Exporters and Shocks

Doireann Fitzgerald\textsuperscript{1} and Stefanie Haller\textsuperscript{2}

\textsuperscript{1}Stanford, \textsuperscript{2}UCD

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Motivation: International Elasticity Puzzle

- Trade facts: need a high elasticity of substitution between goods of different countries, e.g. Yi (2003)
- Macro facts: need a low elasticity of substitution between goods of different countries, e.g. BKK (1994), Heathcote & Perri (2002)
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- Macro facts: need a low elasticity of substitution between goods of different countries, e.g. BKK (1994), Heathcote & Perri (2002)
- This paper: Investigate origins of this puzzle using micro data
What we do

- Rich data set on Irish manufacturing firms and their exports, both destinations and products
- Estimate firm-level **intensive** and **extensive** margin responses to both macro shocks and trade liberalizations:
  - Examples of shocks:
    - US experiences real appreciation relative to UK
    - US grows faster than UK
    - Tariff falls in US market, not in UK market
  - How does an Irish firm change its participation/export sales to US relative to UK in response to these shocks?
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- Bigger elasticities with respect to tariff reductions than with respect to real exchange rate movements
- Extensive margin (participation) more responsive to tariffs than to real exchange rates, but magnitudes small and entrants/exiters are tiny
- ⇒ International Elasticity Puzzle due to intensive margin: still a puzzle!
Sketch of model

- Augment e.g. Roberts & Tybout (1997) to allow for post-entry export dynamics
  - e.g. Ruhl & Willis (2008)
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  - e.g. Ruhl & Willis (2008)
- Firm $i$ faces nominal marginal cost $C_t^i$ to serve all markets
- May face fixed & sunk costs of participation in each market $k$
- Firm $i$ faces demand in market $k$ at time $t$ given by:

$$Q_{ik}^t = \left[ \left( \frac{(1 + \tau_{ik}^t) P_{ik}^*}{P_{k}^*} \right)^{-\theta} Q_k^t \right] D_{ik}^t \exp \left( \eta_{ik}^t \right)$$

- $\eta_{ik}^t$: iid demand shock
- $D_{ik}^t$: state variable - can link current demand to past actions (and hence to past shocks)
Notation

- $X_{ik}^t$: indicator for participation
- $Z_{ik}^t$: vector of exogenous shocks ($P_t^H, P_t^{k*}, E_t^K, C_t^i, Q_t^k, \tau_t^{ik}, \eta_t^{ik}$)
Example 1

- Ruhl & Willis (2008): $D_{t}^{ik}$ depends on past participation in market $k$

$$D_{t+1}^{ik} = d(X_{t}^{ik}, X_{t-1}^{ik}, \ldots)$$
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- $\Rightarrow$ Pricing decision is static
  \[ E_{t}^{k} P_{t}^{ik*} = \frac{\theta}{\theta - 1} C_{t}^{i} \]
Example 1

- Ruhl & Willis (2008): $D_{tk}^{ik}$ depends on past participation in market $k$
  \[ D_{tk+1}^{ik} = d\left(X_{tk}^{ik}, X_{tk-1}^{ik}, \ldots\right) \]

- \( \Rightarrow \) Pricing decision is static
  \[ E_k^t P_{tk}^* = \frac{\theta}{\theta - 1} C_t^i \]

- Participation decision is forward looking because of sunk cost, and through $D$:
  \[ X_{tk}^{ik} = X\left(X_{tk-1}^{ik}, D_{tk}^{ik}, Z_t^{ik}, E_t^t(Z_{t+1}^{ik}, \ldots)\right) \]
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- Real revenue in home currency:
  \[ \frac{E_{t}^{k} P_{t}^{ik*} Q_{t}^{ik}}{P_{t}^{H}} = \tilde{\theta} \left( \frac{C_{t}}{P_{t}^{H}} \right)^{1-\theta} \left( \frac{E_{t}^{k} P_{t}^{k*}/P_{t}^{H}}{1 + \tau_{t}^{ik}} \right)^{\theta} Q_{t}^{k} D_{t}^{ik} \exp \left( \eta_{t}^{ik} \right) \]
Example 1

- Ruhl & Willis (2008): \( D_{ik}^t \) depends on past participation in market \( k \)
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  D_{ik}^{t+1} = d \left( X_{ik}^t, X_{ik}^{t-1}, \ldots \right)
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  \[
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  \[
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  \]

- Real revenue in home currency:
  \[
  R_{ik}^t = \tilde{\theta} \left( \tilde{C}_t \right)^{1-\theta} \left( \frac{RER_{ik}^t}{1 + \tau_{ik}^t} \right)^{\theta} Q_k^k D_{ik}^t \exp \left( \eta_{ik}^t \right)
  \]
Example 2

- $D_{t}^{ik}$: market-specific intangible capital ("customer base") that can be accumulated by costly investment $I_{t}^{ik}$ ("marketing")

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$$D_{t+1}^{ik} = d \left( X_t^{ik}, D_t^{ik}, I_t^{ik} \right)$$

⇒ Pricing decision is still static

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- Participation decision (and investment decision) forward-looking

\[ X^{ik}_t = X(X^{ik}_{t-1}, D^{ik}_t, Z^{ik}_t, \mathbb{E}(Z^{ik}_{t+1}, \cdots)) \]
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$$\frac{E^k_t P^{ik*}_t Q^{ik}_t}{P^H_t} = \tilde{\theta} \left( \frac{C^i_t}{P^H_t} \right)^{1-\theta} \left( \frac{E^k_t P^{k*}_t / P^H_t}{1 + \tau^{ik}_t} \right)^\theta Q^k_t D^{ik}_t \exp \left( \eta^{ik}_t \right)$$
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\]

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\[
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Micro data

- Confidential micro data made available at the Central Statistics Office (CSO) in Ireland
- Plant census
- Prodcom survey of products sold
- Customs data on exports
Micro data: Plant census

- Annual plant census, 2000-2009
- All plants in manufacturing with \( \geq 3 \) employees
- Usual set of plant census variables: 4-digit NACE sector, revenue, employment, wage bill, investment, materials expenditures etc.
- Aggregate up to the firm level
Micro data: Prodcom survey

- Value and volume of all 8-digit products manufactured by the firm and sold in the relevant year
- Available 2000-2009, matched to 95% of CIP by value
- Concordance between production classification (Prodcom) and trade classification (CN)
- Knowing products produced allows us to construct relevant tariff variable at the firm-market-year level using production weights
Micro data: Customs data on exports

- Customs records, 2000-2009 (Intrastat and Extrastat)
  - Intrastat reporting threshold: Euro 635,000 annually
  - Extrastat reporting threshold: Euro 254 per transaction
- Records matched to firms using tax id number and where necessary, confidential info, by CSO
- ⇒ Euro value of exports at 6-digit HS level, by firm-destination-year
  - Allows us to attach the macro shocks for the appropriate destination
  - Allows us to construct a tariff variable at the firm-destination-year level using sales weights
## Summary statistics: Firms and exports

### Exporters and non-exporters

<table>
<thead>
<tr>
<th>Year</th>
<th># firms</th>
<th>Avg employees</th>
<th>Avg revenue</th>
<th>Avg export %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Exporters</td>
<td>Nonex. Exporters</td>
<td>Nonex. Exporters</td>
</tr>
<tr>
<td></td>
<td># firms</td>
<td></td>
<td></td>
<td></td>
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<td>2025</td>
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<td>2003</td>
<td>4902</td>
<td>2063</td>
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<td>2004</td>
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<td>2007</td>
<td>5266</td>
<td>1974</td>
<td>25</td>
<td>78</td>
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<tr>
<td>2008</td>
<td>5337</td>
<td>1920</td>
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<td>73</td>
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<tr>
<td>2009</td>
<td>4906</td>
<td>1860</td>
<td>19</td>
<td>72</td>
</tr>
</tbody>
</table>

Notes: Statistics are for our cleaned dataset of CIP firms. Exporters are firms who are matched with more than 500 Euro of exports from customs data. Avg revenue is in 1000 Euro. Export share is calculated as total exports from the customs match divided by sales reported in the CIP. Values greater than 100 are replaced by 100. Source: CSO and authors' calculations.
### Percent of matched exports by destination

<table>
<thead>
<tr>
<th></th>
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<tbody>
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<td>Australia</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>Canada</td>
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<td>1</td>
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<td>1</td>
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</tbody>
</table>

Notes: Source: CSO and Authors’ calculations. Euro 9 includes Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Portugal.
Summary statistics: Export entry and exit

Transitions of firms into and out of exporting

<table>
<thead>
<tr>
<th>Year-t status</th>
<th>no exports</th>
<th>exports</th>
<th>exit</th>
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</thead>
<tbody>
<tr>
<td>2000-01</td>
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<tr>
<td>2001-02</td>
<td>0.86</td>
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<tr>
<td>2002-03</td>
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<td>0.06</td>
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<tr>
<td>2003-04</td>
<td>0.77</td>
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<tr>
<td>2004-05</td>
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<td>2005-06</td>
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<td>2006-07</td>
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<tr>
<td>2007-08</td>
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<tr>
<td>2008-09</td>
<td>0.82</td>
<td>0.04</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Notes: Share of firms of year-t status ending up in year-t+1 status
## Summary statistics: Size of entrants and exiters

<table>
<thead>
<tr>
<th>Year</th>
<th>US Entrants</th>
<th>US Exiters</th>
<th>Japan Entrants</th>
<th>Japan Exiters</th>
<th>Switzerland Entrants</th>
<th>Switzerland Exiters</th>
<th>Australia Entrants</th>
<th>Australia Exiters</th>
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<tbody>
<tr>
<td>2000</td>
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<td>0.07</td>
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<td>2001</td>
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<td>0.01</td>
<td>0.02</td>
<td>3.23</td>
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<td>0.23</td>
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<td>2002</td>
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<td>2003</td>
<td>0.01</td>
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<tr>
<td>2005</td>
<td>0.02</td>
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<td>0.05</td>
<td>0.02</td>
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<td>2006</td>
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<td>0.03</td>
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<td></td>
<td>0.54</td>
</tr>
</tbody>
</table>

Notes: Ratio of mean sales of entrants to mean sales of incumbents and ratio of mean sales of exiters to mean sales of continuing firms.
Data: Shocks

Macro shocks

- Real consumption exchange rates (Source: IFS)
- Aggregate real expenditure (Source: IFS/OECD/WDI)
  - Nominal destination currency expenditure (GDP - Exports + Imports) deflated by destination market CPI

Tariff shock

- 2000-04: Tariff reductions associated with the Uruguay Round
- WTO: ad valorem MFN tariffs aggregated to HS6
- Construct firm-market-year-specific tariff variables for most important tariff-subject markets (20-25% of Irish exports)
  - Australia, Brazil, Canada, China, India, Japan, Malaysia, Mexico, New Zealand, Saudi Arabia, South Africa, Thailand, Turkey, UAE, USA
Empirical strategy: Intensive margin

- Real revenue in home currency:

\[ R_{tk}^{ik} = \tilde{\theta} \left( \tilde{C}_t \right)^{1-\theta} \left( \frac{RER_t^k}{1 + \tau_t^{ik}} \right)^{\theta} Q_t^k D_t^{ik} \exp \left( \eta_t^{ik} \right) \]
Empirical strategy: Intensive margin

- $\Delta r_{it}^{ik}$: log change in real revenue of firm $i$ from market $k$ at $t$

$$\Delta r_{it}^{ik} = \alpha^k + c_i^t + \sum_{s=0}^{S} \beta'_s \Delta z_{t-s}^{ik} + \epsilon_{it}^{ik}$$

- $\alpha^k$: market fixed effect
- $c_i^t$: firm-year fixed effect to control for costs
- $\Delta z_{t}^{ik}$: vector of shocks: log changes in real exchange rate, real demand, tariff variable
- May also control for $D$ by including log lag real revenue $r_{t-1}^{ik}$
- Use Intrastat and Extrastat destinations
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- May also control for $D$ by including log lag real revenue $r_{t-1}^{ik}$
- Use Intrastat and Extrastat destinations
- Selection bias: Focus on observations likely to be far from entry/exit thresholds: firm-market pairs with positive sales in all sample years
## Results: Intensive margin

### Revenue and shocks

<table>
<thead>
<tr>
<th></th>
<th>coeff</th>
<th>s.e.</th>
<th>coeff</th>
<th>s.e.</th>
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</thead>
<tbody>
<tr>
<td>$\Delta rer_t^k$</td>
<td>0.97</td>
<td>(0.31)**</td>
<td>0.78</td>
<td>(0.29)**</td>
</tr>
<tr>
<td>$\Delta rer_{t-1}^k$</td>
<td>-0.07</td>
<td>(0.33)</td>
<td>0.02</td>
<td>(0.31)</td>
</tr>
<tr>
<td>$\Delta dem_t^k$</td>
<td>1.03</td>
<td>(0.71)</td>
<td>1.11</td>
<td>(0.68)</td>
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<tr>
<td>$\Delta dem_{t-1}^k$</td>
<td>0.20</td>
<td>(0.81)</td>
<td>0.34</td>
<td>(0.77)</td>
</tr>
<tr>
<td>$\Delta tau_{t}^{ik}$</td>
<td>-7.06</td>
<td>(9.93)</td>
<td>-5.76</td>
<td>(9.12)</td>
</tr>
<tr>
<td>$\Delta tau_{t-1}^{ik}$</td>
<td>-19.65</td>
<td>(8.42)**</td>
<td>-17.63</td>
<td>(7.91)**</td>
</tr>
<tr>
<td>$\Delta r_{t-1}^{ik}$</td>
<td>-0.16</td>
<td>(0.01)**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Market f.e.** | yes | yes
**Firm-year f.e.** | yes | yes

| # firm-mkt-years | 12772 | 12772 |
| # firm-years     | 3171  | 3171  |
| $R^2$            | 0.32  | 0.37  |
| $R^2$-adj        | 0.09  | 0.16  |

Notes: Estimation method is OLS. Dependent variable is log euro sales deflated by Irish CPI. Sample consists of firm-market pairs with continuous participation 2000-2009, where included markets are Euro 9, UK, Sweden, Denmark and Extrastat markets. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.
Empirical strategy: Extensive margin

- Participation decision:

\[ X^i_k = X \left( X^i_{t-1}, D^i_k, Z^i_k, \mathbb{E}(Z^i_{t+1}, \ldots) \right) \]

- Effect of shocks may vary across firms
Empirical strategy: Extensive margin

% of firms
100%

CDF

productivity
Φ(Z)  Φ̅(Z)
Empirical strategy: Extensive margin
Empirical strategy: Extensive margin

- $X_{ik}^t$: indicator for participation of firm $i$ in market $k$ at $t$

$$\Pr\left[X_{ik}^t = 1\right] = \alpha^k + c_i^t + \phi X_{ik}^{t-1} + \beta' z_t^i + \delta' z_{ik}^t X_{ik}^{t-1} + \gamma' (s_i^{t-1} \otimes z_{ik}^t) + \theta' (s_{ik}^{t-1} \otimes z_t^i) X_{ik}^{t-1} + \lambda' r_{ik}^{t-1} X_{ik}^{t-1} + \rho' (r_{ik}^{t-1} \otimes z_t^i) X_{ik}^{t-1} + \varepsilon_{ik}^t$$

- $\alpha^k$: market fixed effect
- $c_i^t$: firm-year fixed effect
- $X_{ik}^{t-1}$: indicator for lagged participation
- $z_{ik}^t$: “shock” variables: log real xrate, real demand, tariff
- $s_i^{t-1}$: “cost” variables: indicators for employment
- $r_{ik}^{t-1}$: log of lag real revenue from market $k$
- Use Extrastat destinations only
## Marginal effects from participation equation

<table>
<thead>
<tr>
<th>Status</th>
<th>Employees</th>
<th>rer</th>
<th>demand</th>
<th>tariff</th>
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<td></td>
<td></td>
<td>coeff se</td>
<td>coeff se</td>
<td>coeff se</td>
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<tr>
<td>Potential entrants</td>
<td>1-14</td>
<td>0.00 (0.00)</td>
<td>0.01 (0.00)**</td>
<td>0.02 (0.00)**</td>
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<tr>
<td></td>
<td>15-99</td>
<td>0.01 (0.00)**</td>
<td>0.02 (0.00)**</td>
<td>-0.00 (0.01)</td>
</tr>
<tr>
<td></td>
<td>100+</td>
<td>0.02 (0.00)**</td>
<td>0.02 (0.00)**</td>
<td>-0.03 (0.02)**</td>
</tr>
<tr>
<td>Incumbents</td>
<td>1-14</td>
<td>0.02 (0.01)**</td>
<td>0.01 (0.00)**</td>
<td>0.54 (0.18)**</td>
</tr>
<tr>
<td></td>
<td>15-99</td>
<td>0.01 (0.00)**</td>
<td>0.01 (0.00)**</td>
<td>-0.12 (0.14)</td>
</tr>
<tr>
<td></td>
<td>100+</td>
<td>0.01 (0.01)*</td>
<td>0.00 (0.00)</td>
<td>-0.34 (0.14)**</td>
</tr>
</tbody>
</table>

Notes: Omitted category is firms with fewer than 15 employees in the last period, who did not participate in the last period. $emp_{it}^2$ is an indicator variable for having 15-99 employees in the last period. $emp_{it}^3$ is an indicator variable for having 100+ employees in the last period. For incumbents, evaluated at log of mean revenue for the relevant size category.
Economic significance

- Response to shocks small relative to steady state entry/exit
- Entrants and exiters usually tiny relative to incumbents
- Impact of shocks on aggregate exports comes mainly through intensive margin
Conclusions

- Elasticities of firm-level intensive margin with respect to shocks close to aggregate elasticities

Firm-level extensive margin more responsive to tariffs than to real exchange rates, but entrants/exiters are small.

⇒ Understanding the International Elasticity Puzzle requires us to understand the intensive margin.
Conclusions

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- ⇒ Understanding the International Elasticity Puzzle requires us to understand the intensive margin
Work in progress

- Quantitative analysis: Can costs of adjustment on the intensive margin interact with volatility of shocks to help match the facts?
Figure: Total exports

Notes: All customs refers to total industrial exports according to published Customs data. Customs match refers to total customs exports of CIP firms matched to customs data. Source: CSO and authors’ calculations
Summary statistics: HS6 tariffs

Figure: Average tariffs

Notes: Figure graphs coefficient on year dummies in regression of unweighted ad valorem tariffs at the HS6 level on HS6 fixed effects and year dummies.
Summary statistics: HS6 tariffs

Figure: Residual variation in tariff levels

Notes: Residuals from regressing $\ln(1 + \tau)$ on country fixed effects and HS6-year fixed effects
Summary statistics: HS6 tariffs

Figure: Residual variation in tariff changes

Notes: Residuals from regressing $\Delta \ln(1 + \tau)$ on country fixed effects and HS6-year fixed effects
Data: Tariff shock

- Two baseline tariff variables:
  - Intensive:
    \[ \Delta r\text{tariff}^i_k = \sum_j \left( \frac{rsh^i_{jk} + rsh^i_{jk}}{2} \right) \Delta \ln \left( 1 + \tau^i_{jk} \right) \]
  - Extensive:
    \[ p\text{tariff}^i_k = \sum_j \left( \frac{psh^i_j + psh^i_j}{2} \right) \ln \left( 1 + \tau^i_{jk} \right) \]

- \( rsh^i_{jk} \): share of good \( j \) in \( i \)'s exports to \( k \) at \( t \)
- \( psh^i_j \): share of good \( j \) in \( i \)'s production at \( t \)
Summary statistics: Real exchange rates

Figure: Annual average real exchange rates: Non-Euro destinations
Summary statistics: Real exchange rates

Figure: Annual average real exchange rates: Euro destinations
Summary statistics: Real aggregate demand

Figure: Real aggregate demand: Non-Euro destinations
Summary statistics: Real demand

Figure: Real aggregate demand: Euro destinations
### Results: Extensive margin

#### Participation: Linear probability

<table>
<thead>
<tr>
<th>Term</th>
<th>Coef</th>
<th>S.E.</th>
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<tbody>
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<td>$X_{ik}^{t-1}$</td>
<td>-0.03</td>
<td>(0.08)</td>
</tr>
<tr>
<td>$X_{ik}^{t-1} \times \text{rev}_{ik}^{t-1}$</td>
<td>0.18</td>
<td>(0.01)**</td>
</tr>
<tr>
<td>$\text{rer}_t^{k}$</td>
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<td>(0.00)</td>
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<td>$\text{emp}_2^{i} \times \text{rer}_t^{k}$</td>
<td>0.01</td>
<td>(0.00)**</td>
</tr>
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<td>$\text{emp}_3^{i} \times \text{rer}_t^{k}$</td>
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<td>(0.00)**</td>
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</tr>
<tr>
<td>$X_{ik}^{t-1} \times \text{emp}_3^{i} \times \text{rer}_t^{k}$</td>
<td>-0.01</td>
<td>(0.01)*</td>
</tr>
<tr>
<td>$X_{ik}^{t-1} \times \text{rev}_{ik}^{t-1} \times \text{rer}_t^{k}$</td>
<td>-0.01</td>
<td>(0.00)**</td>
</tr>
<tr>
<td>$\text{dem}_t^{k}$</td>
<td>0.01</td>
<td>(0.00)**</td>
</tr>
<tr>
<td>$\text{emp}_2^{i} \times \text{dem}_t^{k}$</td>
<td>0.00</td>
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</tr>
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<td>(0.00)**</td>
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<tr>
<td>$X_{ik}^{t-1} \times \text{dem}_t^{k}$</td>
<td>0.02</td>
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<tr>
<td>$X_{ik}^{t-1} \times \text{emp}_2^{i} \times \text{dem}_t^{k}$</td>
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<tr>
<td>$X_{ik}^{t-1} \times \text{emp}_3^{i} \times \text{dem}_t^{k}$</td>
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<td>(0.00)**</td>
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<tr>
<td>$X_{ik}^{t-1} \times \text{rev}_{ik}^{t-1} \times \text{dem}_t^{k}$</td>
<td>-0.01</td>
<td>(0.00)**</td>
</tr>
<tr>
<td>$\text{tau}_t^{k}$</td>
<td>0.02</td>
<td>(0.00)**</td>
</tr>
<tr>
<td>$\text{emp}_2^{i} \times \text{tau}_t^{ik}$</td>
<td>-0.03</td>
<td>(0.01)**</td>
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<tr>
<td>$\text{emp}_3^{i} \times \text{tau}_t^{ik}$</td>
<td>-0.06</td>
<td>(0.02)**</td>
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<tr>
<td>$X_{ik}^{t-1} \times \text{tau}_t^{ik}$</td>
<td>0.32</td>
<td>(0.20)</td>
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<td>$X_{ik}^{t-1} \times \text{emp}_2^{i} \times \text{tau}_t^{ik}$</td>
<td>-0.65</td>
<td>(0.23)**</td>
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<td>(0.04)**</td>
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<table>
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<tr>
<th># firm-mkt-years</th>
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<tbody>
<tr>
<td>R$^2$-adj</td>
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