Exporters and Shocks*

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Abstract

Aggregate exports are not very responsive to movements in real exchange rates, though they respond strongly to trade liberalizations, a fact sometimes referred to as the International Elasticity Puzzle. We use micro data on firms and exports for Ireland to provide evidence on the origins of this puzzle. We find that both participation and incumbent sales respond more to tariffs than to real exchange rates. However the behavior of aggregate exports is accounted for primarily by the behavior of sales of incumbent exporters. Our findings are consistent with the existence of adjustment costs along the intensive as well as the extensive margin, which lead firms to respond less to volatile macro shocks than to predictable tariff shocks.

1 Introduction

Aggregate exports are not very responsive to movements in real exchange rates. Calibrated models of international business cycles typically assume a low elasticity of substitution between home goods and foreign goods (in the range 0.5 to 1.5) in order to match comovements of relative prices and relative quantities at a business cycle frequency. However elasticities of substitution in this low range are at odds with evidence on the response of trade to tariff

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liberalizations or changes in trade costs. It is of course unsatisfying to have to calibrate the same model differently in order to match different facts. But this inability of the standard model to match these two different sets of facts also poses a real problem in trying to answer important questions. For example, one must take stand on what exactly is this key elasticity of substitution in order to understand the impact of trade costs on international consumption risk sharing.

The leading explanation for this puzzle is that there are sunk costs of entry into export markets at the plant level (see Ruhl (2008)). If the business cycle shocks that drive exchange rates are less persistent or more volatile than trade liberalization shocks, sunk costs imply that the extensive margin of exports will react more to trade liberalizations than to real exchange rate movements. This explanation is appealing, and consistent with micro evidence of sunk costs of entering export markets (e.g. Roberts and Tybout (1997), Das, Roberts and Tybout (2007)). However, quantitatively it faces the problem that firms that change their participation status are on average much smaller than continuing exporters, implying that very strong participation responses to trade liberalizations would be neccessary in order to explain aggregate behavior.

A recent literature has documented post-entry export dynamics (e.g. Ruhl and Willis (2008), Eaton, Eslava, Kugler and Tybout (2008)), and suggested that costs of adjustment for continuing exporters may be responsible for these dynamics. Depending on the form taken by these costs of adjustment, they could lead the exports of continuing exporters to respond more to persistent and predictable trade liberalizations than to volatile and unpredictable real exchange rate movements. However to date, this mechanism has not been posited as an explanation for the International Elasticity Puzzle. In this paper we use micro data to test both the sunk cost explanation, and the post-entry adjustment cost explanation for this puzzle.

More precisely, we use 10 years of merged plant census and customs micro data for Ireland to estimate the elasticity of export participation and export sales to both market-specific macro shocks (real exchange rates and real demand in target markets) and firm-market-specific tariff shocks. Our data covers the period 2000-2009, and the main trade liberalization episode that we exploit is the last five years of the implementation of MFN tariff reductions agreed under the Uruguay Round (2000-2004). Our empirical strategy builds on the extensive literature on estimating export participation equations in the presence of sunk costs of entry, as well as on the more recent literature on post-entry export dynamics. We modify the empirical strategy of the existing literature to focus on firm responses to

shocks, rather than on steady state behavior, and to allow for these post-entry dynamics. Crucially, we make use of the structure of our data set to focus on within-firm-year responses to shocks that vary across markets.

We find that export participation responds to real exchange rate movements in the direction one would expect: depreciations of the home currency against that of the destination market tend to increase entry and reduce exit, and vice versa for appreciations. The exact sensitivity of participation to real exchange rates varies across the distribution of firm size and past attachment to the market, but overall, the quantitative impact of real exchange rate movements on entry and exit is negligible. Meanwhile our estimated elasticities of entry and especially exit with respect to tariffs are greater in magnitude than those with respect to real exchange rate movements, though less precisely estimated. For the largest firms, the comparative static goes in the expected direction: Higher tariffs reduce entry and increase exit. However, even with the greater sensitivity to tariffs, the implied impact of tariff changes on export volumes through entry and exit is quantitatively modest. This is because entrants and exiters have on average 10-15% of the sales of incumbent firms.

On the intensive margin, we condition on long-term attachment to a market to reduce the likelihood of selection bias affecting our estimates. This prevents us from testing directly for the post-entry export dynamics that would be induced by costs of adjustment on the intensive margin. We find evidence of lagged adjustment to tariff changes, but not to macro shocks. The elasticity of responses to real exchange rates is not significantly different from one. The elasticity of responses to tariff changes is much bigger, and significantly different from one, but again imprecisely estimated. In the case of both types of shocks, the magnitude of the responses are consistent with evidence from aggregate instead of firm data. Together with the extensive margin results, this suggests that sunk costs of entry cannot explain the International Elasticity Puzzle. Instead, it points suggestively to the existence of costs of adjustment on the intensive margin, which lead firms to respond differently to tariff changes and real exchange rate movements.

Our work is related to several literatures. It is related to an older theoretical literature which argues that the expenditure-shifting effects of exchange rate movements may depend on sunk costs of exporting at the plant level (Baldwin (1988), Baldwin and Krugman (1989) and Dixit (1989)). It is also related to several more recent papers that propose that entry and exit can (or cannot) explain facts about international real business cycles. These include Ghironi and Melitz (2005), Alessandria and Choi (2007), Atkeson and Burstein (2008) and Ruhl (2008). We use micro data on the export behavior of firms to provide a test of some

of the hypotheses of these papers.

Methodologically, the paper builds on work by authors who have estimated both reduced form and structural dynamic discrete choice models of export supply with sunk costs of exporting (see Roberts and Tybout (1997), Bernard and Wagner (2001), Bernard and Jensen (2004) and Das, Roberts and Tybout (2007)).

Recent evidence documents several features of exporter behavior that this first generation of sunk cost models has difficulty matching: the hazard of exit is declining in the number of years a plant participates in a market; and conditional on survival, recent entrants grow faster than incumbents (see Ruhl and Willis (2008), Eaton, Eslava, Kugler and Tybout (2008)). Several authors have recently proposed alternatives based on learning (Eaton, Eslava, Krizan, Kugler and Tybout (2010)), search (Chaney (2009)) and innovations to productivity (Arkolakis (2009)) which can do better at matching these facts. Related work in the macro literature which focuses on accumulation of customer base includes Foster, Haltiwanger and Syverson (2010), Gourio and Rudanko (2010) and Drozd and Nosal (2011). Motivated by this literature, our empirical approach allows for market-specific costs of adjustment.

Our empirical strategy also builds on the fixed effects approach to controlling for first-order heterogeneity in costs proposed by Knetter (1989) in the context of testing for pricing-to-market. This approach has been succesfully used in the price literature (e.g. Fitzgerald and Haller (2010)) but not so far in the literature on export entry and exit.

The effect of exchange rate shocks on entry and exit is addressed by Campa (2004), who uses Spanish data and finds quantitatively small effects of exchange rate movements on entry and exit. He estimates for continuing exporters an elasticity of export sales with respect to the real exchange rate that is less than one. Campa does not observe the destination breakdown of exports every year for firms in his sample, potentially affecting precision. Neverthelesss, our findings on the real exchange rate are quite similar to his. Berman, Martin and Mayer (2011) use French data to estimate the responses of participation and sales to real exchange rates. However their results are not directly comparable to ours.

While there is considerable interest in the effect of trade liberalizations on entry, exit and sales, empirical work on estimating the kind of elasticities we are interested in at the firm level has been hampered by the difficulty of constructing appropriate firm- and market-specific tariff measures. An exception to this is Lileeva and Trefler (2010), who focus not so much on the contemporaneous effects of liberalization on participation and sales, but on the consequent effects on productivity upgrading.

The second section of the paper describes the model we use to motivate our empirical

strategy. The third section describes our empirical strategy. The fourth section describes our data. The fifth section describes our results. The final section concludes.

2 Model

The purpose of our model is to provide structure for our empirical analysis. In line with recent evidence, we extend the standard model of sunk costs of exporting to allow for post-entry export dynamics. Several authors (Arkolakis (2009), Chaney (2010), Eaton et al (2010)) have recently derived models of post-entry export dynamics from first principles. For simplicity, we take a reduced-form approach. We posit that these dynamics come through a demand channel, allowing them to differ across markets within the same firm. The model is related to those of Arkolakis (2008) in the trade literature, and Drozd and Nosal (2011), Foster, Haltiwanger and Syverson (2010) and Gourio and Rudanko (2010) in the macro literature.

For simplicity, we condition on participation in the domestic market, and do not model the firm existence decision.[1] We assume that the only link between markets for a given firm is through marginal cost, which is assumed identical across all markets served by the firm.

2.1 Demand

Demand faced by firm i in market k at time t is as follows:

$$Q_t^{ik} = \left(D_t^{ik}\right)^{\alpha} \left(\frac{\left(1+\tau_t^{ik}\right) P_t^{ik*}}{P_t^{k*}} \right)^{-\theta} Q_t^k \exp\left(\eta_t^{ik}\right)$$

D_t^{ik} is a demand shifter that we will refer to as "market-specific intangible capital." Through this term, current demand may depend on past actions. At time t, D_t^{ik} is predetermined. We will consider a number of possible specifications for D_t^{ik}. The parameter$\alpha \in (0,1)$. P_t^{ik*} is the price charged by firm i to buyers from market k expressed in the currency of country k. τ_t^{ik} is the ad valorem tariff on exports to market k, so $\left(1+\tau_t^{ik}\right) P_t^{ik*}$ is the foreign-currency price actually paid by those buyers. P_t^{k*} is the aggregate price level in market k, expressed in the currency of market k. Q_t^k is real aggregate demand in market k. η_t^{ik} is an iid shock to demand.

[1] We thus ignore entry of plants that are born global and entry and exit of plants that sell only to the foreign market.

2.2 Costs

We assume that plant i faces nominal marginal cost $\tilde{C}_t^i$ of serving all markets. This cost is expressed in terms of domestic currency. Real marginal cost is $C_t^i = \tilde{C}_t^i / P_t^H$, where P_t^H is the aggregate price level in the home market. There may also be a fixed cost in real terms F_t^{ik} of participating in market k in any period, and a sunk cost of entry S_t^{ik}, also in real terms. There may also be costs associated with changing D_t^{ik}.

2.3 Static optimization

If we assume that D_t^{ik} is independent of past prices,[2] the optimal choice of price in this setup is purely a static decision, and the optimal price (expressed in home currency) is:

$$E_t^k P_t^{ik*} = \frac{\theta}{\theta - 1} \tilde{C}_t^i$$

This allows us to write real revenue as

$$R_t^{ik} = \left(\frac{\theta - 1}{\theta} \right)^{\theta - 1} \left(D_t^{ik} \right)^{\alpha} \left(C_t^i \right)^{1-\theta} \left(\frac{RER_t^k}{1 + \tau_t^{ik}} \right)^{\theta} Q_t^k \exp\left(\eta_t^{ik} \right)$$

while real gross profits are

$$\Pi_t^{ik} = \frac{R_t^{ik}}{\theta} = \tilde{\theta} \left(D_t^{ik} \right)^{\alpha} \left(C_t^i \right)^{1-\theta} \left(\frac{RER_t^k}{1 + \tau_t^{ik}} \right)^{\theta} Q_t^k \exp\left(\eta_t^{ik} \right)$$

To simplify notation, from now on, we write:

$$Z_t^{ik} = \left(\frac{RER_t^k}{1 + \tau_t^{ik}} \right)^{\theta} Q_t^k \exp\left(\eta_t^{ik} \right)$$

2.4 Dynamic optimization

There are potentially two dynamic aspects to the firm's problem. First, the firm has to choose whether or not it participates in market k, $X_t^{ik} \in \{0, 1\}$, a decision which is forward-looking in the presence of sunk costs. Second, depending on the assumptions we make about D_t^{ik}, there may be additional forward-looking elements to the firm's decision.

[2] An alternative would be to assume as in Foster, Haltiwanger and Syverson (2010) that today's choice of prices affects D tomorrow, or to allow nominal prices to be sticky. We examine these possibilities in an appendix.

Example 1

Suppose that D_t^{ik} depends on the history of past participation, as in Ruhl and Willis (2008):

$$D_{t+1}^{ik} = \sigma\left(X_{t-1}^{ik}, X_{t-2}^{ik}, \ldots\right)$$

This introduces a forward-looking dimension to the firm's problem even if there is no sunk cost of entry ($S_t^{ik} = 0$).

The firm's dynamic problem is:

$$V\left(X_{t-1}^{ik}, D_t^{ik}, C_t^i, Z_t^{ik}\right) = \max_{X_t^{ik} \in \{0,1\}} \left\{ \begin{array}{c} \tilde{\theta}\left(D_t^{ik}\right)^{\alpha}\left(C_t^i\right)^{1-\theta} Z_t^{ik} \\ -X_t^{ik} F_t^{ik} - X_t^{ik}\left(1 - X_{t-1}^{ik}\right) S_t^{ik} \\ +\beta \mathbb{E}_t V\left(X_t^{ik}, D_{t+1}^{ik}, C_{t+1}^i, Z_{t+1}^{ik}\right) \end{array} \right\}$$

subject to

$$D_{t+1}^{ik} = \sigma\left(X_t^{ik}, X_{t-1}^{ik}, \ldots\right)$$

This implies a policy function for participation which takes the form:

$$X_t^{ik} = x\left(X_{t-1}^{ik}, C_t^i, Z_t^{ik}, D_t^{ik}\right) = x\left(C_t^i, Z_t^{ik}, X_{t-1}^{ik}, X_{t-2}^{ik}, \ldots\right)$$

Meanwhile export revenue from market k depends not just on costs (C_t^i) and demand shocks (Z_t^{ik}), but also on the history of past participation in market k, through D_t^{ik}.

Example 2

Suppose that D can be accumulated through costly investment I_t^{ik}, accumulating according to:

$$D_{t+1}^{ik} = (1 - \delta) X_t^{ik} D_t^{ik} + I_t^{ik}$$

This implies that there is full depreciation of previously accumulated intangible capital if the firm stops participating in the market. We can allow for full or partial irreversibility by assuming the cost of investment is given by $P\left(I_t^{ik}\right) I_t^{ik}$ where

$$P\left(I_t^{ik}\right) = \begin{cases} 1 & I_t^{ik} \geq 0 \\ \gamma \in [0, 1) & I_t^{ik} < 0 \end{cases}$$

We can allow for additional costs of adjustment (convex and/or non-convex) through a function $\phi\left(D_t^{ik}, I_t^{ik}\right)$.

The firm's dynamic problem is then:

$$V\left(X_{t-1}^{ik}, D_t^{ik}, C_t^i, Z_t^{ik}\right) = \max_{X_t^{ik}\in\{0,1\}, I_t^{ik}} \left\{ \begin{array}{c} \tilde{\theta}\left(D_t^{ik}\right)^{\alpha}\left(C_t^i\right)^{1-\theta} Z_t^{ik} \\ -P\left(I_t^{ik}\right) I_t^{ik} - \phi\left(D_t^{ik}, I_t^{ik}\right) \\ -X_t^{ik} F_t^{ik} - X_t^{ik}\left(1 - X_{t-1}^{ik}\right) S_t^{ik} \\ +\beta \mathbb{E}_t V\left(X_t^{ik}, D_{t+1}^{ik}, C_{t+1}^i, Z_{t+1}^{ik}\right) \end{array} \right\}$$

subject to

$$D_{t+1}^{ik} = (1-\delta) X_t^{ik} D_t^{ik} + I_t^{ik}$$

This implies two policy functions of the form:

$$X_t^{ik} = x\left(X_{t-1}^{ik}, D_t^{ik}, C_t^i, Z_t^{ik}\right)$$

and

$$I_t^{ik} = i\left(X_{t-1}^{ik}, D_t^{ik}, C_t^i, Z_t^{ik}\right)$$

Note that while participation is observable to us, investment in intangible market-specific capital is not.

As in the previous example, export revenue from market k depends on costs (C_t^i) and demand shocks (Z_t^{ik}) and on the history of past participation in market k, through D_t^{ik}. However in contrast with the previous example, export revenue also depends on the history of past shocks to costs and demand.

3 Empirical strategy

3.1 Export participation

The standard export participation equation (e.g. Roberts and Tybout (1997)) regresses a participation indicator on plant or firm fixed or random effects, time fixed effects, an indicator for lagged participation, and a vector of (lagged) variables that are intended to capture time variation in costs at the firm or plant level. This is the approach that would be implied by

our model with $D_t^{ik} \equiv 1$. We modify this approach along a number of dimensions.

First, we exploit the fact that we observe export participation at the level of the individual market by using firm-year fixed effects to control for time-varying marginal cost. This implies that the effects of all other variables on participation are identified from within-firm-year cross-market variation. This is particularly convenient given our focus on sensitivity to shocks. It allows us to clean out that part of both macro and trade liberalization shocks that have an effect on participation in all markets through their effect on marginal cost, while allowing this effect to be heterogeneous across firms.

Second, in addition to allowing participation to depend on lagged participation, we allow participation of incumbents to depend on lagged sales in the relevant market. This is motivated by the appearance of D_t^{ik} in the policy function.[3]

Third, we allow participation to depend on the level of shocks, and we allow the sensitivity of participation to shocks to differ across firm-market observations. The reason for doing this is that the participation decison of firm-market pairs that are close to entry or exit thresholds will be quite sensitive to shocks. However the participation of firm-market pairs that are far from those thresholds will not be sensitive to shocks. Since the marjority of observations are likely to be far from the thresholds, imposing a uniform sensitivity across all firm-market observations could lead us to underestimate the impact of shocks on the participation decision.

We approximate the probability of participation as follows:

$$\Pr\left[X_t^{ik}=1\right] = G\left[\begin{array}{c} \alpha^k + c_t^i + \boldsymbol{\beta}'\mathbf{z}_t^{ik} + \boldsymbol{\gamma}'\left(\mathbf{s}_{t-1}^i \otimes \mathbf{z}_t^{ik}\right) \\ +\phi X_{t-1}^{ik} + \boldsymbol{\lambda}' r_{t-1}^{ik} X_{t-1}^{ik} + \boldsymbol{\delta}'\mathbf{z}_t^{ik} X_{t-1}^{ik} \\ +\boldsymbol{\theta}'\left(\mathbf{s}_{t-1}^i \otimes \mathbf{z}_t^{ik}\right) X_{t-1}^{ik} + \boldsymbol{\rho}'\left(r_{t-1}^{ik} \otimes \mathbf{z}_t^{ik}\right) X_{t-1}^{ik} + \varepsilon_t^{ik} \end{array}\right] \tag{1}$$

In this expressionα^k is a time-invariant market-specific effect which captures time-invariant components of trade costs and all time-invariant factors which lead the probability of participation for all firms to be greater in some markets than others. It also accounts for scaling of the macro variables in the shock vector $\mathbf{z}_t^{ik}$. c_t^i is a firm-year fixed effect which captures the first-order effect of firm-year-specific marginal cost, as well as any other variables that are common across markets for a given firm at a point in time. X_{t-1}^{ik} is lagged participation.

[3]Note that while in the standard case, estimating a fixed effects model with a lagged dependent variable or functions of lags of the dependent variable is problematic, in our case, the structure of the fixed effects is such that the usual bias does not apply.

r_{t-1}^{ik} is the lag of log real sales for incumbents in market k. $\mathbf{z}_t^{ik}$ is a vector of macro variables and trade policy variables. The baseline vector contains an index of the real exchange rate between the home market and market k, an index of real demand in market k, and a firm-market-year-specific ad valorem tariff. These variables are constructed as described below in sections 4.3 and 4.4. The vector of shocks is interacted with $\mathbf{s}_{t-1}^{i}$, a vector of indicators for firm size, to allow the sensitivity of entry to shocks to vary across the plant size distribution. It is also interacted with the indicator for lagged participation, the product of lagged participation and $\mathbf{s}_{t-1}^{i}$, and the lag of log real sales for incumbents in the market. These interactions allow the response of participation to shocks to vary across the distribution of incumbents. Finally, ε_t^{ik} is the error term.

Since we want to use firm-year fixed effects, as a baseline specification, we estimate a linear probability model (i.e. $G(\cdot)$ is a linear function. We calculate robust standard errors.

3.2 Export revenue

Taking logs and first differences of export revenue in the model motivates the following empirical specification:

$$\Delta r_t^{ik} = \alpha^k + c_t^i + \sum_{j=0}^{J} \boldsymbol{\beta}_j' \Delta \mathbf{z}_{t-j}^{ik} + \boldsymbol{\gamma}' \mathbf{a}_{t-1}^{ik} + \eta_t^{ik} \tag{2}$$

r_t^{ik} is the log of real sales measured in Euros. As in the participation equation, α^k is a time-invariant market-specific fixed effect which captures time-invariant reasons why sales growth might be higher for all firms in some markets than others. c_t^i is a firm-year fixed effect which captures changes in costs (assumed to be the same across markets within a firm) as well as demand factors where changes are common across markets for a given firm at a point in time. $\mathbf{z}_t^{ik}$ is (as above) a vector of macro variables and trade policy variables. The baseline vector contains an index of the real exchange rate between the home market and market k, an index of real demand in market k, and a firm-market-year-specific ad valorem tariff. These variables are constructed as described below in sections 4.3 and 4.4. Contemporaneous and lagged differences of this vector are included in the equation. $\mathbf{a}_{t-1}^{ik}$is a vector of indicators for the (lagged) number of years the plant has been in market k. Inclusion of this vector allows revenue growth to depend on the history of participation. η_t^{ik} captures changes in variables that are idiosyncratic to the firm, market and year (e.g. idiosyncratic demand shocks).

A major issue in estimating (2) is selection. We only observe the growth rate of export

revenue for firm-market-years where both $X_t^{ik} = 1$ and $X_{t-1}^{ik} = 1$. Participation depends on unobserved idiosyncratic shocks, which also show up in the revenue equation. This implies that the expectation of η_t^{ik} conditional on the independent variables need not equal to zero for firm-market-years close to the participation thresholds.

There are several aspects of the setup that make the standard approaches to controlling for selection (such as a Heckman correction) inappropriate or tricky to implement, most obviously the absence of any variable in our data set that plausibly affects participation but not revenue. So instead we do the following. We restrict our estimation sample to firm-market pairs where we observe participation in every year in the sample. Our implicit assumption is that these pairs are sufficiently far from the participation thresholds that the distribution of idiosyncratic shocks η_t^{ik} is not truncated. For this sample, there is no heterogeneity in $\mathbf{a}_{t-1}^{ik}$, so we drop this vector from the set of independent variables. This approach is clearly not ideal, but it has at least the merit of transparency. We can also check how the results differ when we include cases where the firm enters or exits a market over the lifetime of the sample. Under all specifications, we calculate robust standard errors.

4 Data

4.1 Micro data

Our work makes use of three sources of micro data: the Irish Census of Industrial Production (CIP), the Irish customs data, and the Irish Prodcom survey.

The CIP, which covers manufacturing, mining and utilities, takes place annually. Firms are required to fill in a return for all plants with 3 or more employees. In this paper, we make use of the data for the years 2000 to 2009 and for NACE Revision 1.1 sectors 10-36 (manufacturing and mining). We aggregate the data up to the firm level, since this is the level at which a match with the customs data can be performed. Of the variables collected in the CIP, those relevant for our purposes are the 4-digit NACE classification, country of ownership, employment, total revenue and domestic revenue. Additionally, the CIP collects information on investment, the wage bill, expenditures on intermediates and share of intermediates imported. We use this information for robustness checks.

Our second source of data is customs records of Irish merchandise exports for the years 2000 to 2009. These are collected monthly by tax id, at the Combined Nomenclature (CN) 8-digit level, by destination country. We have access to the data aggregated to an annual frequency. These data are matched by the Central Statistics Office to the CIP data using

the tax id numbers, which are distinct from the firm and plant identifiers in the CIP and Prodcom survey. The match is done on the basis of firms rather than plants, as tax id numbers are associated with firms, not plants. We have access to the customs records that are matched with a firm id number. This includes firms that are present in the CIP and a few firms that are not. We restrict attention to the records that match with CIP firms. We do not have access to unmatched customs records.

A key feature of customs data in the EU is that data for intra-European and extra-European trade are collected separately, using two different systems called Intrastat and Extrastat. For Ireland, the reporting threshold for intra-European trade (635,000 Euro per year) is much higher than the reporting threshold for extra-European trade (254 Euro per transaction). We have reason to believe that a substantial fraction of smaller exporters do not report intra-European exports to Intrastat, and have intra-European exports imputed through VAT returns (precise destination within the EU is not imputed). We observe these imputed flows, but we do not make use of them.

We classify firms that appear in the CIP as exporters to a particular destination if they are matched to positive exports to that destination from the customs data. Clearly the quality of the match is important. In the data appendix, we provide summary statistics on the quality of the match.

Our third source of data is the Prodcom survey for the years 2000 to 2009. This is an annual survey of the value and volume of all products manufactured by the enterprise and sold in the relevant year. The survey basis is all firms in the CIP excluding some mining sectors. Products are classified at the 8-digit level according to the Prodcom classification. While in principle this survey covers almost all CIP firms, in practice, coverage of the matched data is imperfect (on average 95% of total CIP turnover). We make use of the value data, but not of the volume data from this survey. We use these data solely for the purpose of creating measures of tariffs at the firm-market level.

In constructing our sample for analysis, we use the CIP as a basis. We drop firms that have a zero value for total revenue or zero employees in more than half of their years in the sample. We also drop firms if more than half of their observations were estimated or imputed by the Central Statistics Office due to non-response or incomplete returns. This affects small firms more than big firms. We perform some minor recoding of firm identifiers to maintain the panel dimension of the data. Further details on the data and how we have cleaned it are provided in the data appendix.

4.2 Summary statistics on firms and exports

Figure 1 plots total revenue and export revenue from firms in our sample over the period 2000-2009. Ireland experienced a boom followed by a bust during our sample period, and this is clear in the behavior of total revenue. In contrast to many countries, Irish merchandise exports did not fall significantly during the 2008 crisis.

Table 1 reports summary statistics on exporters and non-exporters separately for all years in our sample. Firms are classified as exporters if they are matched with positive exports from the customs data. As is standard in both developed and developing countries, exporters are bigger than firms which sell exclusively to the domestic market, both in terms of employees and total sales. Export intensity is higher for Irish firms than in many other countries, possibly due to the small size of the economy and the traditionally high degree of integration with the UK market. We observe a cyclical reduction in export participation over the period of the boom, and an increase in participation during the two years of the bust that we observe.

Table 2 reports transitions into and out of exporting. As has been documented elsewhere, there is a good deal of persistence in export status. Table 3 reports the mean sales of entrants as a share of the mean sales of incumbents, and of exiters as a share of the mean sales of continuing firms, for four important Extrastat destinations. From this it is clear (as has also been documented elsewhere) that the bulk of exports is accounted for by incumbents.

Table 4 reports the share of exports in our matched sample by destination for a select set of destinations (the shares from published data on all merchandise exports match closely the shares based on our matched sample). The main destination markets for Irish exports are the US, the UK and other EU markets, principally the Euro Zone. We work with these destinations, and in addition a number of less important Extrastat markets: Brazil, Hong Kong, India, Malaysia, Mexico, New Zealand, Russia, Saudi Arabia, South Africa, Thailand and the United Arab Emirates.

4.3 Tariff data

Irish exporters do not face tariffs in EU or EFTA destinations in our sample period. For other WTO member countries with which the EU does not have any special agreement, Irish exporters face the MFN tariff. In some markets (e.g. Turkey), Irish exporters face a preferential tariff offered to exporters from EU countries. In all of these cases, conditional on Irish membership of the EU, the actual level of tariffs is determined by multilateral bargaining

under the auspices of the WTO (in the case of MFN tariffs) or bilateral bargaining between the EU and partner countries (in the case of preferential tariffs). Since Ireland is a small relative to the EU as a whole, we are reasonably convinced that the behavior of the firms in our sample does not affect the tariffs they face.

To construct measures of tariffs at the firm-market level, we require data on the relevant tariffs at the product-market level. The source of our tariff data is the WTO. We collect MFN tariff data for the following destinations: Australia, Brazil, Canada, China, Hong Kong, India, Japan, Malaysia, Mexico, New Zealand, Russia, Saudi Arabia, South Africa, Thailand, United Arab Emirates and the US. We also collect information on preferential tariffs offered to EU countries by Turkey. These countries are chosen because they are the relatively more important export destinations for Ireland. The US accounts for on average 20% of Irish merchandise exports over this period, and the remaining destinations account for between 5 and 10% (see Table 4). For many of the developing countries in the sample, tariff data is not available for all of the sample years. We do not interpolate, but make use only of the years for which data is available.

In order to match export and production data to the tariff data, we need a concordance between the CN and Prodcom classifications used in our data for exports and production, and the product classifications used by different destinations for tariffs. The most disaggregated level at which such a concordance is available is the 6-digit level: The CN 6-digit and the Prodcom 6-digit correspond to the Harmonized System (HS) 6-digit level, which is used by all countries as a basis for their tariff lines. We restrict attention to HS6 product-market-years for which there are only ad-valorem tariffs,[4] and for which all tariffs within the HS6 are the same. As a robustness check, we relax the requirement that there be no variation in tariffs within the HS6 category, and use the unweighted average of these tariffs. We must concord HS6 categories over time, as the HS6 classification changes in 2002 and 2007. For simplicity, we focus on HS6 categories for which there is a 1-1 match in both 2002 and 2007.

Before explaining how we use the tariff data to construct firm-market-year specific measures of tariffs and changes in tariffs, we illustrate the relevant variation in the raw tariff data. Identification of the response of participation to tariffs relies on variation both across markets and over time in the deviation of the tariff level a particular firm faces from the mean tariff in that market across all firms and over time. This can be generated by variation in tariffs across products within a market, across markets in a way that varies across products, and over time. We illustrate this type of variation as follows. We estimate (where j indexes

[4]The impact of non-ad-valorem tariffs on trade depends on prices, which we do not observe.

products and k indexes markets):

$$\ln\left(1+\tau_t^{jk}\right) = \alpha^k + \gamma_t^j + \varepsilon_t^{jk}$$

Figure 2 is a histogram of the residuals from this regression, ε_t^{jk}. There is a good deal of residual variation in this variable.

Identification of the response of export revenue to tariffs relies on variation in tariff changes across markets and over time in the deviation of the change in the tariff a particular firm faces from the mean tariff change in that market across all firms and over time. This requires time-series variation in tariffs. The main source of time series variation in tariff levels that we exploit is the last five years of the implementation of MFN tariff reductions agreed under the Uruguay Round (2000-2004). We illustrate this type of variation as follows. We estimate (where j indexes products and k indexes markets):

$$\Delta \ln\left(1+\tau_t^{jk}\right) = \alpha^k + \gamma_t^j + \varepsilon_t^{jk}$$

Figure 3 is a histogram of the residuals from this regression, ε_t^{jk}. There is considerably less residual variation in this variable than in tariff levels.

4.3.1 Tariff variable for participation equation

In creating a tariff variable for the right hand side of our participation equation, we assume that the products a firm produces provide a good guide to the types of products the firm might potentially export to any given destination. Under this assumption, the tariffs on these products then provide a good guide to the effective degree of protection faced by the firm in deciding whether or not to participate in the market. Consistent with the model, we then construct our baseline tariff measure for the participation equation as:

$$ptariff_t^{ik} = \sum_j \left(\frac{psh_t^{ij} + psh_{t-1}^{ij}}{2}\right) \ln\left(1+\tau_t^{jk}\right)$$

where psh_t^{ij} is the share of product j in firm i's total production at date t, τ_t^{jk} is the ad valorem tariff in market k on good j at time t, and the sum is taken over all the products the firm produces at date t and date $t-1$ In robustness tests, we also make use of measures which weight using contemporaneous production shares, or lagged production shares.

4.3.2 Tariff variable for revenue equation

Since we estimate our revenue equation in differences, we need a measure of the effective change in tariffs to include in this equation. We construct our baseline measure of the effective change in tariffs as follows:

$$\Delta rtariff_t^{ik} = \sum_j \left(\frac{rsh_t^{ijk} + psh_{t-1}^{ijk}}{2} \right) \Delta \ln \left(1 + \tau_t^{jk} \right)$$

where rsh_t^{ijk} is the share of product j in firm i's total exports to market k at date t. In robustness tests, we also make use of measures which weight using contemporaneous export shares or lagged export shares. We also make use of measures which weight using the average of current and lagged production shares.

4.4 Macro data

The macro variables we include in our regressions are the real consumption exchange rate between Ireland and the target market, and a measure of real local currency demand in the target market. Real exchange rates are constructed using data on annual average nominal exchange rates and CPIs from International Financial Statistics. Figures 4 and 5 illustrate that the bulk of the variation in real exchange rates is driven by variation in nominal exchange rates. Real demand in the target market is calculated as GDP in current domestic currency less exports in current domestic currency plus imports in current domestic currency, deflated by the relevant CPI. The National Accounts data are taken from the OECD, while the CPIs come from International Financial Statistics.

5 Results

5.1 Export participation

For the export participation equation, we restrict our estimation sample to Extrastat countries, where we measure participation with greater precision than for Intrastat countries. Table 5 reports the results from estimating equation (1) on this sample. To make it easier to interpret the estimates, Table 6 reports the marginal effects of the three different shocks by size and lagged participation status. For incumbents, these marginal effects are evaluated at the mean of lagged log revenue for the relevant size class.

We find that real depreciations of the home currency against that of the target market make it more likely both that potential entrants will enter, and that incumbents will continue to participate in the market. However the participation of potential entrants is more sensitive to real exchange rates the bigger they are (in terms of lagged number of employees), while that of incumbent firms is less sensitive the bigger they are (both in terms of lagged number of employees, and lagged sales in the relevant market). For both potential entrants and incumbents, the higher is real demand in the target market, the more likely they participate in this period. As with real exchange rates, the participation decision of potential entrants is more sensitive to real demand the bigger they are, while that of incumbent firms is less sensitive the bigger they are. For large firms which are potential entrants, and for large firms which are incumbents, the probability of participation in a target market is decreasing in the tariff they face in that market, which is what theory would predict. The opposite is true for the smallest firms, while the participation of mid-sized firms does not appear to be sensitive to tariffs. The point estimates of the sensitivity of participation to tariffs for incumbent firms are an order of magnitude greater than the point estimates of the sensitivity of participation to real exchange rates.

To interpret the quantitative implication of these findings, note from Table 2 that the rate of entry into exporting hovers around 5%, while the rate of exit is 10-15% annually. Looking at the marginal effects from Table 6, a 10% depreciation of the home currency will increase the probability of entry into exporting for the largest non-exporters by 0.2 percentage points (0.1×0.02). Meanwhile, a reduction of tariffs from 10% to 0 will tend to increase the probability of entry into exporting for the largest non-exporters by 0.3 percentage points (0.1×0.03). These numbers are small relative to average steady state entry rates, and likely to be even smaller relative to the entry rates of the largest non-exporters. For the largest exporters, a 10% depreciation of the home currency will reduce the probability of exit from exporting by 0.1 percentage points (0.1×0.01). For the largest exporters, a reduction of tariffs from 10% to 0 will reduce the probability of exit by 3.4 percentage points (0.1×0.34). This is not trivial. But the export sales of future exiters are on average a small fraction of those of firms who will continue (Table 3), implying that participation responses of this order of magniture are insufficient to generate large responses of exports to changes in tariffs.

We examine the robustness of our results along a number of dimensions.

5.2 Export revenue

The sample we use to estimate the revenue growth equation pools across Intrastat and Extrastat destinations. As explained above, as a baseline, we use only firm-market pairs where there is participation throughout the sample. The results from estimating our baseline specification of the revenue growth equation are reported in Table 7. The coefficient on the contemporaneous real exchange rate change is significantly different from zero, and not significantly different from one. Lagged real exchange rate changes do not enter significantly. Neither current nor lagged growth in real demand enters significantly, though it is somewhat interesting that the point estimate of the coefficient on current growth in real demand is equal to one. The coefficient on the contemporaneous change in tariffs is negative, but not significantly different from zero, while the coefficient on the lagged change in tariffs is negative and significantly different from zero. The point estimates of the coefficients on the tariff variables are an order of magnitude greater (in absolute value) than the coefficients on the real exchange rate variables.

The signs of the estimated coefficients are all as predicted by theory. Depreciations of the home currency against that of the target market, increases in foreign real demand, and reductions of tariffs in target markets are all associated with growth of export revenue. The magnitude of the coefficient on real exchange rates is squarely in the ballpark of estimates based on macro data, though it does not look like a plausible price elasticity of demand. The coefficient on tariffs is less precisely estimated; but nevertheless, the fact that the elasticity of export revenue with respect to tariffs is (in absolute value) much greater than that of export revenue with respect to real exchange rates is consistent with estimates based on macro data.

It is also interesting that while lagged exchange rate changes do not seem to have an impact on revenue, revenue appears to be more sensitive to lagged than to contemporaneous changes in tariffs. Our findings are consistent with firms not responding actively to movements in real exchange rates (which are mainly driven by movements in nominal exchange rates), but choosing instead to invoice exports in foreign currency, and passively allowing revenue to move one-for-one with movements in exchange rates. On the other hand, the greater response of exports to lagged than contemporaneous changes in tariffs is consistent with firms taking actions in response to tariff reductions that have future as well as current payoffs in terms of revenue.

We examine the robustness of our results along a number of dimensions.

In Table 8, we exploit a different trade liberalization experiment from the baseline tariff

reductions in non-EFTA markets associated with the Uruguay round. This is the accession of a series of Eastern European countries to the EU, the first wave in May 2004, the second wave in January 2007. While accession was not associated with tariff changes (zero tariffs were in effect throughout the sample period), it was associated with the elimination of customs controls between Ireland and these destination markets. Because these episodes are associated with the destinations being reclassified between Extrastat and Intrastat, and hence how precisely participation is measured, we do not examine the effect on participation. However we can examine the effect of eliminating customs controls for firms who export continuously to these markets. To do so, we restrict the sample only to EFTA destinations where tariffs are always zero. In addition to the macro shocks, we include in the regression an indicator variable that equals 1 if the status of the destination market changes from non-EU to EU in a given year, as well as the lag of this variable. The results in the table are for the case where the indicator is set equal to 1 for the first round of accession countries in 2004, and for the second round of accession countries in 2007. The point estimates on these coefficients have the expected sign (accession increases trade by 21%), and the magnitude is substantial, but not estimated to be significantly different from zero.

6 Conclusion

We document the response of export participation and export sales at the firm-market level to both macro shocks and trade liberalization shocks. We find that both participation and sales of continuing exporters are more responsive to tariff reductions than they are to macro shocks, in particular, to movements in real exchange rates. Our results are consistent with a story where producers perceive macro shocks as being more volatile or less persistent than trade liberalization shocks, and there are both sunk costs of entry, and costs of adjusting sales for continuing exporters. Moreover, we provide independent evidence consistent with market-specific costs of adjustment for continuing exporters. We find that the probability of exit is negatively related to a firm's attachment to a particular market, as measured by lagged sales in that market or number of years in the market. We also find that the growth rate of market-specific sales is negatively related to tenure in the market, and that this growth responds to lagged tariffs but not to lagged real exchange rates.

Our results provide support for recent papers by Ruhl (2008) and Drozd and Nosal (2011) which suggest that costs of adjustment for exporters may play a role in explaining sluggish responses of aggregate exports to real exchange movements. At the same time, they are

consistent with the findings of the literature of substantial responses of trade aggregates to trade liberalizations. While further analysis is clearly merited - in particular with the goal of understanding the nature of adjustment costs on the intensive margin - we think that this is important progress towards understanding the International Elasticity Puzzle.

References

[1] Alessandria, G. and H. Choi (2007), "Do Sunk Costs of Exporting Matter For Net Export Dynamics?" *Quarterly Journal of Economics*, 122 (1).

[2] Arkolakis, C. (2008), "Market Penetration Costs and the New Consumers Margin in International Trade," mimeo.

[3] Arkolakis, C. (2009), "A Unified Theory of Firm Selection and Growth," mimeo.

[4] Atkeson, A. and A. Burstein (2008), "Pricing to Market, Trade Costs and International Relative Prices," *American Economic Review*.

[5] Baldwin, R. (1988), "Hysteresis in Import Prices: The Beachhead Effect," *American Economic Review* 78 (4), 773-85.

[6] Baldwin, R. and P. Krugman (1989), "Persistent Trade Effects of Large Exchange Rate Shocks," *Quarterly Journal of Economics* 104 (4), 635-54.

[7] Berman, N., P. Martin and T. Mayer (2009), "How do Different Exporters React to Exchange Rate Changes? Theory, empirics and aggregate implications," mimeo.

[8] Bernard, A. and B. Jensen (2004), "Why Some Firms Export," *Review of Economics and Statistics* 86 (2), 561-569.

[9] Bernard, A., S. Redding, B. Jensen and P. Schott (2007), "Firms in International Trade," *Journal of Economic Perspectives*, Summer.

[10] Bernard, A. and J. Wagner (2001), "Exports and Success in German Manufacturing," *Weltwirtschaftliches Archiv* 133 (1), 134-157.

[11] Campa, J. (2004), "Exchange Rates and Trade: How Important is Hysteresis in Trade?" *European Economic Review* 48, 527-548.

[12] Chaney, T. (2010), "The Network Structure of International Trade," mimeo.

[13] Das, M., M. Roberts and J. Tybout (2007), "Market Entry Costs, Producer Heterogeneity and Export Dynamics," *Econometrica* 75 (3), 837-873.

[14] Dixit, A. (1989) "Entry and Exit Decisions Under Uncertainty," *Journal of Political Economy* 97 (3), 620-38.

[15] Drozd, L. and J. Nosal (2011), "Understanding International Prices: Customers as Capital," *American Economic Review*, forthcoming.

[16] Eaton, J., M. Eslava, C. Krizan, M. Kugler and J. Tybout (2010), "A Search and Learning Model of Export Dynamics," mimeo.

[17] Eaton, J., M. Eslava, M. Kugler and J. Tybout (2008), "The Margins of Entry into Export Markets: Evidence From Colombia," in E. Helpman, D. Marin, and T. Verdier, eds., *The Organization of Firms in a Global Economy,* Cambridge, MA: Harvard University Press.

[18] Fitzgerald, D. and S. Haller (2010), "Pricing-to-Market: Evidence From Producer Prices," mimeo.

[19] Foster, L., J. Haltiwanger and C. Syverson (2010), "The Slow Growth of New Plants: Learning About Demand," mimeo.

[20] Ghironi, F. and M. Melitz (2005), "International Trade and Macroeconomic Dynamics With Heterogeneous Firms," *Quarterly Journal of Economics* 120 (3), 865-915.

[21] Gourio, F. and L. Rudanko (2010), "Customer Capital," mimeo.

[22] Knetter, M. (1989), "Price Discrimination by U.S. and German Exporters," *American Economic Review* 79 (1), 198-210.

[23] Melitz, M. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica* 71 (6), 1695-1725.

[24] Roberts, M. and J. Tybout (1997), "The Decision to Export in Colombia: An Empirical Model of Entry With Sunk Costs," *American Economic Review* 87 (4), 545-564.

[25] Ruhl, K. (2008), "The International Elasticity Puzzle," mimeo.

[26] Ruhl, K. and J. Willis (2008), "New Exporter Dynamics," mimeo.

Table 1: Summary statistics on exporters and non-exporters

	# firms		Avg employees		Avg revenue		Avg export %	Avg # dest
	All	Exporters	Nonex.	Exporters	Nonex.	Exporters	Exporters	Exporters
2000	4826	2025	32	87	11808	29657	42	7
2001	4768	2072	33	84	13012	29227	42	7
2002	4944	2079	30	80	10281	33699	42	7
2003	4902	2063	28	78	10775	37748	42	7
2004	4585	2024	28	80	12020	40664	42	7
2005	4307	1916	30	82	14604	43993	44	7
2006	4476	1950	29	81	14796	43683	43	7
2007	5266	1974	25	78	13330	44762	40	7
2008	5337	1920	21	73	10353	44320	38	6
2009	4906	1860	19	72	9501	44660	39	7

Notes: Statistics are for our cleaned dataset of CIP firms. Firms are defined as exporters if they are matched to more than 500 Euro per year in exports from the customs data. Export share is calculated as total exports from the customs data divided by sales reported in the CIP. Values greater than 100 are replaced by 100. Source: CSO and authors' calculations.

Table 2: Transitions of firms into and out of exporting

Year-t status	exports			no exports		
Year-t+1 status	no exports	exports	exit	no exports	exports	exit
2000-01	0.04	0.93	0.03	0.88	0.06	0.06
2001-02	0.05	0.90	0.04	0.86	0.04	0.10
2002-03	0.07	0.87	0.06	0.84	0.06	0.10
2003-04	0.05	0.87	0.08	0.77	0.06	0.17
2004-05	0.06	0.86	0.08	0.82	0.05	0.13
2005-06	0.07	0.85	0.08	0.85	0.05	0.10
2006-07	0.07	0.85	0.07	0.86	0.03	0.11
2007-08	0.06	0.84	0.10	0.78	0.04	0.18
2008-09	0.06	0.87	0.07	0.82	0.04	0.14

Notes: Table reports share of firms of year-t status ending up in each category of year-t+1 status. Statistics are for our cleaned dataset of CIP firms. Firms are defined as exporters if they are matched to more than 500 Euro per year in exports from the customs data. Exiters are firms which do not appear in the CIP under the same firm id in the next period. Source: CSO and authors' calculations.

Table 3: Size of entrants and exiters

	US		Australia		Switzerland		Japan	
year	Entrants	Exiters	Entrants	Exiters	Entrants	Exiters	Entrants	Exiters
2000		0.01		0.05		0.31		0.07
2001	0.01	0.02	0.23	0.26	3.23	0.17	0.01	0.02
2002	0.01	0.07	0.02	0.02	0.05	0.03	0.05	0.06
2003	0.01	0.07	0.05	0.05	0.03	0.02	0.04	0.03
2004	0.04	0.52	0.01	0.03	0.00	0.01	0.10	0.02
2005	0.02	0.02	0.04	0.02	0.01	0.01	0.05	0.02
2006	0.04	0.02	0.01	0.06	0.00	0.02	0.05	0.17
2007	0.51	0.01	0.04	0.03	0.01	0.01	0.03	0.05
2008	0.09	0.04	0.02	0.50	0.01	0.12	0.03	0.92
2009	0.35		0.54		0.03		0.45	

Notes: Table reports ratio of mean sales of entrants to mean sales of incumbents and ratio of mean sales of exiters to mean sales of continuing firms. Statistics are for our cleaned dataset of CIP firms. Firms are defined as exporters if they are matched to more than 500 Euro per year in exports from the customs data. Exiters are firms which do not appear in the CIP under the same firm id in the next period. Source: CSO and authors' calculations.

Table 4: Shares of exports in our matched sample by destination

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Australia	1	1	1	1	1	1	1	1	1	1
Canada	0	1	0	1	0	0	0	0	0	1
China	0	0	1	1	1	1	1	2	2	3
Denmark	1	0	1	1	0	0	1	1	1	0
Japan	4	4	4	3	3	3	3	2	2	2
Norway	0	0	0	0	0	0	0	0	0	0
Sweden	1	1	1	1	1	1	1	1	1	1
Switzerland	1	1	1	1	4	5	4	5	4	4
UK	17	15	15	15	15	15	16	16	16	15
US	22	20	22	23	21	16	16	18	19	22
Euro 9	42	43	45	44	43	47	44	42	41	42
Accession countries	1	1	1	1	1	1	1	1	2	1

Notes: Source: CSO and authors' calculations. The Euro 9 includes Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Portugal and Spain (Greece and Luxembourg are excluded because Irish trade with these countries is negligible). Accession countries are Eastern European countries which joined the EU in 2004 and 2007: Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

Table 5: Participation

	coeff	s.e.
X^{ik}_{t-1}	-0.03	(0.08)
$X^{ik}_{t-1} * rev^{ik}_{t-1}$	0.18	(0.01)**
rer^{k}_{t}	0.00	(0.00)
$emp2^{i}_{t-1} * rer^{k}_{t}$	0.01	(0.00)**
$emp3^{i}_{t-1} * rer^{k}_{t}$	0.02	(0.00)**
$X^{ik}_{t-1} * rer^{k}_{t}$	0.04	(0.01)**
$X^{ik}_{t-1} * emp2^{i}_{t-1} * rer^{k}_{t}$	-0.01	(0.01)*
$X^{ik}_{t-1} * emp3^{i}_{t-1} * rer^{k}_{t}$	-0.01	(0.01)*
$X^{ik}_{t-1} * rev^{ik}_{t-1} * rer^{k}_{t}$	-0.01	(0.00)**
dem^{k}_{t}	0.01	(0.00)**
$emp2^{i}_{t-1} * dem^{k}_{t}$	0.00	(0.00)**
$emp3^{i}_{t-1} * dem^{k}_{t}$	0.01	(0.00)**
$X^{ik}_{t-1} * dem^{k}_{t}$	0.02	(0.00)**
$X^{ik}_{t-1} * emp2^{i}_{t-1} * dem^{k}_{t}$	0.00	(0.00)
$X^{ik}_{t-1} * emp3^{i}_{t-1} * dem^{k}_{t}$	-0.00	(0.00)**
$X^{ik}_{t-1} * rev^{ik}_{t-1} * dem^{k}_{t}$	-0.01	(0.00)**
tau^{ik}_{t}	0.02	(0.00)**
$emp2^{i}_{t-1} * tau^{ik}_{t}$	-0.03	(0.01)**
$emp3^{i}_{t-1} * tau^{ik}_{t}$	-0.06	(0.02)**
$X^{ik}_{t-1} * tau^{ik}_{t}$	0.32	(0.20)
$X^{ik}_{t-1} * emp2^{i}_{t-1} * tau^{ik}_{t}$	-0.65	(0.23)**
$X^{ik}_{t-1} * emp3^{i}_{t-1} * tau^{ik}_{t}$	-0.88	(0.23)**
$X^{ik}_{t-1} * rev^{ik}_{t-1} * tau^{ik}_{t}$	0.08	(0.04)**
# firm-mkt-years	299549	
R^2-adj	0.62	

Notes: Estimation method is OLS. Dependent variable is an indicator for participation. Sample consists of all firm-mkt-years in the Extrastat sample with positive current and lagged sales in the Irish market, and for which the independent variables are available. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level. The omitted category is firms with 1-14 employees in the previous period. $emp2^{i}_{t-1}$ indicates that the firm had 15-99 employees and $emp3^{i}_{t-1}$ that the firm had 100+ employees in the previous period.

Table 6: Marginal effects from participation equation

		rer		demand		tariff	
Status	Employees	coeff	se	coeff	se	coeff	se
Potential entrants	1-14	0.00	(0.00)	0.01	(0.00)**	0.02	(0.00)**
	15-99	0.01	(0.00)**	0.02	(0.00)**	-0.00	(0.01)
	100+	0.02	(0.00)**	0.02	(0.00)**	-0.03	(0.02)**
Incumbents	1-14	0.02	(0.01)**	0.01	(0.00)**	0.54	(0.18)**
	15-99	0.01	(0.00)**	0.01	(0.00)**	-0.12	(0.14)
	100+	0.01	(0.01)*	0.00	(0.00)	-0.34	(0.14)**

Notes: Marginal effects are calculated based on the estimates reported in Table 5.

Table 7: Sales

	coeff	s.e.
Δrer_t^k	0.97	(0.31)**
Δrer_{t-1}^k	-0.07	(0.33)
Δdem_t^k	1.03	(0.71)
Δdem_{t-1}^k	0.20	(0.81)
Δtau_t^{ik}	-7.06	(9.93)
Δtau_{t-1}^{ik}	-19.65	(8.42)**
Market f.e.	yes	
Firm-year f.e.	yes	
# firm-mkt-years	12272	
# firm-years	3171	
# firms	461	
R^2	0.32	
R^2-adj	0.09	

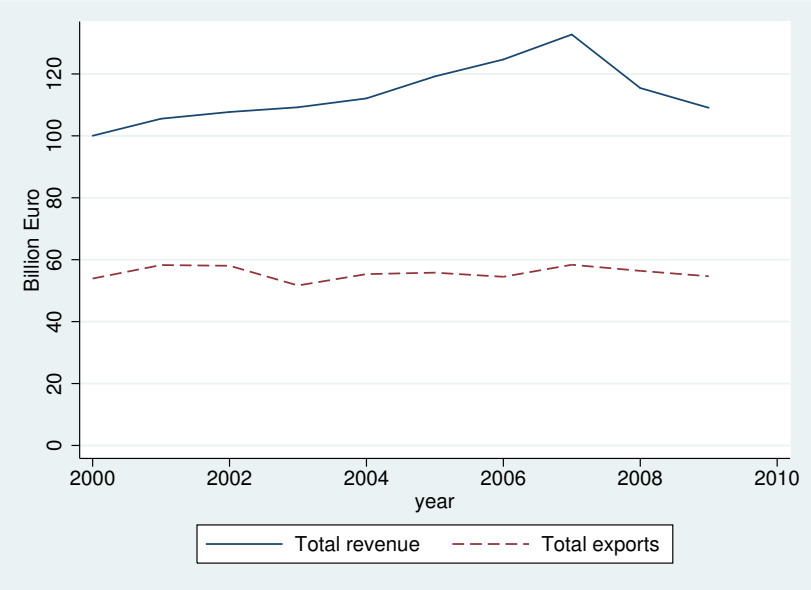
Notes: Sample consists of all firm-mkt pairs in Intrastat and Extrastat destinations for which continuous participation is observed throughout the sample. Estimation method is OLS. Dependent variable is the change in log Euro revenue deflated by the Irish CPI. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level.

Table 8: Sales: EU Accession

	coeff	s.e.
Δrer_t^k	0.09	(0.33)
Δrer_{t-1}^k	-0.02	(0.38)
Δdem_t^k	1.78	(0.66)**
Δdem_{t-1}^k	-0.39	(0.82)
Δeu_t^k	0.03	(0.20)
Δeu_{t-1}^k	0.18	(0.14)
Market f.e.	yes	
Firm-year f.e.	yes	
# firm-mkt-years	10786	
# firm-years	2753	
# firms	393	
R^2	0.33	
R^2-adj	0.09	

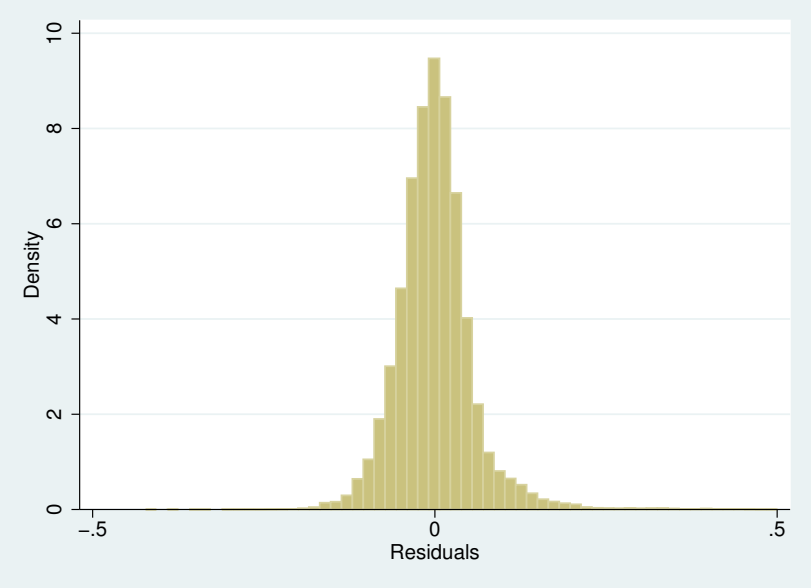
Notes: Sample consists of all firm-mkt pairs in EFTA for which continuous participation is observed throughout the sample. Estimation method is OLS. Dependent variable is the change in log Euro revenue deflated by the Irish CPI. Robust standard errors are calculated. ** indicates significance at the 5% level. * indicates significance at the 10% level. The EU accession dummy (change in EU status) is set equal to 1 for Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia in 2004, and for Bulgaria and Romania in 2007.

Figure 1: Total revenue and total exports



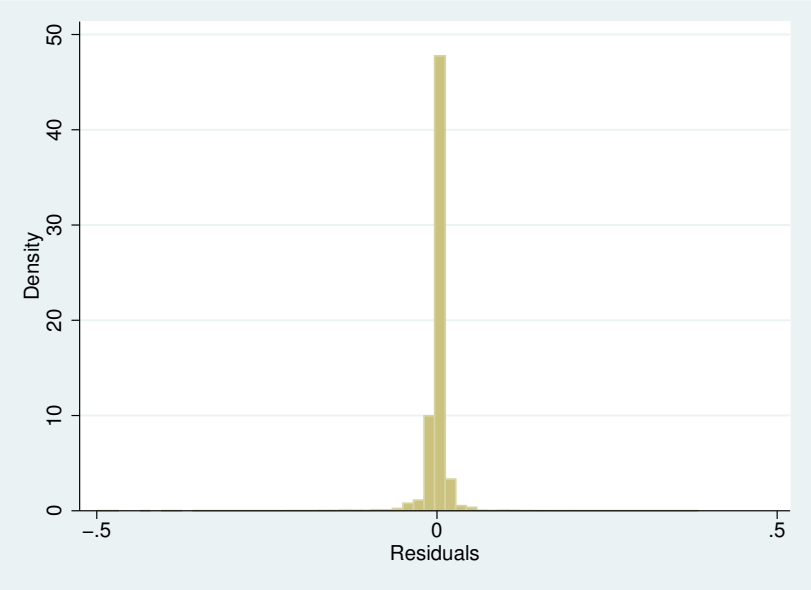
Notes: Figure shows total nominal revenue for CIP firms in our sample, and total nominal exports matched to these firms from customs data. Source: CSO and authors' calculations.

Figure 2: Residual variation in tariff levels



Notes: Figure shows histogram of residuals from regressing $\ln(1+\tau)$ on country fixed effects and product-year fixed effects. Source: WTO and authors' calculations.

Figure 3: Residual variation in tariff changes



Notes: Figure shows histogram of residuals from regressing $\Delta \ln(1+\tau)$ on country fixed effects and product-year fixed effects.
Source: WTO and authors' calculations.

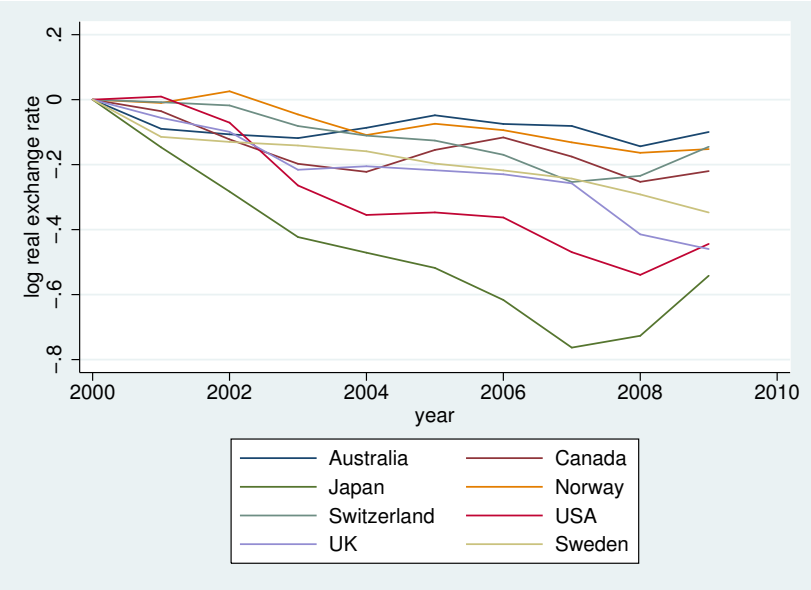


Figure 4: Annual average real exchange rates: Non-Euro destinations

Notes: Source: IFS and authors' calculations.

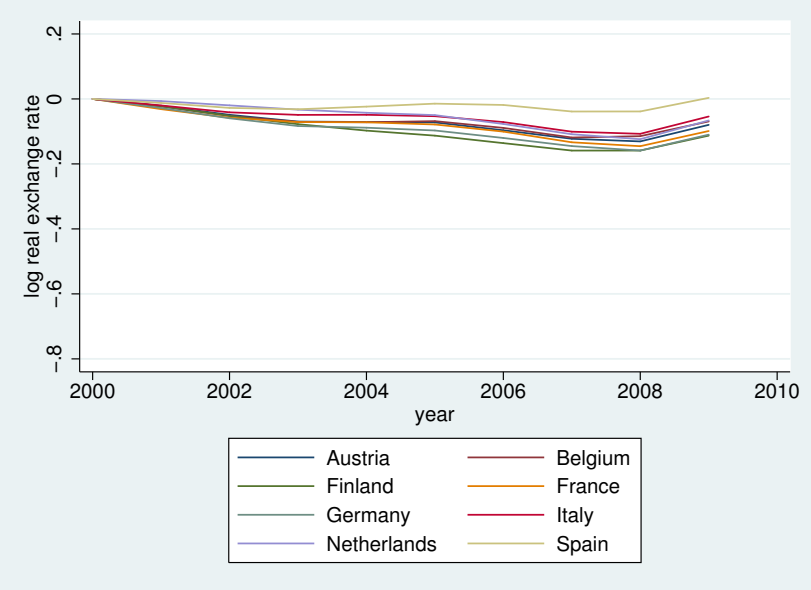


Figure 5: Annual average real exchange rates: Euro destinations

Notes: Source: IFS and authors' calculations.