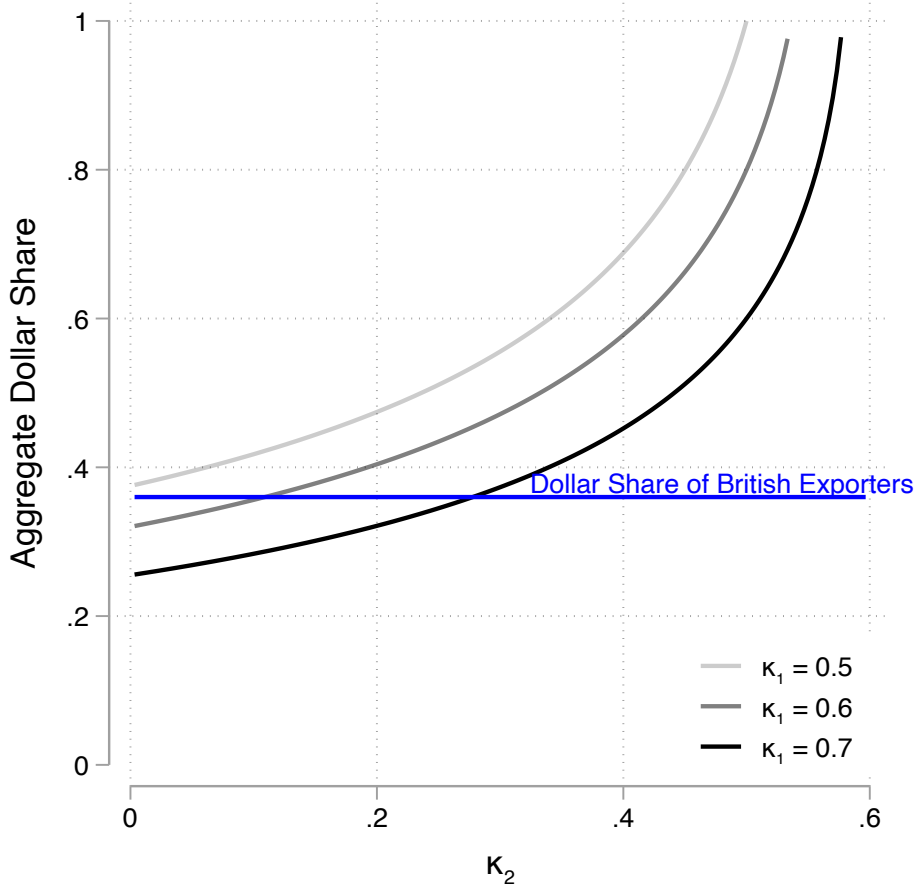
Note: $\kappa_1 = 0.6$.

Aggregate dollar share

In the steady state, aggregate level dollar invoicing share is:

$$\overline{\omega}^{\text{USD}} = \frac{1 - \kappa_2 - \sqrt{(\kappa_1\kappa_2)^2 - 2\kappa_2 + 1}}{(\kappa_2)^2}$$

$\Rightarrow$ the positive feedback ($\kappa_2 > 0$) does not necessarily lead to an ever-increasing dollar invoicing share.



Contribution to the literature

Invoicing currency and ERPT:

Engel (2006); Gopinath, Itskhoki & Rigobon (2010); Devereux, Dong & Tomlin (2017); Auer, Burstein & Lein (2021); Chen, Chung & Novy (2021); Corsetti, Crowley & Han (2021)

Empirics and theory on invoicing choices:

Strategic complementarity: Goldberg & Tille (2008)

Operational hedging: Chung (2016); Amiti, Itskhoki & Konings (2020)

⇒ Document interdependence of invoicing choices across markets and over time

Dominant currency and international shock transmissions:

Gopinath et al (2020); Mukhin (2021)

⇒ Add a cost of currency use that captures dynamic and global spillovers
⇒ Quantify contribution of spillover effects to the rise of a dominant currency

Back

Contribution to the literature

Invoicing currency and ERPT:

Engel (2006); Gopinath, Itskhoki & Rigobon (2010); Devereux, Dong & Tomlin (2017); Auer, Burstein & Lein (2021); Chen, Chung & Novy (2021); Corsetti, Crowley & Han (2021)

Empirics and theory on invoicing choices:

Strategic complementarity: Goldberg & Tille (2008)

Operational hedging: Chung (2016); Amiti, Itskhoki & Konings (2020)

⇒ Document interdependence of invoicing choices across markets and over time

Dominant currency and international shock transmissions:

Gopinath et al (2020); Mukhin (2021)

⇒ Add a cost of currency use that captures dynamic and global spillovers
⇒ Quantify contribution of spillover effects to the rise of a dominant currency

Back

Contribution to the literature

Invoicing currency and ERPT:

Engel (2006); Gopinath, Itskhoki & Rigobon (2010); Devereux, Dong & Tomlin (2017); Auer, Burstein & Lein (2021); Chen, Chung & Novy (2021); Corsetti, Crowley & Han (2021)

Empirics and theory on invoicing choices:

Strategic complementarity: Goldberg & Tille (2008)

Operational hedging: Chung (2016); Amiti, Itskhoki & Konings (2020)

⇒ Document interdependence of invoicing choices across markets and over time

Dominant currency and international shock transmissions:

Gopinath et al (2020); Mukhin (2021)

⇒ Add a cost of currency use that captures dynamic and global spillovers
⇒ Quantify contribution of spillover effects to the rise of a dominant currency

Back

Firm's pricing problem

The firm chooses an invoicing currency c and its one-period ahead pre-set price $\bar{p}_{fd}^{c}$ to maximize its expected profit in each destination d:

$$\max_{c} \left\{ \max_{\bar{p}_{fd}^{c}} \mathbb{E}\left[\pi_{fd}(\bar{p}_{fd}^{c} - e_{d}^{c})\right] - F_{fd}^{c} \right\}$$

where F_{fd}^{c} is the cost of using currency c in destination d, e.g.

- cost of conducting transactions in a foreign currency
- cost of managing the risks in holding foreign currencies
- cost of hiring staffs to take care of the above issues

$\Rightarrow$ Functional form of F_{fd}^{c} to be investigated empirically.

Solution:

- without cost $\rightarrow$ choose currency that most closely mimics its optimal flexible price
- with cost $\rightarrow$ may deviate from the above solution

Firm's pricing problem

The firm chooses an invoicing currency c and its one-period ahead pre-set price $\bar{p}_{fd}^{c}$ to maximize its expected profit in each destination d:

$$\max_{c} \left\{ \max_{\bar{p}_{fd}^{c}} \mathbb{E}\left[\pi_{fd}(\bar{p}_{fd}^{c} - e_{d}^{c})\right] - F_{fd}^{c} \right\}$$

where F_{fd}^{c} is the cost of using currency c in destination d, e.g.

- cost of conducting transactions in a foreign currency
- cost of managing the risks in holding foreign currencies
- cost of hiring staffs to take care of the above issues

$\Rightarrow$ Functional form of F_{fd}^{c} to be investigated empirically.

Solution:

- without cost $\rightarrow$ choose currency that most closely mimics its optimal flexible price
- with cost $\rightarrow$ may deviate from the above solution

Firm's pricing problem

The firm chooses an invoicing currency c and its one-period ahead pre-set price $\bar{p}_{fd}^{c}$ to maximize its expected profit in each destination d:

$$\max_{c} \left\{ \max_{\bar{p}_{fd}^{c}} \mathbb{E}\left[\pi_{fd}(\bar{p}_{fd}^{c} - e_{d}^{c})\right] - F_{fd}^{c} \right\}$$

where F_{fd}^{c} is the cost of using currency c in destination d, e.g.

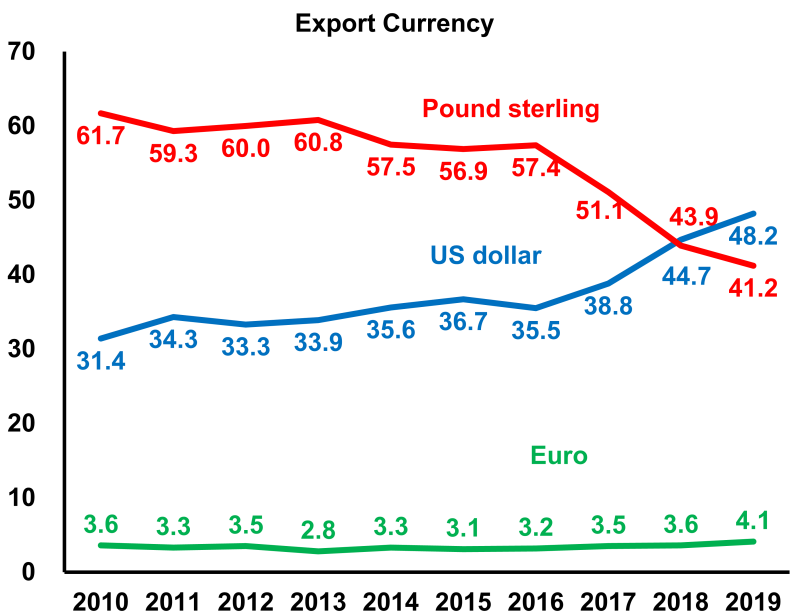
- cost of conducting transactions in a foreign currency
- cost of managing the risks in holding foreign currencies
- cost of hiring staffs to take care of the above issues

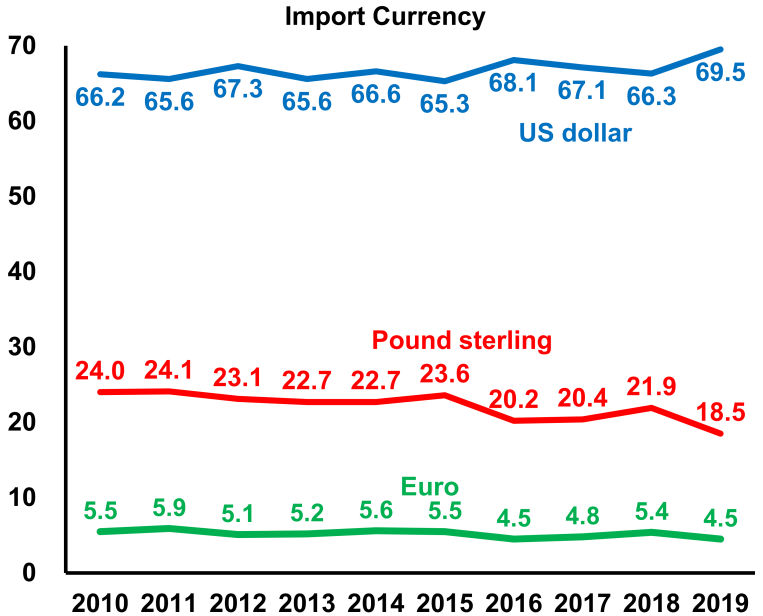
$\Rightarrow$ Functional form of F_{fd}^{c} to be investigated empirically.

Solution:

- without cost $\rightarrow$ choose currency that most closely mimics its optimal flexible price
- with cost $\rightarrow$ may deviate from the above solution

Aggregate invoicing shares of UK's extra-EU trade





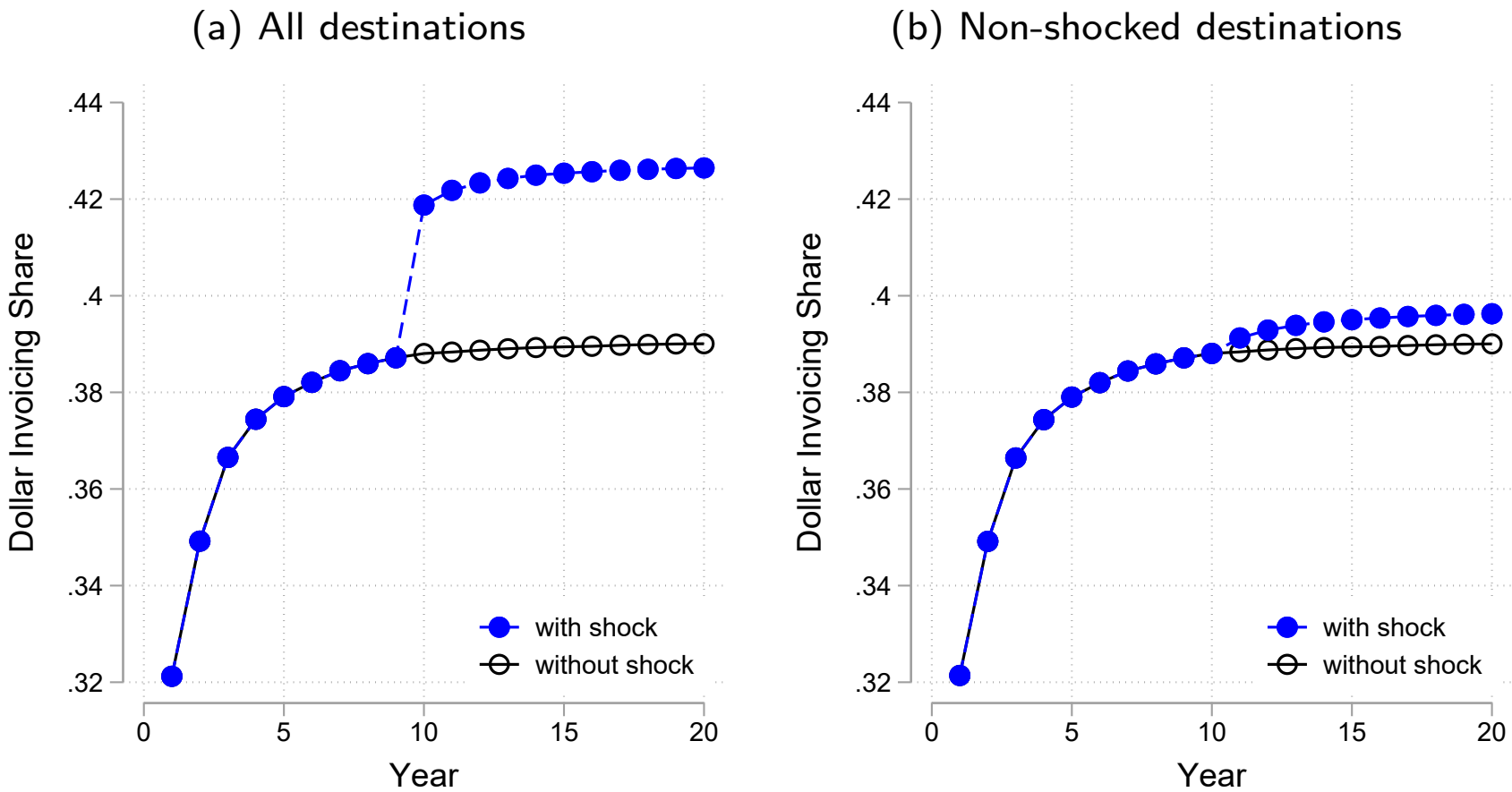
Source: HMRC IOC reports, 2011-2020.

- Significant rise of dollar share in exports; relatively stable dollar share in imports
- We investigate firms' invoicing choices using micro data of 2010-2016 and build a model to explain the evolution of the aggregate invoicing shares

Counterfactual 2: Propagation of shocks

- **Spillover effects of destination-specific shocks**:
  - We simulate the model for 20 years. Firms add one destination in each year.
  - A positive shock is given to the profitability of using dollars in destination 1 at year 10.
  - Direct impact: dollar share of destination 1 increases
  - Indirect impact: dollar share of non-shocked destinations rises over time

Propagation of destination-specific shock



Notes: The model is simulated for 20 years. Firms add one destination in each period. A positive shock is given to the profitability of using dollars in destination 1 at year 10.