# Exporters and Exchange Rates

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Stanford and ESRI

PRELIMINARY

# Motivation

- Aggregate responses to nominal exchange rate movements depend on the responses of individual producers
- Extensive evidence from micro data on pricing responses to exchange rates, much less on the quantity side
- Debate on importance of plant entry and exit in explaining real exchange rate behavior
  - Baldwin (1988), Baldwin & Krugman (1989), Dixit (1989)
  - Ghironi & Melitz (2005), Alessandria & Choi (2007), Atkeson & Burstein (2008)
- This paper: Use plant census data to estimate sensitivity of export entry and exit to the exchange rate

# Findings

- Entry increases in response to depreciations, exit in response to appreciations
  - Need to allow for sensitivities of entry and exit to the exchange rate that are heterogeneous across plants to see this
- Use estimated sensitivities and distribution of plants to compute effect of year-to-year exchange rate movements on entry and exit
- Effects are relatively modest

# What's new?

- Identify sensitivity of entry and exit to exchange rates from within-plant-year variation
- Allow sensitivity of entry and exit to exchange rates to vary with costs and export histories

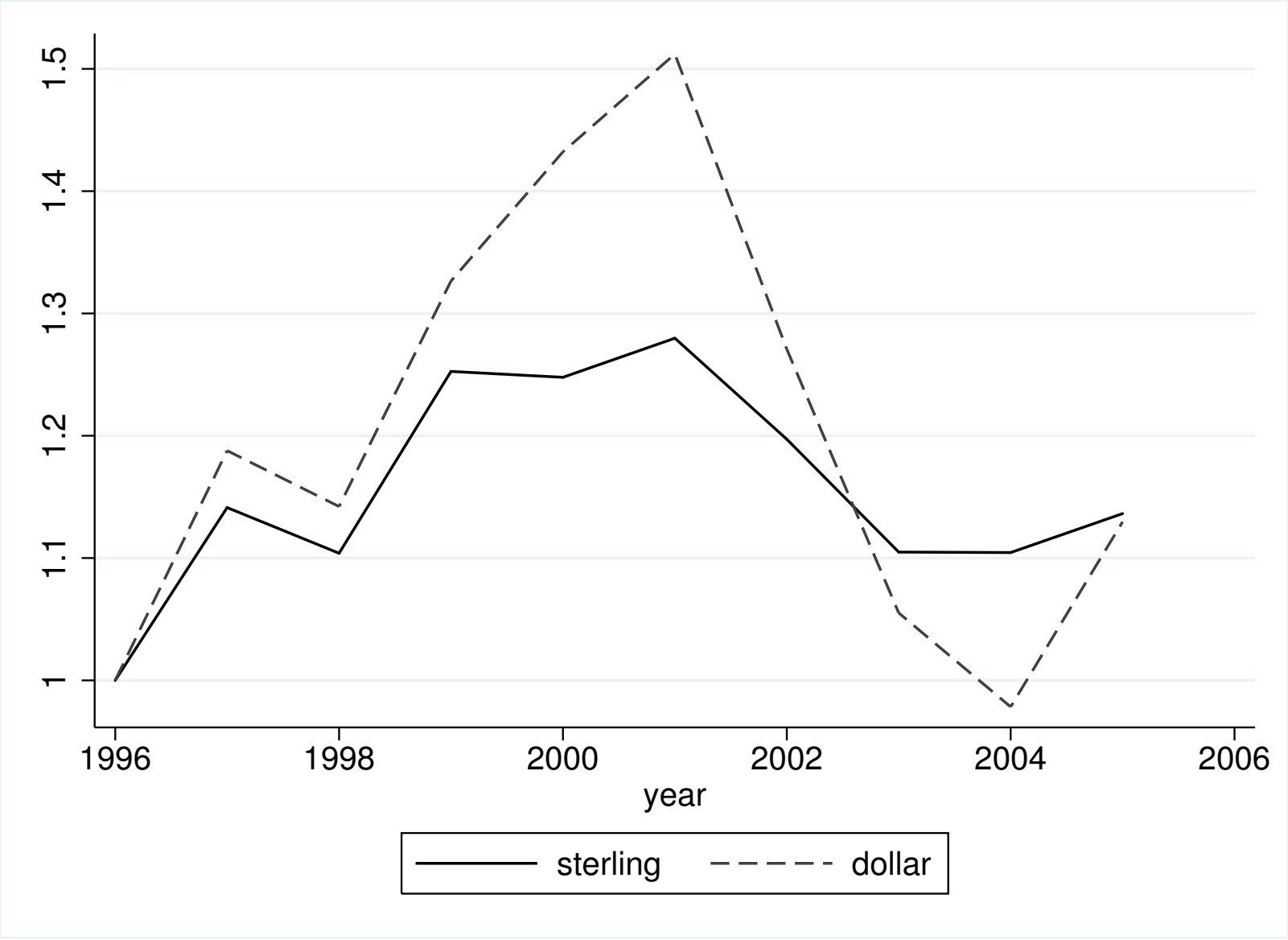
# Related literature

- Baldwin (1988), Baldwin & Krugman (1989), Dixit (1989)
- Ghironi & Melitz (2005), Alessandria & Choi (2007), Atkeson & Burstein (2008)
- Roberts & Tybout (1997), Bernard & Jensen (2004), Das, Roberts and Tybout (2007)
- Campa (2004), Berman, Martin & Meyer (2009)
- Eaton, Eslava, Kugler & Tybout (2008), Ruhl & Willis (2008a),
- Ruhl & Willis (2008b), Arkolakis (2009), Eaton, Eslava, Krizan, Kugler & Tybout (2010), Chaney (2010)
- Arkolakis (2008), Drozd and Nosal (2010), Foster, Haltiwanger & Syverson (2010), Gourio & Rudanko (2010)

# Data

- Annual plant census for Ireland, 1996-2005
- All plants in mining & manufacturing with $\geq 3$ employees
- Variables: sales, employment, exports, plant age, ownership
- Also share of exports to UK, US, "Europe," Rest of the World
- Focus on exports to UK and US

# Exchange rates



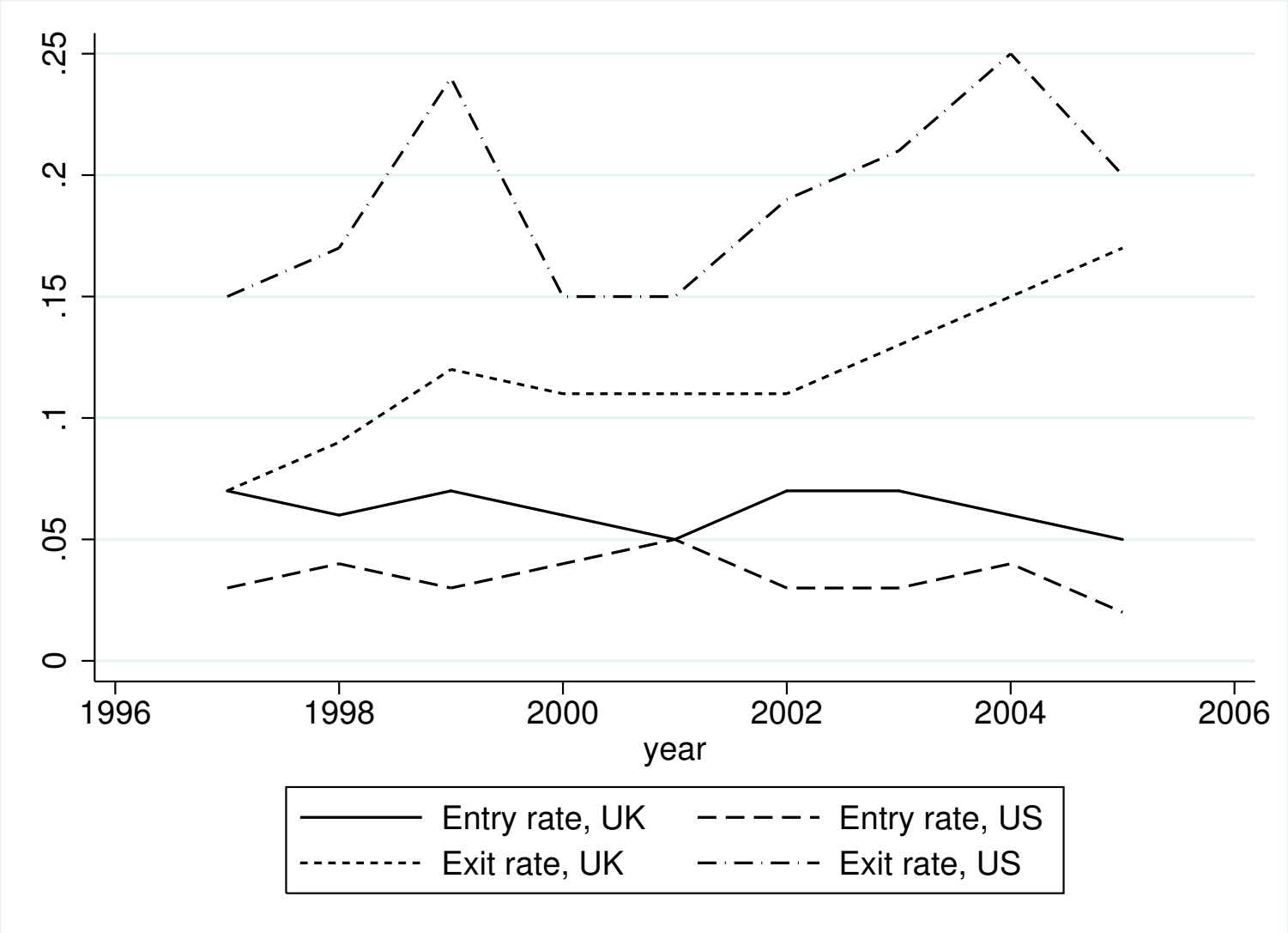
# Summary statistics

Table 1: Importance of UK and US markets

| | All dest. | UK | US |
|---|---|---|---|
| | Avg 1996-2005 | | |
| Share of total merchandise exports | 1.00 | 0.21 | 0.16 |
| Share of plants exporting to | 0.51 | 0.44 | 0.17 |
| Avg share of sales to dest. in plants exporting to dest. | 0.47 | 0.13 | 0.14 |

Notes: First row reports UK and US shares in total Irish merchandise exports (Source: OECD). Second and third row report statistics for plants in cleaned data set which excludes plants based on flags for imputed data (Source: CSO and authors' calculations). Second row reports share of plants that expor to all destinations, to the UK and to the US. Third row reports average export share in total sales for exporters, average share of UK sales in total sales for plants that export to UK and average share of US sales in total sales for plants that export to US.

# Summary statistics




Notes: This figure reports entry and exit rates for plants in cleaned data set which excludes plants based on flags for imputed data (Source: CSO and authors' calculations). Entry rates exclude plants born to export.

# Model

- Use stylized model of demand accumulation to guide empirics
- Can derive similar implications from other mechanisms

# Demand

- Demand faced by plant $i$ in market $k$ at $t$ is

$$Q_t^{ik} = \left[ \left( \frac{P_t^{ik*}}{P_t^{k*}} \right)^{-\theta} Q_t^k \right] \exp\left(\eta_t^{ik}\right) \left(D_t^{ik}\right)^{\alpha}$$

- where $\theta > 1$, $\alpha \in (0,1)$,
- $\eta_t^{ik}$ an iid demand shock
- $D_t^{ik}$ a demand shifter that varies with "attachment" to a market
- $D(0)^{ik}$ is value for plant $i$ if it has just entered market $k$

# Flow profits conditional on participation

- Flow profits net of fixed components of costs are

$$\Pi_t^{ik} = \left[\tilde{\theta} Q_t^k \left(E_t^k P_t^k\right)^{\theta} \left(\tau^k C_t^i\right)^{1-\theta}\right] \exp\left(\eta_t^{ik}\right) \left(D_t^{ik}\right)^{\alpha} - F_t^{ik}$$

# Participation decision

- Potential entrant enters market $k$ if

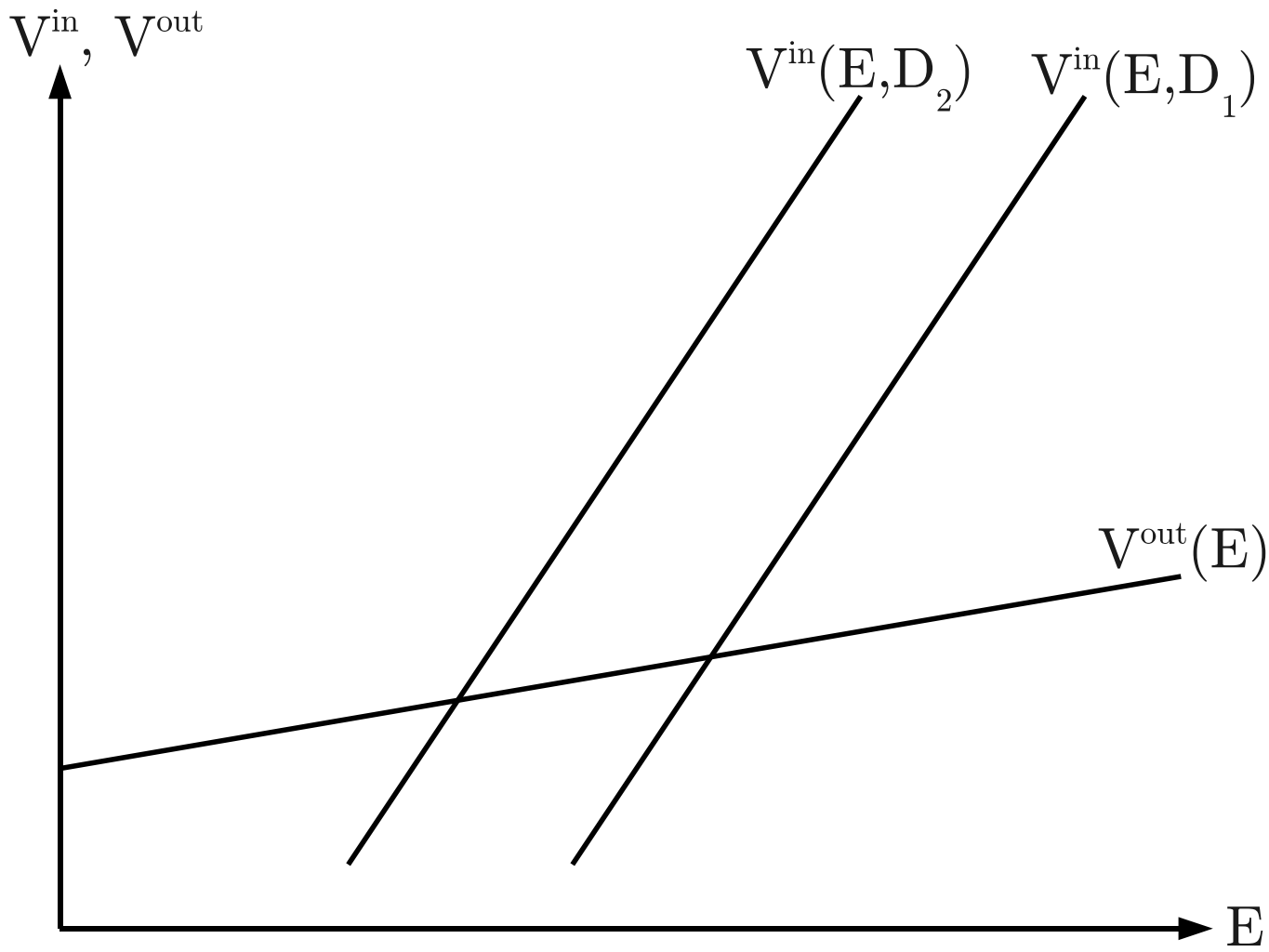
$$V^{in}\left(D(0)^{ik}, \eta_t^{ik}, z_t^i, W_t, E_t^k\right) > V^{out}\left(z_t^i, W_t, E_t^k\right)$$

- Current participant in market $k$ exits if

$$V^{in}\left(D_t^{ik}, \eta_t^{ik}, z_t^i, W_t, E_t^k\right) < V^{out}\left(z_t^i, W_t, E_t^k\right)$$

- Probability of entry in response to exchange rate shock depends on size of shock, costs, and cost-shock interaction
- Probability of exit depends on size of shock, on costs, on attachment to export market, and interactions

# Why interaction terms?



# Empirical strategy: Entry

- Focus on plant-years "at risk" for entry in both UK and US markets: $X_{t-1}^{iUK} = X_{t-1}^{iUS} = 0$
- Condition on current and lagged participation at home
- Approximate probability of entry as follows:

$$\Pr\left[\text{Enter}_t^{ik}\right] = \alpha^k + c_t^i + \gamma e_t^k + \delta' \mathbf{s}_{t-1}^i e_t^k + \eta_t^{ik}$$

- $\alpha^k$: market fixed effect
- $c_t^i$: plant-year fixed effect
- $e_t^k$: log exchange rate
- $\mathbf{s}_{t-1}^i$: vector of "cost" variables - indicators for plant size, plant age, ownership and export status in other markets

# Empirical strategy: Exit

- Focus on plant-years "at risk" for exit from both UK and US markets: $X_{t-1}^{iUK} = X_{t-1}^{iUS} = 1$
- Condition on current and lagged participation at home
- Approximate probability of exit as follows:

$$\Pr\left[\text{Exit}_t^{ik}\right] = \alpha^k + c_t^i + \gamma e_t^k + \lambda' \mathbf{a}_t^{ik} + \delta' \mathbf{s}_{t-1}^i e_t^k + \rho' \mathbf{a}_t^{ik} e_t^k + \eta_t^{ik}$$

- $\alpha^k$: market fixed effect
- $c_t^i$: plant-year fixed effect
- $e_t^k$: log exchange rate
- $\mathbf{s}_{t-1}^i$: vector of "cost" variables - indicators for plant size, plant age, ownership and export status in other markets
- $\mathbf{a}_t^{ik}$: vector of controls for attachment to market $k$ - age-in-market, lagged foreign currency revenues

# Results: Entry

## Table 3: Entry

| | (1) | (2) |
|---|---|---|
| $e_t^k$ | 0.02 (0.02) | |
| $I\left(10 \leq employees_{t-1}^i \leq 19\right) e_t^k$ | | |
| $I\left(20 \leq employees_{t-1}^i \leq 49\right) e_t^k$ | | |
| $I\left(50 \leq employees_{t-1}^i \leq 99\right) e_t^k$ | | |
| $I\left(employees_{t-1}^i \geq 100\right) e_t^k$ | | |
| $I\left(8 \leq age_t^i \leq 14\right) e_t^k$ | | |
| $I\left(15 \leq age_t^i \leq 23\right) e_t^k$ | | |
| $I\left(age_t^i \geq 24\right) e_t^k$ | | |
| $I\left(foreignowned_{t-1}^i = 1\right) e_t^k$ | | |
| $I\left(extootherdest_{t-1}^i = 1\right) e_t^k$ | | |
| # plants | 3512 | |
| # plant-years | 17449 | |
| $R^2$-adj | 0.15 | |

Notes: Estimation method is OLS. Sample consists of all plant-years where plant is at risk for entry in both UK and US markets, and where there is positive lagged and current sales in the Irish market. Dependent variable is an indicator for entry. Plant-year and market fixed effects in all regressions. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

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| $I\left(10 \leq employees_{t-1}^i \leq 19\right) e_t^k$ | | | 0.02 | (0.01)** |
| $I\left(20 \leq employees_{t-1}^i \leq 49\right) e_t^k$ | | | 0.03 | (0.01)** |
| $I\left(50 \leq employees_{t-1}^i \leq 99\right) e_t^k$ | | | 0.04 | (0.02)** |
| $I\left(employees_{t-1}^i \geq 100\right) e_t^k$ | | | 0.09 | (0.03)** |
| $I\left(8 \leq age_t^i \leq 14\right) e_t^k$ | | | -0.02 | (0.01)* |
| $I\left(15 \leq age_t^i \leq 23\right) e_t^k$ | | | -0.01 | (0.01) |
| $I\left(age_t^i \geq 24\right) e_t^k$ | | | -0.02 | (0.01)** |
| $I\left(foreignowned_{t-1}^i = 1\right) e_t^k$ | | | 0.00 | (0.03) |
| $I\left(extootherdest_{t-1}^i = 1\right) e_t^k$ | | | 0.15 | (0.04)** |
| # plants | 3512 | | 3512 | |
| # plant-years | 17449 | | 17449 | |
| $R^2$-adj | 0.15 | | 0.16 | |

Notes: Estimation method is OLS. Sample consists of all plant-years where plant is at risk for entry in both UK and US markets, and where there is positive lagged and current sales in the Irish market. Dependent variable is an indicator for entry. Plant-year and market fixed effects in all regressions. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

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# Results: Exit

## Table 4: Exit

| | (1) | (2) | (3) |
|---|---|---|---|
| $e_t^k$ | -0.09 (0.08) | | |
| $revenue_{t-1}^{ik*}$ | | | |
| $revenue_{t-1}^{ik*} e_t^k$ | | | |
| $I\left(yearsinmarket_{t-1}^{ik} \geq 2\right)$ | | | |
| $I\left(yearsinmarket_{t-1}^{ik} \geq 2\right) e_t^k$ | | | |
| $I\left(10 \leq employees_{t-1}^{i} \leq 19\right) e_t^k$ | | | |
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| $I\left(8 \leq age_t^i \leq 14\right) e_t^k$ | | | |
| $I\left(15 \leq age_t^i \leq 23\right) e_t^k$ | | | |
| $I\left(age_t^i \geq 24\right) e_t^k$ | | | |
| $I\left(foreignowned_{t-1}^{i} = 1\right) e_t^k$ | | | |
| $I\left(extootherdest_{t-1}^{i} = 1\right) e_t^k$ | | | |
| # plants | 1007 | | |
| # plant-years | 3799 | | |
| $R^2$-adj | 0.15 | | |

Notes: Estimation method is OLS. Sample consists of all plant-years where plant is at risk for exit in both UK and US markets, and where there is positive lagged and current sales in the Irish market. Dependent variable is an indicator for exit. Plant-year and market fixed effects in all regressions. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

# Results: Exit

## Table 4: Exit

| | (1) | (2) | (3) |
|---|---|---|---|
| $e_t^k$ | -0.09 (0.08) | -0.13 (0.10) | |
| $revenue_{t-1}^{ik*}$ | | | |
| $revenue_{t-1}^{ik*} e_t^k$ | | | |
| $I\left(yearsinmarket_{t-1}^{ik} \geq 2\right)$ | | | |
| $I\left(yearsinmarket_{t-1}^{ik} \geq 2\right) e_t^k$ | | | |
| $I\left(10 \leq employees_{t-1}^{i} \leq 19\right) e_t^k$ | | -0.04 (0.05) | |
| $I\left(20 \leq employees_{t-1}^{i} \leq 49\right) e_t^k$ | | -0.11 (0.04)** | |
| $I\left(50 \leq employees_{t-1}^{i} \leq 99\right) e_t^k$ | | -0.06 (0.05) | |
| $I\left(employees_{t-1}^{i} \geq 100\right) e_t^k$ | | -0.09 (0.05)* | |
| $I\left(8 \leq age_t^i \leq 14\right) e_t^k$ | | -0.03 (0.04) | |
| $I\left(15 \leq age_t^i \leq 23\right) e_t^k$ | | 0.03 (0.04) | |
| $I\left(age_t^i \geq 24\right) e_t^k$ | | -0.00 (0.04) | |
| $I\left(foreignowned_{t-1}^{i} = 1\right) e_t^k$ | | 0.00 (0.03) | |
| $I\left(extootherdest_{t-1}^{i} = 1\right) e_t^k$ | | 0.09 (0.05)* | |
| # plants | 1007 | 1007 | |
| # plant-years | 3799 | 3799 | |
| $R^2$-adj | 0.15 | 0.15 | |

Notes: Estimation method is OLS. Sample consists of all plant-years where plant is at risk for exit in both UK and US markets, and where there is positive lagged and current sales in the Irish market. Dependent variable is an indicator for exit. Plant-year and market fixed effects in all regressions. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

# Results: Exit

## Table 4: Exit

| | (1) | (2) | (3) |
|---|---|---|---|
| $e_t^k$ | -0.09 (0.08) | -0.13 (0.10) | -0.29 (0.12)** |
| $revenue_{t-1}^{ik*}$ | | | -0.05 (0.00)** |
| $revenue_{t-1}^{ik*} e_t^k$ | | | 0.02 (0.01)* |
| $I\left(yearsinmarket_{t-1}^{ik} \geq 2\right)$ | | | -0.09 (0.03)** |
| $I\left(yearsinmarket_{t-1}^{ik} \geq 2\right) e_t^k$ | | | 0.12 (0.08) |
| $I\left(10 \leq employees_{t-1}^{i} \leq 19\right) e_t^k$ | | -0.04 (0.05) | -0.04 (0.05) |
| $I\left(20 \leq employees_{t-1}^{i} \leq 49\right) e_t^k$ | | -0.11 (0.04)** | -0.17 (0.05)** |
| $I\left(50 \leq employees_{t-1}^{i} \leq 99\right) e_t^k$ | | -0.06 (0.05) | -0.13 (0.06)** |
| $I\left(employees_{t-1}^{i} \geq 100\right) e_t^k$ | | -0.09 (0.05)* | -0.19 (0.06)** |
| $I\left(8 \leq age_t^i \leq 14\right) e_t^k$ | | -0.03 (0.04) | -0.00 (0.04) |
| $I\left(15 \leq age_t^i \leq 23\right) e_t^k$ | | 0.03 (0.04) | 0.04 (0.04) |
| $I\left(age_t^i \geq 24\right) e_t^k$ | | -0.00 (0.04) | -0.01 (0.04) |
| $I\left(foreignowned_{t-1}^{i} = 1\right) e_t^k$ | | 0.00 (0.03) | -0.00 (0.03) |
| $I\left(extootherdest_{t-1}^{i} = 1\right) e_t^k$ | | 0.09 (0.05)* | 0.03 (0.05) |
| # plants | 1007 | 1007 | 969 |
| # plant-years | 3799 | 3799 | 3419 |
| $R^2$-adj | 0.15 | 0.15 | 0.23 |

Notes: Estimation method is OLS. Sample consists of all plant-years where plant is at risk for exit in both UK and US markets, and where there is positive lagged and current sales in the Irish market. Dependent variable is an indicator for exit. Plant-year and market fixed effects in all regressions. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

# Results: Exit

## Table 4: Exit

| | (1) | (2) | (3) |
|---|---|---|---|
| $e_t^k$ | -0.09 (0.08) | -0.13 (0.10) | -0.29 (0.12)** |
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| $revenue_{t-1}^{ik*} e_t^k$ | | | 0.02 (0.01)* |
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| $I\left(50 \leq employees_{t-1}^{i} \leq 99\right) e_t^k$ | | -0.06 (0.05) | -0.13 (0.06)** |
| $I\left(employees_{t-1}^{i} \geq 100\right) e_t^k$ | | -0.09 (0.05)* | -0.19 (0.06)** |
| $I\left(8 \leq age_t^i \leq 14\right) e_t^k$ | | -0.03 (0.04) | -0.00 (0.04) |
| $I\left(15 \leq age_t^i \leq 23\right) e_t^k$ | | 0.03 (0.04) | 0.04 (0.04) |
| $I\left(age_t^i \geq 24\right) e_t^k$ | | -0.00 (0.04) | -0.01 (0.04) |
| $I\left(foreignowned_{t-1}^{i} = 1\right) e_t^k$ | | 0.00 (0.03) | -0.00 (0.03) |
| $I\left(extootherdest_{t-1}^{i} = 1\right) e_t^k$ | | 0.09 (0.05)* | 0.03 (0.05) |
| # plants | 1007 | 1007 | 969 |
| # plant-years | 3799 | 3799 | 3419 |
| $R^2$-adj | 0.15 | 0.15 | 0.23 |

Notes: Estimation method is OLS. Sample consists of all plant-years where plant is at risk for exit in both UK and US markets, and where there is positive lagged and current sales in the Irish market. Dependent variable is an indicator for exit. Plant-year and market fixed effects in all regressions. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

# Economic significance: Entry

- Use coefficient estimates to construct predicted change in entry probability for each plant-market-year at risk for entry

$$\Delta \Pr\left[\hat{\text{Enter}}_t^{ik}\right] = \hat{\gamma}\Delta e_t^k + \hat{\delta}'\mathbf{s}_{t-1}^i \Delta e_t^k$$

- where $\Delta e_t^k$ is year-on-year exchange rate change
- Then predicted entry due to exchange rate change is

$$\sum_i \Delta \Pr\left[\hat{\text{Enter}}_t^{ik}\right]$$

- Compare this with actual entry
- Condition on current and lagged participation at home

# Economic significance: Exit

- Use coefficient estimates to construct predicted change in exit probability for each plant-market-year at risk for exit

$$\Delta \Pr\left[\widehat{\text{Exit}}_t^{ik}\right] = \hat{\gamma}\Delta e_t^k + \hat{\delta}'\mathbf{s}_{t-1}^i \Delta e_t^k + \hat{\rho}'\mathbf{a}_t^{ik}\Delta e_t^k$$

- where $\Delta e_t^k$ is year-on-year exchange rate change
- Then predicted exit due to exchange rate change is

$$\sum_i \Delta \Pr\left[\widehat{\text{Exit}}_t^{ik}\right]$$

- Compare this with actual exit
- Condition on current and lagged participation at home

# Economic significance: Entry

Table 5: Economic significance: Entry

| | UK | | | | US | | | |
|---|---|---|---|---|---|---|---|---|
| year | entry | $\Delta\hat{\text{entry}}$\| | $\Delta e_t^{UK}$ | $\Delta e_t^{UK}$ | entry | $\Delta\hat{\text{entry}}$\| | $\Delta e_t^{US}$ | $\Delta e_t^{US}$ |
| 1997 | 124 | 9 | 0.13 | | 89 | 32 | 0.17 | |
| 1998 | 127 | -2 | -0.03 | | 100 | -7 | -0.04 | |
| 1999 | 133 | 9 | 0.13 | | 78 | 27 | 0.15 | |
| 2000 | 125 | 0 | 0.00 | | 104 | 14 | 0.08 | |
| 2001 | 105 | 2 | 0.03 | | 162 | 10 | 0.05 | |
| 2002 | 149 | -5 | -0.07 | | 75 | -27 | -0.17 | |
| 2003 | 151 | -6 | -0.08 | | 89 | -29 | -0.19 | |
| 2004 | 134 | 0 | 0.00 | | 122 | -11 | -0.08 | |
| 2005 | 107 | 2 | 0.03 | | 68 | 20 | 0.14 | |

Notes: Entry and forecast entry based on exchange rate changes are calculated for plant-market-years where plant is at risk for entry, and where there is positive lagged and current sales in the Irish market. Forecast entry is based on the linear probability model, broad sample which includes the full set of cost interactions as independent variables.

# Economic significance: Exit

Table 6: Economic significance: Exit

| | UK | | | | US | | |
|---|---|---|---|---|---|---|---|
| year | exit | $\Delta\hat{\text{exit}}$ \| | $\Delta e_t^{UK}$ | $\Delta e_t^{UK}$ | exit | $\Delta\hat{\text{exit}}$ \| | $\Delta e_t^{US}$ | $\Delta e_t^{US}$ |
| 1998 | 99 | 9 | -0.03 | | 72 | 1 | -0.04 | |
| 1999 | 106 | -32 | 0.13 | | 85 | -4 | 0.15 | |
| 2000 | 96 | 1 | 0.00 | | 57 | -2 | 0.08 | |
| 2001 | 139 | -7 | 0.03 | | 78 | -2 | 0.05 | |
| 2002 | 116 | 17 | -0.07 | | 95 | 7 | -0.17 | |
| 2003 | 140 | 21 | -0.08 | | 105 | 5 | -0.19 | |
| 2004 | 123 | 0 | 0.00 | | 94 | 1 | -0.08 | |
| 2005 | 132 | -6 | 0.03 | | 68 | -3 | 0.14 | |

Notes: Exit and forecast exit based on exchange rate changes are calculated for plant-market-years where plant is at risk for exit, and where there is positive lagged and current sales in the Irish market. Forecast exit is based on the linear probability model, broad sample which includes the full set of cost interactions, lagged foreign currency revenue and interactions and smallest set of age-in-market indicators and interactions as independent variables.

# Interim conclusions

- Entry to and exit from export markets show statistically significant responses to the level of the exchange rate, with the expected signs
- To see this, it is important to allow sensitivities to the exchange rate to vary across plants
- Economic impact of these responses is modest

# Next up

- Robustness
- Match customs data with plant data to sharpen identification
- Investigate sensitivity of sales to the exchange rate