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

29 December 2021

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)

What explains the extensive use of US dollars today?

A simple hypothesis:

- the US dominated world trade until the rise of China

$\Rightarrow$ 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 are (already) dominated by dollars or using relative 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

What explains the extensive use of US dollars today?

A simple hypothesis:

- the US dominated world trade until the rise of China

$\Rightarrow$ 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 are (already) dominated by dollars or using relative 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

What explains the extensive use of US dollars today?

A simple hypothesis:

- the US dominated world trade until the rise of China

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

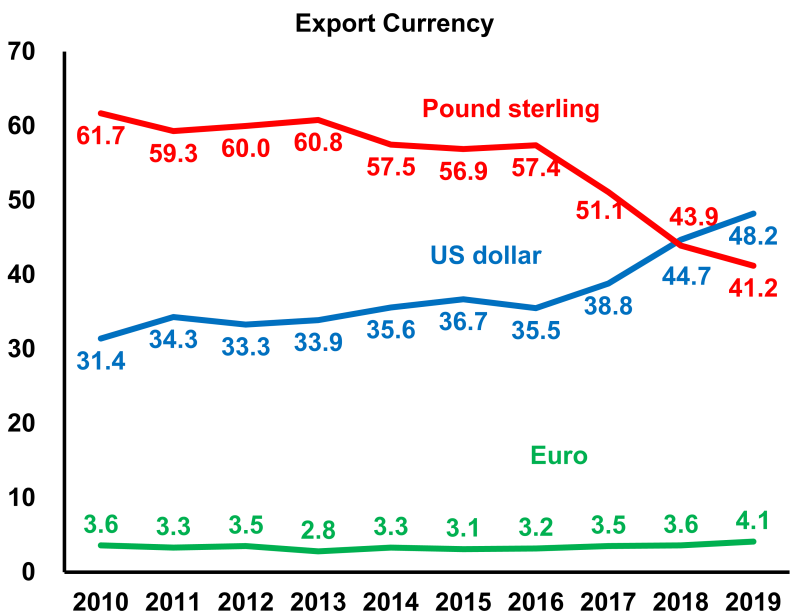
Empirical evidence is scarce:

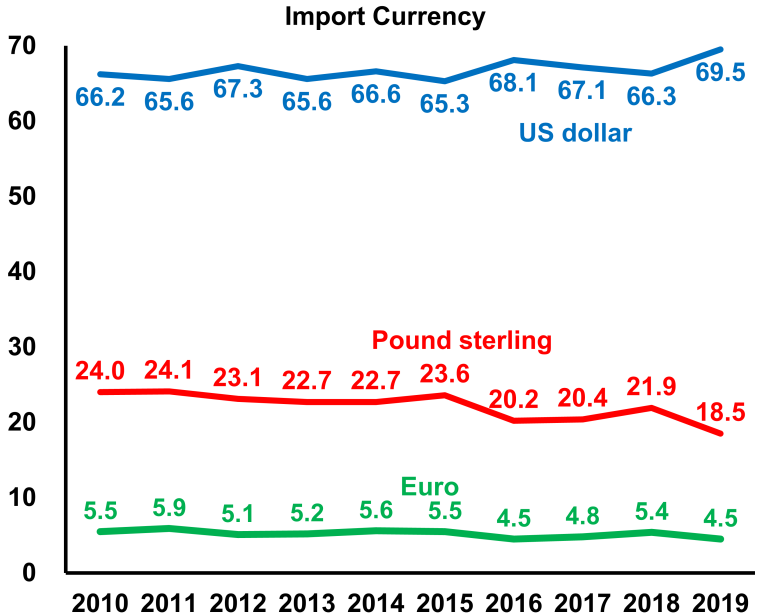
- transactional level data with invoicing currency is difficult to obtain
- existing studies focused on countries that are (already) dominated by dollars or using relative short panels

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

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

This paper

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

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

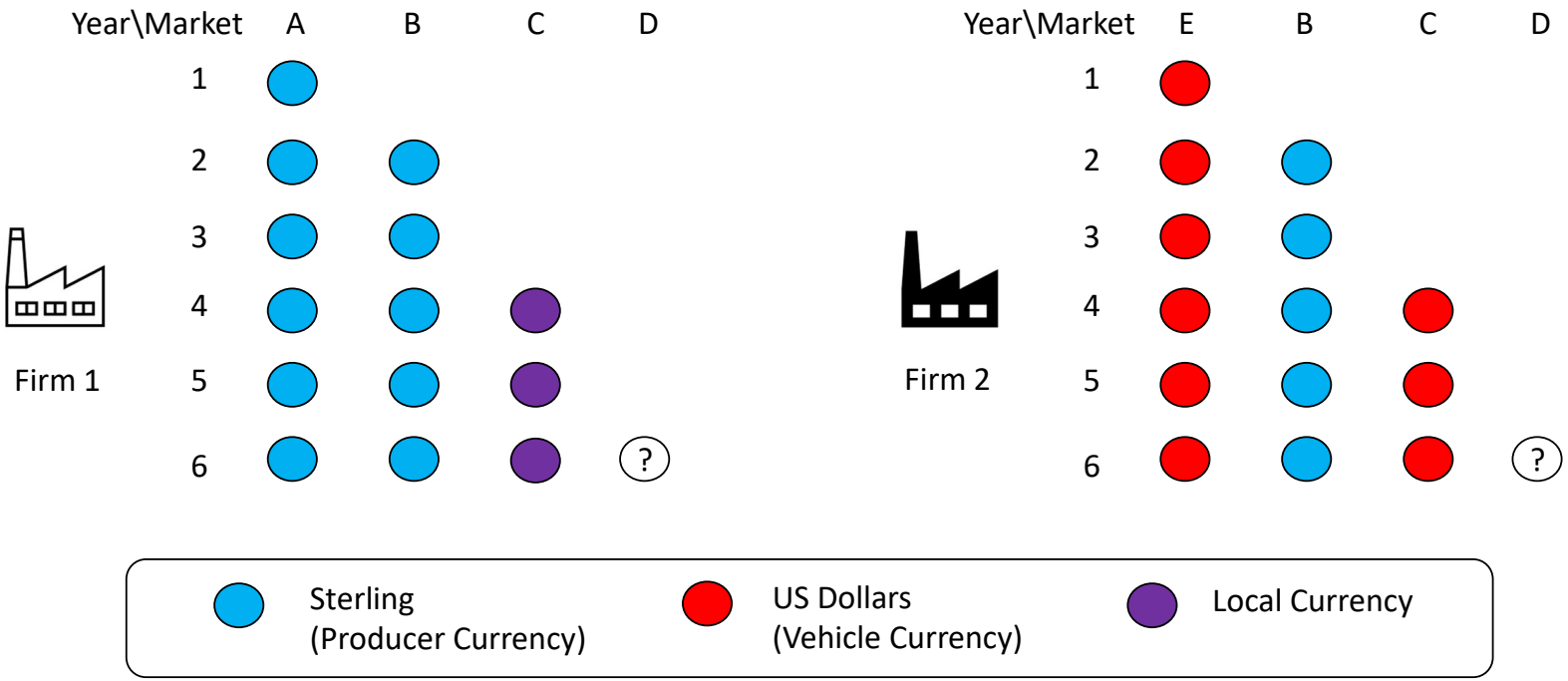
$\Rightarrow$ dollar invo. prob. in a new market increases in prior dollar experience

This paper

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

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 dollar share of UK's extra-EU exports would be 7% lower ($0.39 \rightarrow 0.32$) without the spillover effect.

This paper

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 dollar share of UK's extra-EU exports would be 7% lower ($0.39 \rightarrow 0.32$) without the spillover effect.

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

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

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

Roadmap

- Basic model with a fixed cost of currency use
- Empirical results
- Full model with joint invoicing decisions across markets
- Aggregate implications

Conceptual framework

We propose a framework 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

Conceptual framework

We propose a framework 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

Conceptual framework

We propose a framework 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

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

Optimal flexible price setting

Log optimal flexible price in local currency:

$$p_{fd} \propto \frac{\Gamma_{fd}}{1+\Gamma_{fd}} p_{-fd} + \frac{1}{1+\Gamma_{fd}} \left(\sum_{j}^{J} \psi_f^j e_j - e_d \right)$$

where

- p_{fd}: Log optimal price of firm f in local currency in destination d
- p_{-fd}: Log competitors' prices
- e_j: Log exchange rate in units of producer currency per unit of currency j
- ψ_f^j: Share of imported inputs invoiced in currency j in firm's production cost
- $\Gamma_{fd} \equiv \Gamma(S_{fd}; \rho, \eta)$: Markup elasticity to price, which is governed by firm f's market share in destination d (S_{fd}), elasticity of substitution within (ρ) and across sectors (η).

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

- $\mathbb{E}[\Pi_{fd}^{c}] \equiv \mathbb{E}[\pi_{fd}^{c}] - F_{fd}^{c}$: firm f's 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
- $\Gamma_{fd} \equiv \Gamma(S_{fd}; \rho, \eta)$: Markup elasticity depends on market share & elasticities of substitution within (ρ) & across sectors (η)

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

Empirical Analysis

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

We estimate our empirical specifications using two samples

1. Full sample to document the static determinants of currency choices
2. A subsample of new markets focusing on dollar dynamics

Statistics

Empirical specification

Linear probability model for dollar-invoicing by UK exporters (2010-2016):

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

where

- f (firm), h (product), i (industry), d (destination), t (year)
- $\mathbb{1}^{USD}_{fhdt}$: equal to one if dollar-invoicing and zero otherwise
- $\zeta^{\text{USD}}_{(-f)idt}$: strategic complementarity measure
  - ⋆ competitors' dollar-invoicing export share
  - ⋆ instrumented using competitors' dollar-invoiced import shares
- ψ^{USD}_{ft}, ψ^{Euro}_{ft}, ψ^{LCI}_{ft}: operational hedging measures
  - ⋆ dollar-, euro- and destination- currency invoiced import shares
- size_{ft}: total export value (in logs) to proxy for firm size

Empirical specification

Linear probability model for dollar-invoicing by UK exporters (2010-2016):

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

where

- f (firm), h (product), i (industry), d (destination), t (year)
- $\mathbb{1}_{fhdt}^{USD}$: equal to one if dollar-invoicing and zero otherwise
- $\zeta_{(-f)idt}^{\text{USD}}$: strategic complementarity measure
  - ⋆ competitors' dollar-invoicing export share
  - ⋆ instrumented using competitors' dollar-invoiced import shares
- ψ_{ft}^{USD}, ψ_{ft}^{Euro}, ψ_{ft}^{LCI}: operational hedging measures
  - ⋆ dollar-, euro- and destination- currency invoiced import shares
- size_{ft}: total export value (in logs) to proxy for firm size

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 ($S_{fidt} = \frac{\text{Export}_{fidt}}{\sum_i \text{Export}_{fidt}}$)

Strategic complementarity and operational hedging

DepVar: $\mathbb{1}_{fhdt}^{USD}$	(1) OLS	(2) OLS	(3) OLS	(4) IV
UK competitors' dollar invoicing share	0.319***	0.041***	0.026***	0.076***
	(0.001)	(0.001)	(0.001)	(0.004)
Dollar import share			0.164***	0.164***
			(0.000)	(0.000)
Euro import share			-0.009***	-0.009***
			(0.001)	(0.001)
Destination currency import share			-0.018***	-0.018***
			(0.001)	(0.001)
Firm size			0.016***	0.016***
			(0.000)	(0.000)
Observations	4,719,628	3,052,546	4,719,628	4,719,628
Firm-Product-Year FE		✓		
Country-Year FE		✓	✓	✓
Product-Year FE			✓	✓

Strategic complementarity: more likely to use dollars if more competitors use dollars

Operational hedging: more likely to use dollars if the firm uses lots of dollar inputs

Heterogeneity: by firm size | by high and low differentiation goods

Dollar invoicing in new destinations

Using a sample of entrants into new destinations, we examine how previous experience with dollar invoicing affects the invoicing choice in new markets:

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

- Variables capturing dynamics due to unobserved factors
  - $\omega^{\text{USD}}_{ft-1}$: dollar export share of firm f in year prior to entry into new market
  - $\mathit{Spell}^{\text{USD},l}_{ft-1} = 1$ if the firm has used dollars for l years in its existing markets prior to entry into new market
- Variables capturing static incentives
  - $\zeta^{\text{USD}}_{(-f)idt}$: strategic complementarity measure
  - ψ^{USD}_{ft}, ψ^{Euro}_{ft}, ψ^{LCI}_{ft}: operational hedging measures

Impact of prior dollar invoicing on new markets (1)

DepVar: $\mathbb{1}_{fhdt}^{USD}$	
UK competitors' dollar invoicing share	0.069***
	(0.007)
Dollar import share	0.093***
	(0.001)
Euro import share	-0.014***
	(0.002)
Destination currency 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.

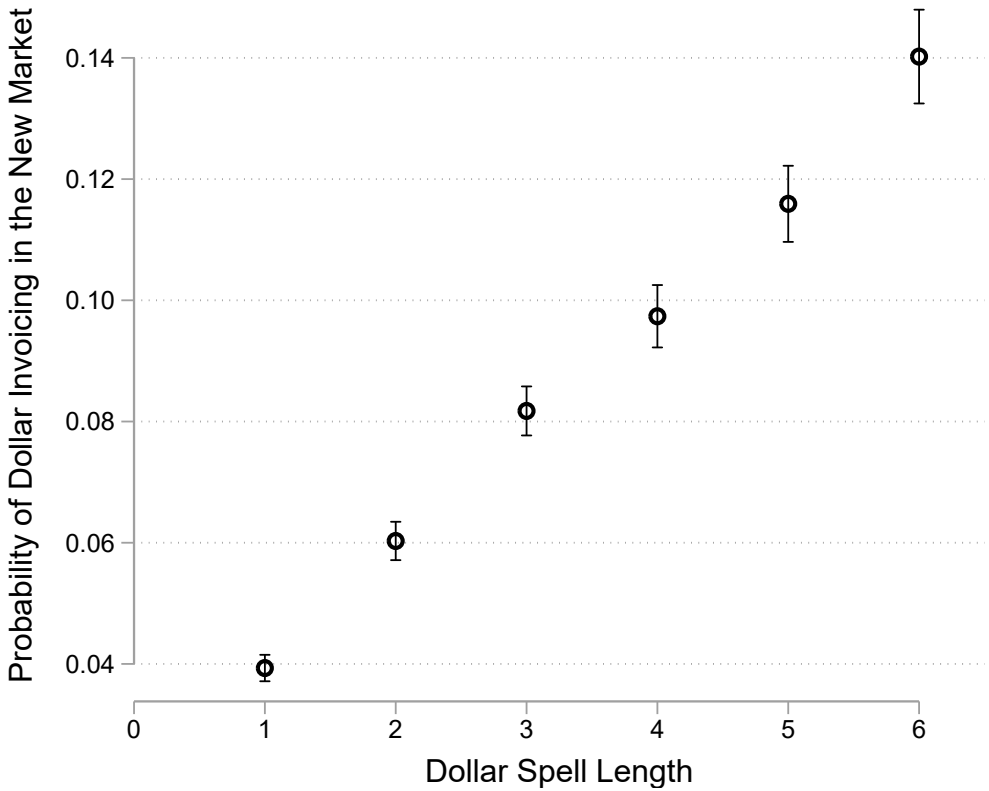
A 10 percentage point rise in a firm's dollar-invoicing share at $t-1$

$\Rightarrow$ implies a 2.9 percentage point increase in the probability of dollar invoicing in a new destination

- strategic complementarities slightly smaller
- operational hedging motive slightly smaller

Impact of prior dollar invoicing on new markets (2)

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

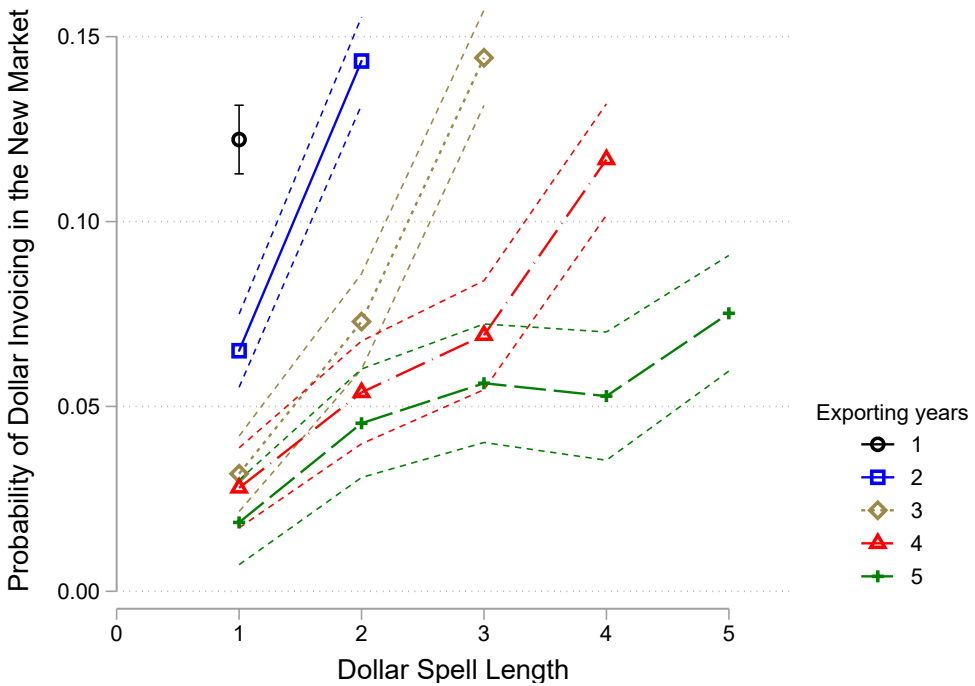


- Dollar spell length is the number of years the firm has invoiced any foreign sales in dollars prior to its entry into the new market
- Dollar invoicing probability in a new market is increasing in the dollar spell length

Estimation Tables

Impact of prior dollar invoicing on new markets (3)

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



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

Roadmap

How can we build a model that explains the newly documented dynamic effects and the aggregate evolution of dollar shares?

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

$\Rightarrow$ Aggregate implications

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

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

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

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

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

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

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

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

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

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:

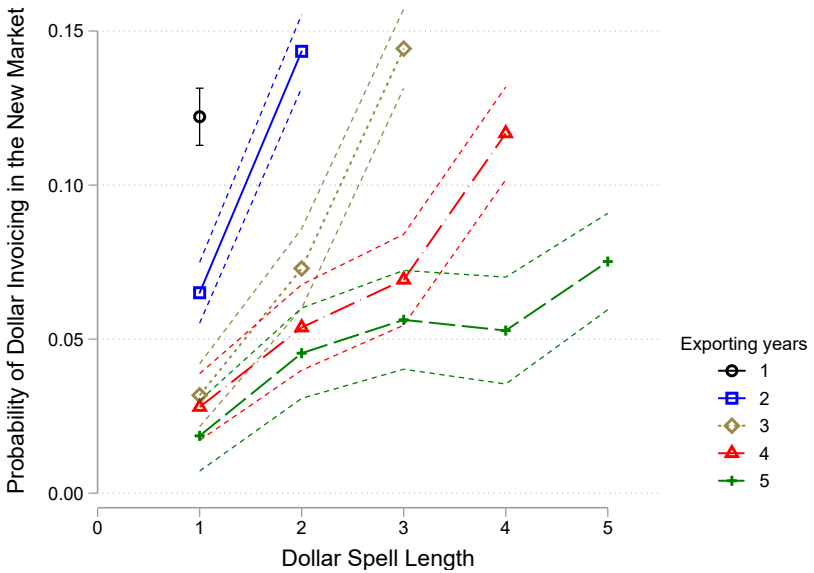
$$\mathbb{E}[\pi_{fd}^{\text{USD}} - \pi_{fd}^{\text{PCI}} | \zeta_{(-f)d}, \psi_{fd}] \sim U(0,1);$$
$$\mathbb{E}[\pi_{fd}^{\text{LCI}} - \pi_{fd}^{\text{PCI}} | \zeta_{(-f)d}, \psi_{fd}] \sim U(0,1)$$

- Firm f chooses dollars in a new destination d if

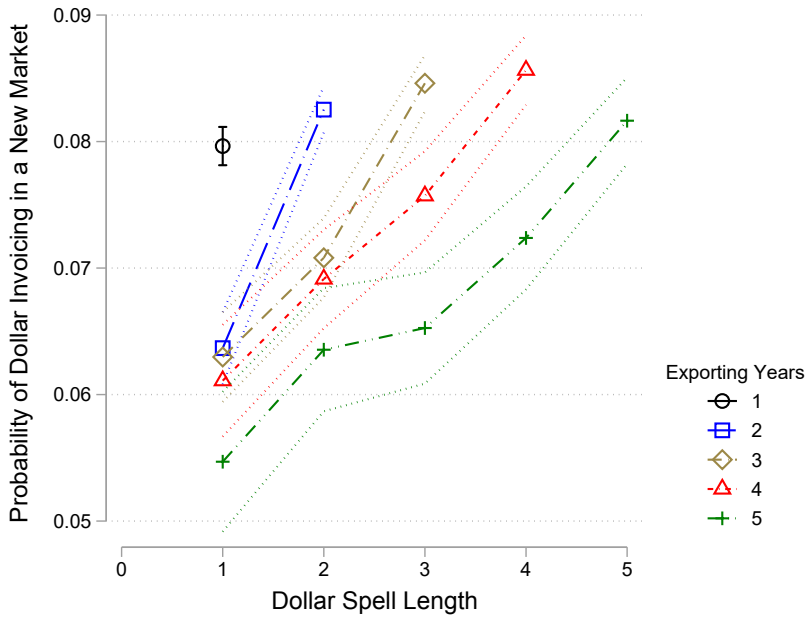
$$\mathbb{E}[\pi_{fd}^{\text{USD}} - \pi_{fd}^{\text{PCI}} | \zeta_{(-f)d}, \psi_{fd}] > F_f^{\text{USD}}(c_1, ..., c_d) - 0 \quad \text{and}$$
$$\mathbb{E}[\pi_{fd}^{\text{USD}} - \pi_{fd}^{\text{LCI}} | \zeta_{(-f)d}, \psi_{fd}] > F_f^{\text{USD}}(c_1, ..., c_d) - F_f^{\text{LCI}}(c_1, ..., c_d)$$

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

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 $t-1$

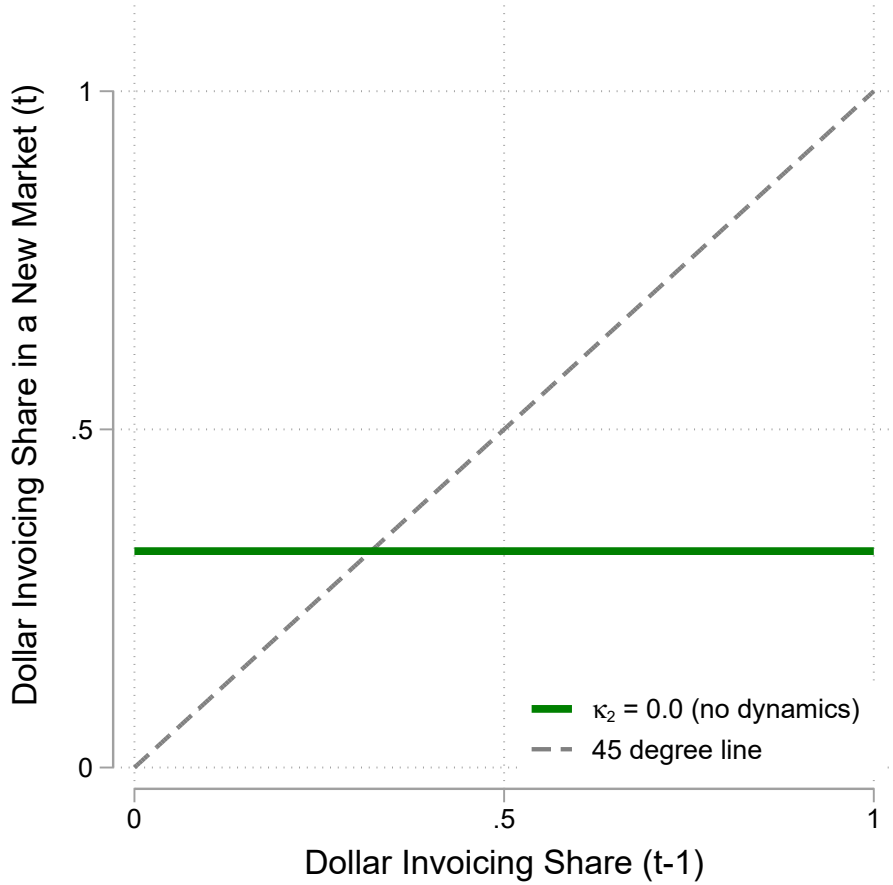
Pattern generated by the reduced form setting

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



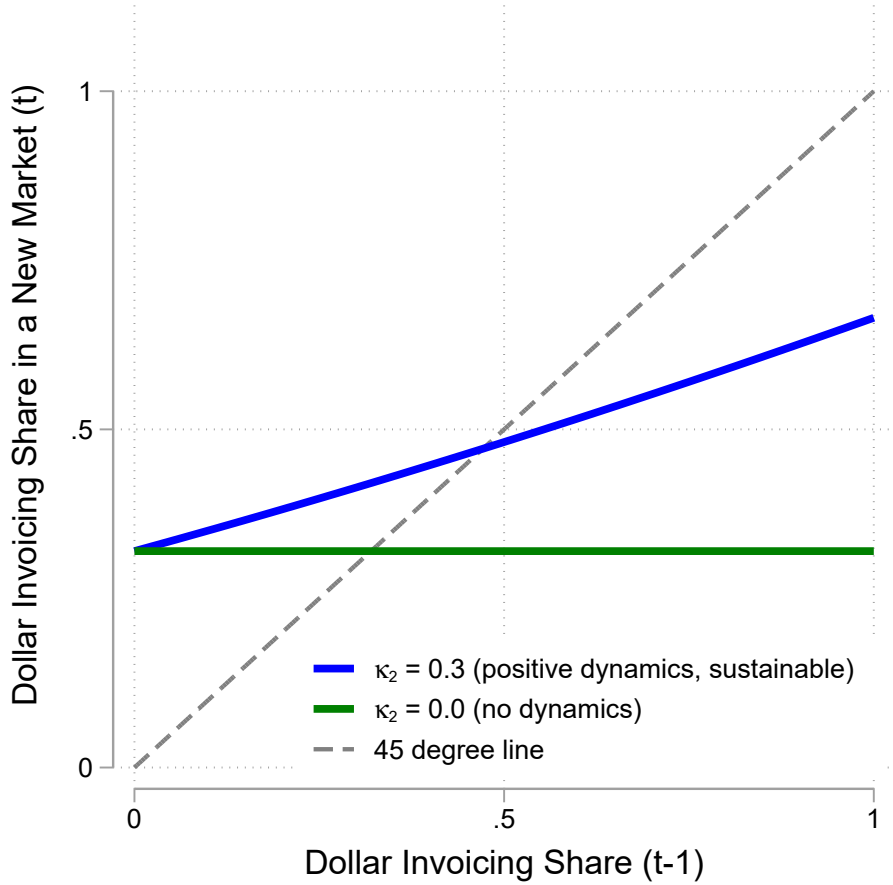
Note: $\kappa_1 = 0.6$.

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



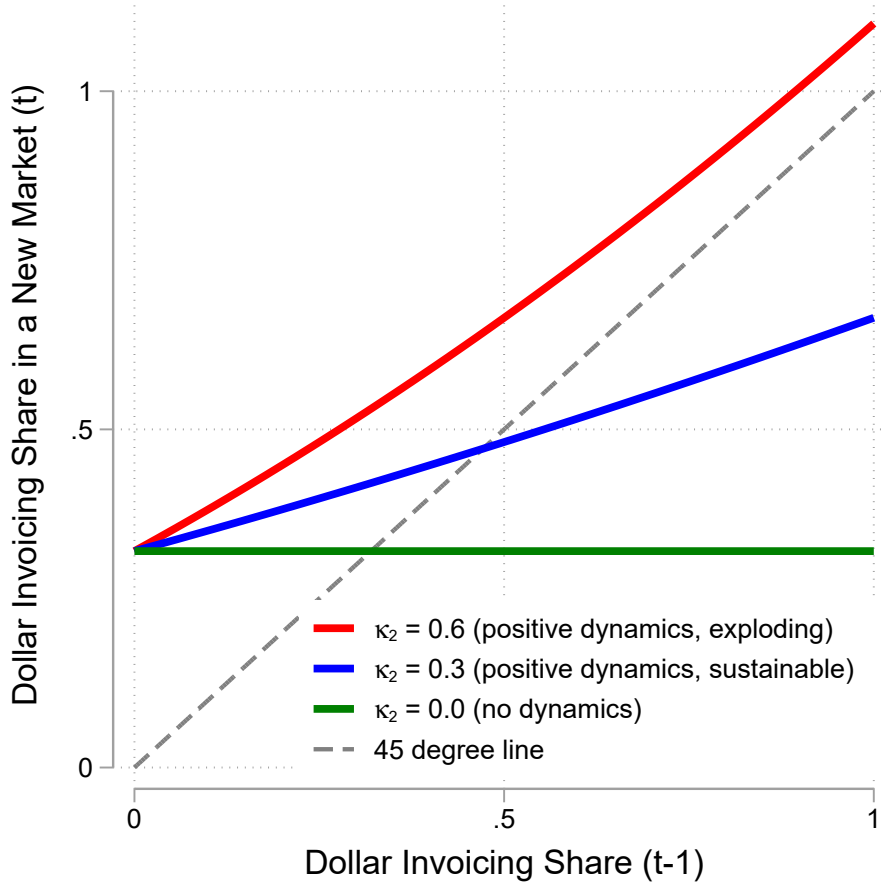
Note: $\kappa_1 = 0.6$.

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



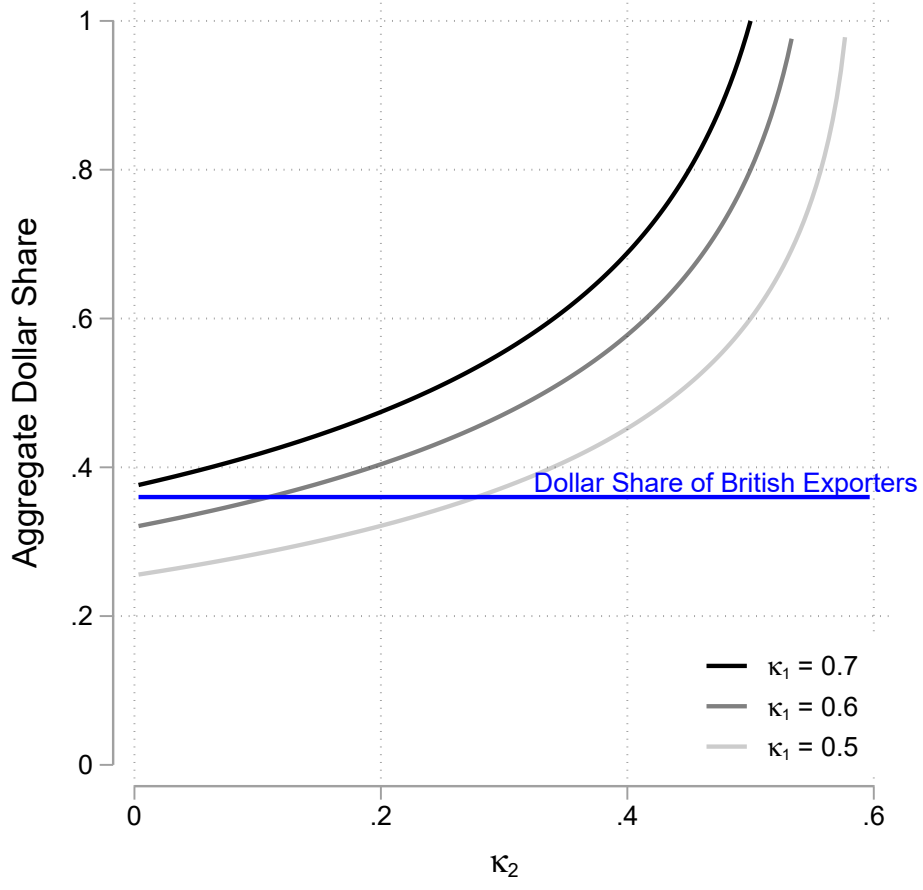
Note: $\kappa_1 = 0.6$.

Aggregate dollar share

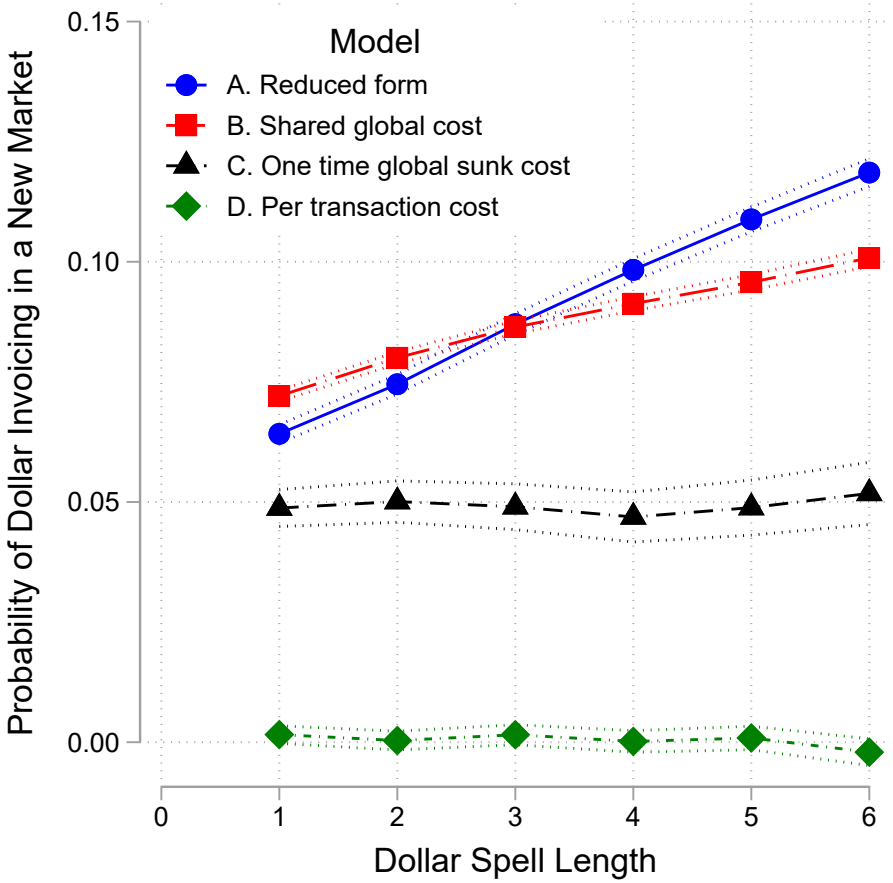
In the steady state, aggregate level dollar invoicing share is:

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

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



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.

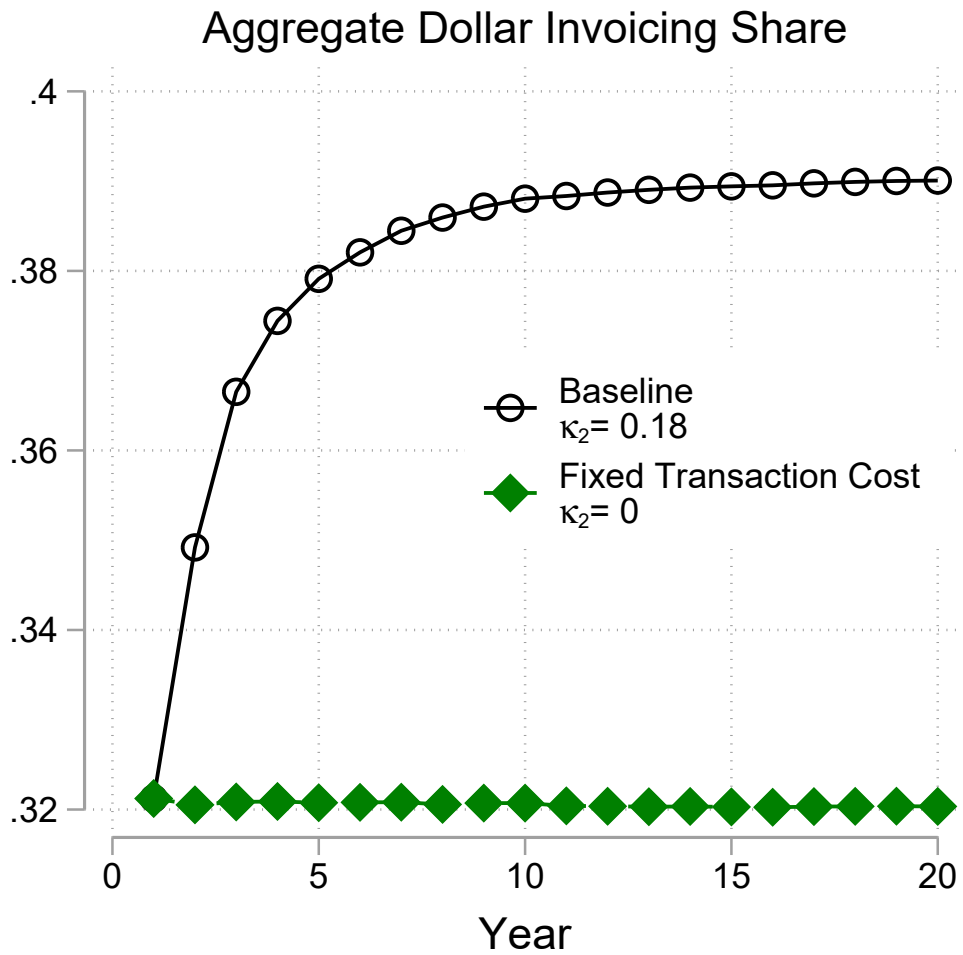
Counterfactual analyses: aggregate implications (1)

- **Aggregate dollar invoicing share of extra-EU British exports:**
  - 2010: 31.0%
  - 2019: 48.2%

- Simulate model with reduced form form fixed cost under different cost reduction parameters.

$$F(\omega^c_{ft-1}) = \kappa_1 - \kappa_2 \cdot \omega^c_{ft-1}$$

Importance of the feedback from prior dollar use

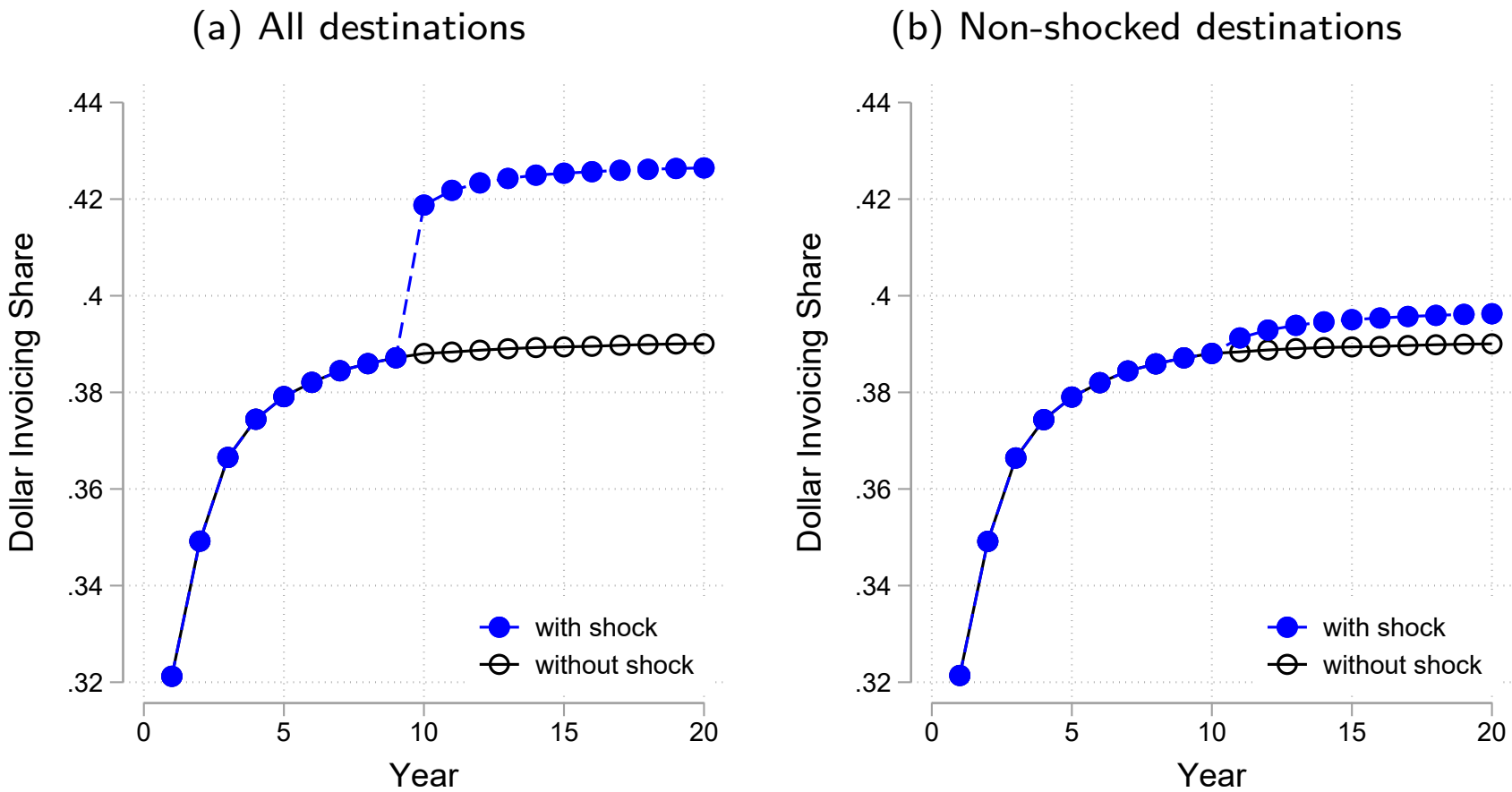


Aggregate dollar invoicing share of British exporters would be 7% lower without the dynamic channel.

Counterfactual analyses: aggregate implications (2)

- **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.

Conclusions

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

- Document firm-level patterns of invoicing dynamics
- Propose a model with a firm-level cost of currency uses
- Results suggest spillover effects over time and across destinations
- We estimate the dollar share of UK's extra-EU exports would be 7% lower ($0.39 \rightarrow 0.32$) without the spillover effect.

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 extra-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 extra-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:

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

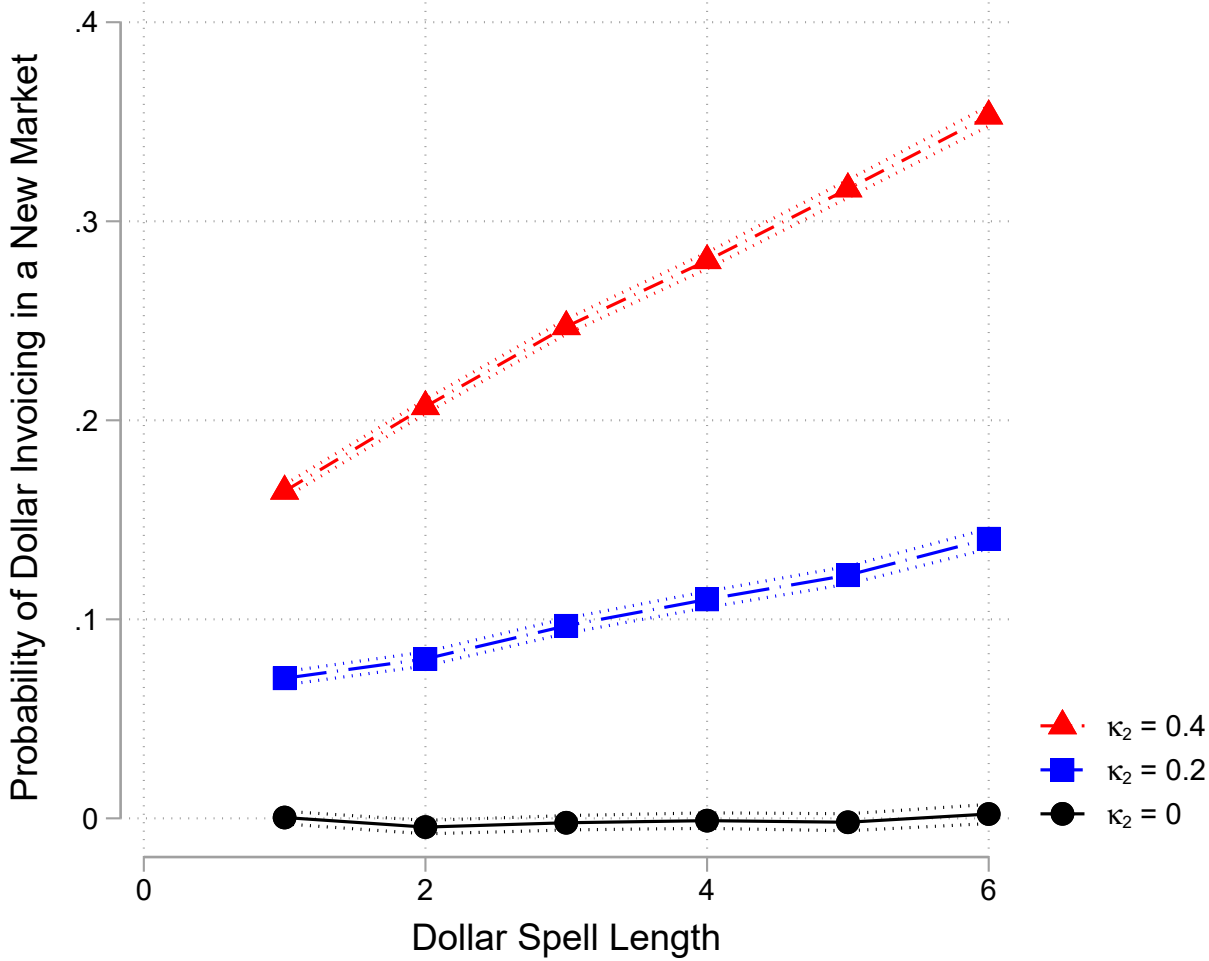
  where Export^{c}_{fidt} denotes firm f's export value invoiced in currency c at 6-digit HS industry i to country d in year t.

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

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

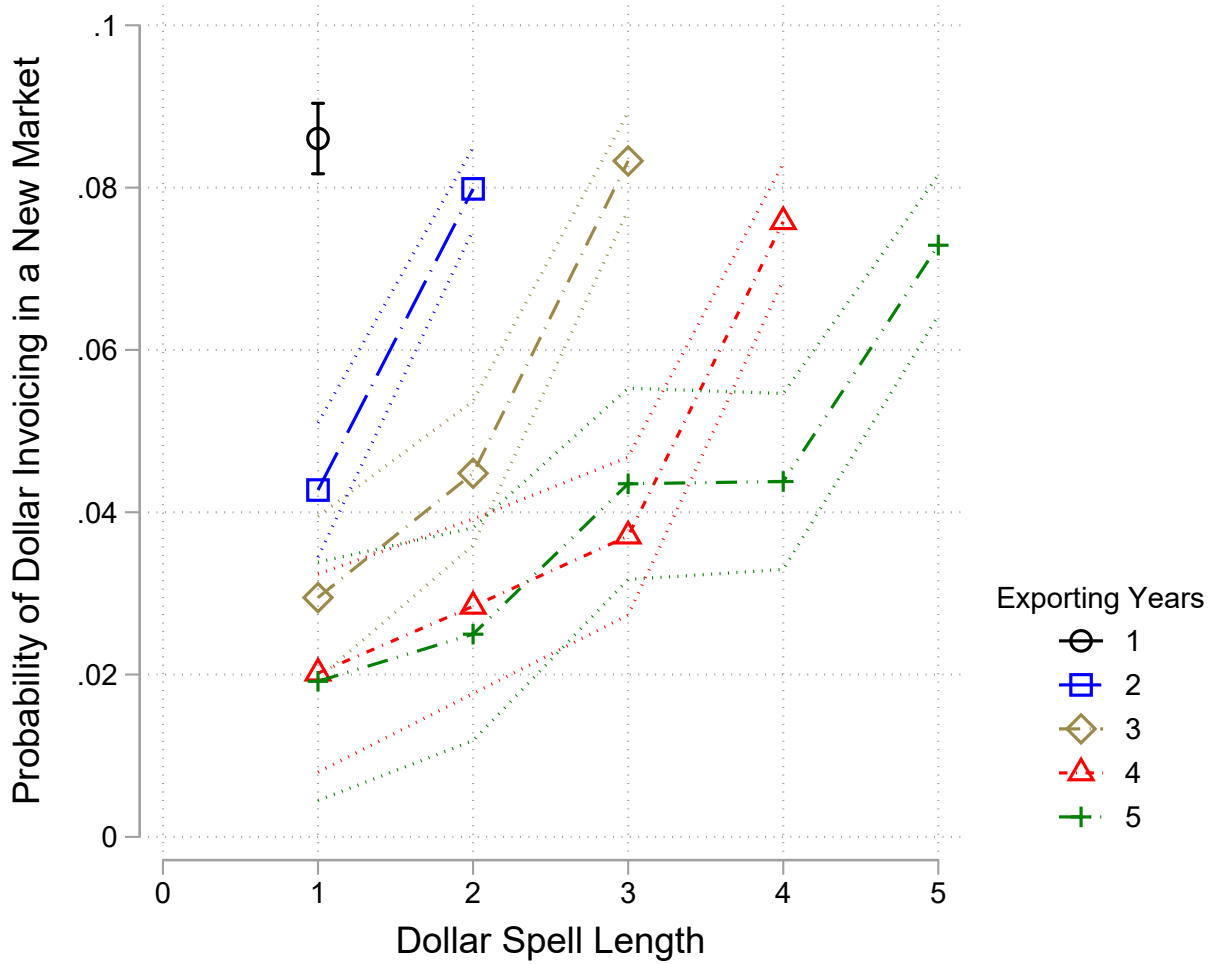
Back

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 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