Learning to Export and the Timing of Entry to Export Markets

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Abstract

Exporters normally enter their first foreign markets some time after beginning to sell locally, then enter subsequent markets progressively. Standard trade models are essentially static and do not explain these elementary facts about exporting, which can bias the estimation of trade patterns. This paper proposes a model that endogenously generates the timing of entry to new export markets. The timing results from a learning mechanism. More productive firms are less sensitive to the learning effect and therefore (1) enter markets more quickly and (2) enter larger markets earlier and smaller markets later. These predictions are confirmed using Swedish firm-level data.

"Time … is what keeps everything from happening at once." — Ray Cummings

1. Introduction

The timing of entry to export markets is an important aspect of trade patterns, as most firms delay entry to new markets and do so to widely varying degrees. However, standard trade models do not capture the timing of entry and thus effectively assume that new firms are formed in their mature state with fully-developed exporting behaviour. In reality, new firms are regularly being formed and firms that eventually export often take several years to enter their first export market, then enter new markets progressively. Therefore, what appears in

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the data to be a non-exporter may simply be a firm that has not yet begun to export. To properly explain exporting patterns, it is important to understand the timing of entry.

This paper proposes a model for the timing of entry to new export markets. The model is based on experience in the process of entry: the more markets a firm has entered, the more expertise it has in entering new markets and the lower the fixed cost of entry to any given market. The firm therefore has an incentive to delay entry to a new market as this implies a lower fixed cost of entry, provided that other markets are entered in the meantime. On the other hand, delaying entry implies foregone revenue. Firms are of the heterogeneous-productivity type proposed by Melitz (2003), which drives the variation in export expansion strategies. The trade-off between reduced entry costs and foregone revenue endogenously generates the timing of entry. As the focus is on the dynamics of individual firms and in order not to complicate the model unnecessarily, the economy is assumed to be in the steady state, with firms formed at a constant rate from a stable distribution of productivity levels and failing at a constant rate such that their distribution by age and productivity level remains constant over time.

The fixed costs of entry in the model are intended to reflect the costs of adapting products and production processes, reaching consumers through advertising, and setting up a distribution network. These tasks are generally more costly for larger markets, so the fixed cost of entry is increasing in market size. The fixed cost of entry is also decreasing in the number of markets already entered, to reflect the accumulation of knowledge in the required tasks and the potential for acquired knowledge to be applied to subsequent markets. It is in this sense that firms in the model "learn": they acquire information from entering new markets, though the amount of learning is able to be predicted in advance. The savings in entry costs can be thought of as reductions in waste in the entry process, some aspects of which scale with the size of the market being entered, so the decrease in the fixed cost of entry is larger in absolute terms for a larger subsequent market.

The model generates a number of predictions about export expansion patterns that are tested and confirmed using Swedish firm-level data. These predictions are that, all else equal: (1) more productive firms enter export markets more quickly; (2) more productive firms enter larger markets earlier and smaller markets later than less productive firms; and (3) all firms enter nearer markets earlier than more distant markets. The second prediction in particular is specific to the learning mechanism proposed here and would be difficult to explain using alternative mechanisms that could not be interpreted as the fixed costs of entry being reduced by experience.

The predictions follow intuitively from the model. The fixed costs of entry do not depend on firm productivity, whereas exporting revenues are increasing in firm productivity.[4] The revenue foregone by delaying entry is therefore increasing in firm productivity, while the saving in fixed costs is identical for all firms. Therefore, the revenue foregone from delaying entry to a given market exceeds the fixed cost reduction for firms above a certain productivity threshold, so more productive firms enter new markets after shorter delays. Similarly, the loss from foregoing revenue to a larger market is greater for more productive firms, so they enter larger markets earlier and smaller markets later than less productive firms.

The model is focused on the market-level pattern of entry, so firms are assumed not to be able to enter only part of an export market by paying a lower fixed cost, in contrast to Arkolakis (2010). Allowing partial entry would permit an additional channel for the accumulation of experience, but one more informative about the degree of market penetration than the timing or order of entry. Though the model could be applied at different levels of geographical aggregation, the empirical analysis uses countries (sovereign states) as this is a relatively distinct geographical delimitation.[5] Country borders appear to be important, even in relatively integrated regions such as the European Union (EU) or North America, judging by the obstacles that they represent for trade and for market integration.[6] As exporting revenues and the benefits of experience are deterministic, firms in the model do not exit from export markets. A more advanced model would also generate exits, but that is not central to the current exercise.

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[4] That the fixed costs of entry are independent of firm productivity is assumed for simplicity but is a stricter assumption than what is necessary. The same results would obtain were they to be decreasing in firm productivity or even increasing, provided that they increase at a lower rate than exporting revenues.

[5] The empirical results presented below confirm the empirical predictions at the country level, suggesting that it is an important level of aggregation, whatever other levels of aggregation may also be relevant.

[6] The importance of national borders as obstacles to trade has been demonstrated in several studies, notably McCallum (1995), Engel and Rogers (1996), Anderson and van Wincoop (2003), and Balistreri and Hillberry (2007), even if this has been disputed using trade data at a very low level of geographical aggregation (Hillberry and Hummels, 2008). The border effect has even been identified with goods that have no distance-related trade costs, suggesting the importance of cultural factors (Blum and Goldfarb, 2006). The limitations of market integration across the EU were highlighted by Engel and Rogers (2004).

The assumption that experience reduces the costs of entry to new export markets has empirical support. The survey responses of UK firms in Kneller and Pisu (2006, 2007) show that exporting experience reduces the firm managers' perceived barriers of entry to new markets, while Morales, Sheu, and Zahler (2011) and Schmeiser (2012) identify exporting patterns that are suggestive of firms learning to export. Schmeiser (2012) also represents a theoretical precedent, as she tests a model with a similar learning mechanism to that presented in this paper, albeit one that imposes a restrictive functional form on the effects of experience on entry costs.

An alternative to the model proposed here could involve learning about the production process, so that exporting would improve the productivity of the firm instead of reducing entry costs. However, it is at best unclear from the large empirical literature on the topic whether exporting activity affects productivity.[7] In any case, the empirical tests conducted below use firm productivity measured in the first year of operation and could not therefore be driven by an effect of exporting on productivity.

This paper contributes to the literature in a number of ways. The first is that it presents a simple explanation for firms delaying entry to new export markets that has empirical support. Nguyen (2012) proposed an alternative explanation based on *ex ante* uncertainty about exporting success.[8] In that model, an inexperienced firm has limited information about its exporting profitability that is updated when it enters new markets. That contrasts with the model presented here, in which the benefit of exporting experience is a predictable decrease in the entry costs. The two mechanisms generate similar predictions and so it is difficult to separate them empirically, but the results presented below suggest that the learning mechanism presented here explains some aspects of exporting behaviour that are not

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[7] Evidence of an effect of exporting on firm productivity has been identified in some cases (Aw, Chung, and Roberts, 2000; Blalock and Gertler, 2004; Damijan and Kostevc, 2006; Van Biesebroeck, 2006; De Loecker, 2007, 2013; Greenaway and Kneller, 2007; Aw, Roberts, and Xu, 2008) but not in others (Clerides, Lach, and Tybout, 1998; Bernard and Jensen, 1999, 2004; Arnold and Hussinger, 2005; Fafchamps, El Hamine, and Zeufack, 2008). For a summary of this body of research see Wagner (2007).

[8] Eaton, Eslava, Krizan, Kugler, and Tybout (2011) and Albornoz, Calvo Pardo, Corcos, and Ornelas (2012) use the same type of uncertainty mechanism. Holloway (2012) estimates this type of model for the film industry and quantifies the effect of success in a foreign market on the probability of entry to additional markets. Akhmetova and Mitaritonna (2013) develop the model further by introducing partial correlation between markets in exporting success and imperfect learning, which extends the process of learning across markets and time. Time-varying demand factors and a resource constraint enhance the dynamics of the set of export destinations in their model.

explained by uncertainty about exporting success.[9] Alternative interpretations include credit, liquidity, or management constraints that make it more costly to enter markets simultaneously, as in Lucas (1978). The model captures these explanations provided that the aggregate entry costs are lower if entry is delayed or if the smaller markets are entered first, so in a sense it synthesises the timing aspects of a range of existing and potential models.

The second contribution of this paper is to demonstrate an empirical link between firm productivity and the speed of entry to new export markets. The link between productivity and participation in exporting has long been recognised (Bernard, Jensen, Redding, and Schott, 2007). The finding that more productive firms also enter new markets more quickly fits naturally with this idea. The result does, however, demand an intuitive explanation, for which the model proposed in this paper is a candidate.

The third contribution is to explain part of the variation in the order of entry to export markets and to attribute this to an underlying factor, namely firm productivity. Lawless (2009) modelled the order of entry with idiosyncratic destination-level demand and fixed cost parameters, implying that all firms enter markets in the same order. She found a strong correlation in entry orders in Irish data, but a large amount of variation was left unexplained. Similarly, Eaton, Kortum, and Kramarz (2011) identified a substantial amount of variation in entry orders for French firms. Morales, Sheu, and Zahler (2011) and Chaney (2011) explain the tendency for firms that export to certain markets to subsequently enter similar markets. However, the between-firm variation in entry orders in their models results entirely from exogenous variation in the initial sets of export markets, rather than being explained by some endogenous factor.

The remainder of the paper is organised as follows. The model is presented in Section 2. The optimal entry strategies are discussed in Section 3. The data on Swedish manufacturing firms are described in Section 4. The model is tested using the Swedish data in Section 5. Concluding remarks are presented in Section 6.

[9] The survey responses presented in Kneller and Pisu (2006, 2007) support the idea that reductions in entry costs as a result of exporting experience are important in a manner distinct from the uncertainty mechanism.

2. Model

The economy in the model is comprised of the firm's home country and *I* foreign markets. Firms are small enough that their individual decisions do not affect price levels or the strategies of other firms. To enter a new market, the firm must pay an initial fixed cost, which is a function of market size and the number of markets previously entered. The firm has full *ex ante* information about the fixed costs of entry and the levels of exporting revenue associated with each potential export market. The economy is in the steady state, with all parameters being constant and firms being formed and failing at constant rates such that the distribution of their ages and productivity levels does not vary over time. The remainder of this section outlines the model in detail.

2.1. Consumers

Consumers are assumed to have identical, constant elasticity of substitution preferences of the Dixit and Stiglitz (1977) type, with demand elasticity $\sigma > 1$. With a continuum of Ω goods available in the economy, the utility of a representative individual is:

$$U = \left[\int_0^{\Omega} x_{\omega}^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

The consumer price of good ω is p_{ω} and individual income is *Y*. Demand for good ω by the representative consumer is therefore $x_{\omega} = \frac{p_{\omega}^{-\sigma}}{P^{1-\sigma}} Y$, where $P = \left[\int_0^{\Omega} p_{\omega}^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$ is the price index.

2.2. Firms

Firms are assumed to be of the increasing returns to scale, heterogeneous productivity type proposed by Melitz (2003), in which each firm realises its productivity level after it is formed.[10] The productivity parameter a_{ω} indicates the number of units of output that the firm can produce with each unit of labour. Upon realising its productivity level, the firm decides whether to operate and sell its products on the home market, and what exporting strategy to employ. A fixed cost associated with establishing a firm offsets the expected profits in equilibrium and ensures that firms are formed at a positive and finite rate. Firms fail at a constant rate according to a Poisson process. The price of the sole production input

[10] An alternative definition of firm heterogeneity would be in product quality rather than productivity, with firms having uniform production costs but different levels of demand. The two approaches are effectively equivalent, however, as the crucial feature is that a better firm earns higher profits in all markets.

is normalised to one, so the firm maximises profits by setting its output price equal to $p_\omega = 1/(\rho a_\omega)$, where $1/\rho = \sigma/(\sigma-1)$ is the markup on the input price.

2.3. Export revenues

The firm has I potential export markets, where market i has aggregate demand for final products Y_i and overall prices represented by the index P_i. Transport costs are of the iceberg type, with τ_i units shipped from the home country for each unit that arrives in country i; for notational convenience this is converted to the trade freeness parameter $\phi_i = \tau_i^{1-\sigma}$. Dropping the subscript ω, a firm with unit cost parameter a and output price $p = 1/(\rho a)$ receives the following single-period revenues from exporting to market i:

$$r(P_i, Y_i) = \phi_i \frac{\rho^{\sigma-1} a^{\sigma-1}}{\sigma P_i^{1-\sigma}} Y_i \tag{2}$$

Equation (2) may be simplified by defining the 'size' of an export destination to be its aggregate final demand adjusted for the toughness of competition from other firms, $s_i = \alpha P_i^{\sigma-1} Y_i$. The variable s_i directly reflects the potential sales volume of a new entrant to market i. Without loss of generality, parameters are normalised such that $\alpha \equiv \rho^{\sigma-1}/\sigma$, so (2) becomes:

$$r(s_i) = \phi_i a^{\sigma-1} s_i \tag{3}$$

The fixed costs of exporting are sunk upon entry and the per-unit revenue (3) is strictly positive, so once the firm has entered market i it continues to export there in perpetuity and receives revenues of $r(s_i)$ in each period. Firms have a per-period discount factor β, reflecting the probability of survival, so the long-term revenue from export market i discounted back to the period of entry is $R_i = \sum_{t=0}^{\infty} \beta^t r(s_i) = r(s_i)/(1-\beta)$. Plugging equation (3) into this expression yields:

$$R_i = \frac{1}{1-\beta} \phi_i a^{\sigma-1} s_i \tag{4}$$

2.4. Fixed costs of entry to export markets

The model assumes a fixed cost of entry to each new export market, which reflects the costs of adapting products to meet specific technical or cultural standards, finding customers, and setting up a distribution network. The fixed cost of entry to market i at time t is represented by the function $f^X(s_i, n_t)$, where s_i is the size of the market as defined above and n_t is the number of export markets the firm has entered before period *t*, reflecting its experience as an exporter.[11] Again the market size reflects both aggregate demand and the lack of competition from other firms, factors assumed to be correlated with the difficulty of entering an export market. Experience accrues after one period and is measured as the number of destinations, so the amount of learning is independent of market size.[12]

The fixed cost function is assumed to be: (1) increasing in the size of the market but non-increasing per unit of size, so $f_s^X > 0$ and $f_s^X \le f^X / s$; (2) decreasing in prior exporting experience, so $f_n^X < 0$; and (3) decreasing more in absolute terms for larger markets, so $f_{sn}^X < 0$. These criteria are sufficient conditions for generating the propositions derived below. The second assumption is the most fundamental to reproducing the timing of entry, as the reductions in fixed costs from exporting experience are necessary to motivate delayed entry to new markets. The third assumption is necessary to motivate the heterogeneity in the orders of entry to export markets. The first assumption complements the third, as larger reductions in entry costs for larger markets do not make sense unless they were larger to begin with.

To understand the motivation for these assumptions, it is useful to consider a conceptual example. Consider a firm that has never exported, will rely on television advertising to reach customers, and has three potential types of advertisement that it may run. The first assumption is motivated by the fact that the cost of television advertising increases with viewership, but that some scale-independent costs, such as actually producing the advertisement, imply a degree of scale advantages. Suppose that when the firm enters its first market it tries the three types of advertising and, based on the feedback that it receives, discovers that two of them are not effective. When the firm enters its next market it will therefore save some amount on advertising, as it only runs the type of advertisement that proved to be effective, which motivates the second assumption. The third assumption follows from the observation that the saving from not running the ineffective types of

[11] Distance is likely to be correlated with some factors that affect the cost of entry, such as language differences. However, including distance as a factor in the fixed cost function would not affect the main predictions of the model, so it is left out in the interests of simplicity.

[12] This assumption simplifies the model but is not necessary, as the experience gained from smaller markets need only be larger in proportion to the fixed cost of entry to those markets.

advertisement is larger if the market is larger. The same reasoning applies to adaptation costs and organising a distribution network, for which wasteful activities not pursued imply savings in the fixed costs of entry and these savings are larger the larger is the market and therefore the absolute amount of avoided waste.

2.5. Long-term profits

As production costs and exporting demand are constant and deterministic in the model, it is never optimal for a firm to abandon an export market that it has already entered. The entry strategy can therefore be expressed as a vector **t** of entry times, where the firm enters market *i* in period t_i. By convention $t_i = \infty$ if the firm does not enter market *i* at all. Substituting in the expression for single-period revenue (4), the discounted payoff of the strategy represented by **t** is therefore:

$$\Pi = \frac{1}{1-\beta} a^{\sigma-1} \sum_{i=1}^{I} \beta^{t_i} \phi_i s_i - \sum_{i=1}^{I} \beta^{t_i} f^X \left(s_i, n_{t_i} \right) \qquad (5)$$

As stated above, the expected profits from operating in the home market and the exporting payoff expressed in (5) are equal to the fixed cost of establishing a firm, which ensures that the flow of new firms is positive and finite. Following Chaney (2008), it is assumed that any profits are redistributed among individuals in the firm's home country as dividends.

3. Optimal export entry strategy

The firm's optimal export entry strategy is defined as the set of export markets and entry times that maximises aggregate net exporting profits (5), which is characterised by the vector $\mathbf{t}^*$. The remainder of this section outlines certain features of the optimal strategies.

3.1. Productivity ordering of firms

The strategy payoff in (5) is linear and increasing in the monotonic transformation of firm productivity $a^{\sigma-1}$, as the revenue from each market is proportional to $a^{\sigma-1}$ while the fixed costs are independent of firm productivity. The multiplier on $a^{\sigma-1}$ is proportional to the term $A = \sum_{i=1}^{I} \beta^{t_i} \phi_i s_i$, which combines the number of markets entered, the sizes of those markets, and the timing of entry. The term *A* is henceforth referred to as the 'aggressiveness' of a strategy.

Consider now the three hypothetical strategies illustrated in Figure 1, which are numbered in increasing order of aggressiveness so that $A^{(1)} < A^{(2)} < A^{(3)}$. As the payoff of each strategy is linear in $a^{\sigma-1}$, the payoffs from any pair of strategies may intersect at most once. If two payoffs do intersect, then the productivity level at which they intersect constitutes a threshold, with the more aggressive strategy being preferable for all firms above the productivity threshold and vice versa. For example, in Figure 1 the productivity level $a_{<1,3>}$ represents the threshold between Strategy 1 and Strategy 3. Identical reasoning applies to any pair of strategies and results in a monotonic ordering, with more aggressive strategies employed by more productive firms. Some strategies may not be optimal for any firms and therefore do not appear in the productivity ordering, as is the case with Strategy 2 in Figure 1.

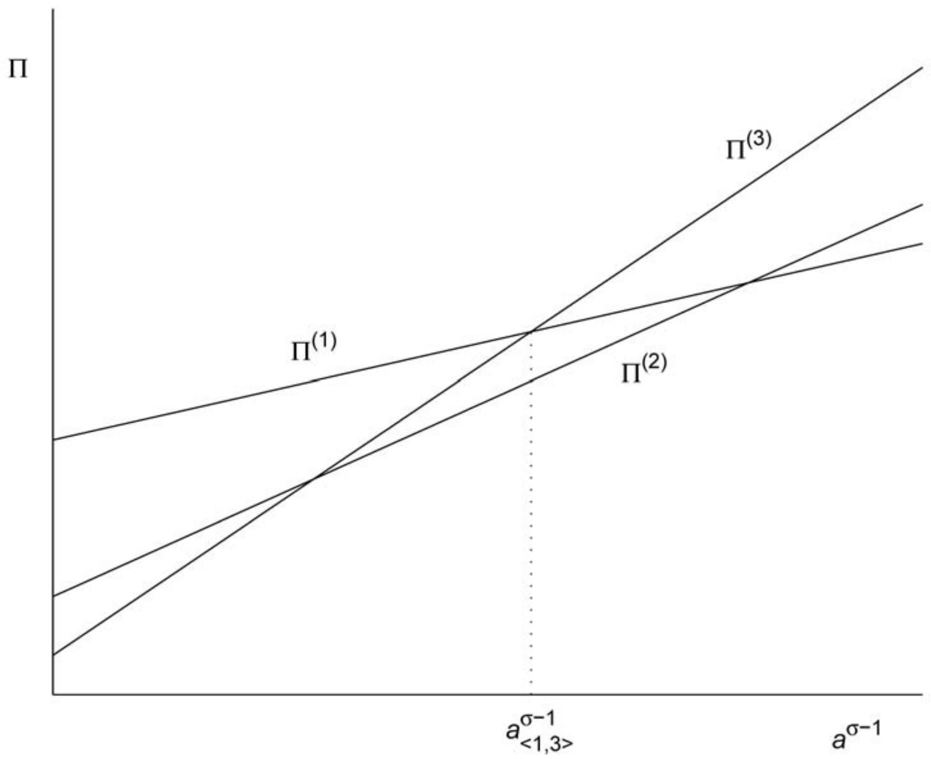

Figure 1. Strategy payoffs as functions of firm productivity levels.

3.2. Timing of entry to new export markets

The following proposition characterises the relationship between firm productivity and the speed of entry to new export markets.

Proposition 1. *The time taken for a firm to enter a given set of markets is weakly decreasing in firm productivity.*

Proof. *See Appendix 1.*

The prediction that more productive firms enter markets more quickly results from the trade-off underlying the decision about when to enter a given market: delaying entry until other markets have been entered implies reduced fixed costs of entry, but also foregone revenue. Firms delay entry if and only if the fixed cost reduction exceeds the foregone revenue. As fixed costs of entry are independent of productivity whereas exporting revenues are increasing in productivity, immediate entry is optimal only for the firms above some productivity threshold. Clearly, Proposition 1 depends on the assumption that the fixed costs of entry are reduced by the experience of prior entry to other markets; however, it does not depend on any other assumption about the form of the fixed cost function.

The home country is considered to be a market that yields experience, so a more productive firm is also predicted to enter its first export market after a shorter delay.

3.3. Order of entry by market size

The model generates endogenous variation in the order of entry to export markets. Firms have opposing incentives either to (1) enter smaller markets first, to maximise gains from experience in entering new export destinations, or (2) enter larger markets first, to receive higher revenues in the near term. The model generates both types of patterns, with the choice of which pattern depending on firm productivity. The relationship between firm productivity and the optimal order of entry by market size is characterised by the following proposition.

Proposition 2. *Firms that enter the larger of two markets before the smaller market are more productive than firms that enter the same markets in the opposite order, controlling for the entry times to other markets.*

Proof. *See Appendix 1.*

The prediction made in Proposition 2 results from a trade-off between the benefits of attaining revenues earlier and of reducing fixed entry costs. More productive firms earn more revenue from each market, so for them foregoing revenue from a larger market is more costly. On the other hand, the aggregate fixed costs of entry are lower when the smaller market is entered first, but by the same amount for all firms. The foregone revenue is therefore relatively important for more productive firms and they enter the larger market first, while for less productive firms the fixed cost reduction is relatively important and they enter the smaller market first. For parameters that permit both orders to be optimal for some firms there is a threshold level of productivity, above which firms enter the larger market first and vice versa.

Proposition 2 naturally depends on the assumption that exporting experience reduces the fixed costs of entry, as without it no firms would delay entry to any markets. More particularly, it is driven by the assumption that the cross-derivative on the fixed cost function is negative, so that the reduction in entry costs is larger in absolute terms for larger markets. This is because larger markets yield higher revenues, all else being equal, so this feature is necessary to motivate firms to enter smaller markets first.

The pattern outlined in Proposition 2 extends to any subset of exporting strategies as well as to sets of export markets. Amongst firms that eventually enter the same set of markets, this produces an overall ordering in which more productive firms export to larger markets earlier whereas less productive firms enter smaller markets earlier.[13] Though the orders of entry differ between firms based on their productivity levels, firms in the model generally enter larger markets first as net exporting profits are increasing in market size. This feature is also consistent with the data.

While the prediction in Proposition 1 could be explained by a number of alternative factors, the prediction made in Proposition 2 is more specific and requires a model of the particular type proposed here. Namely, the model must have a benefit that accrues from entering export markets, is realised when other markets are subsequently entered, and is increasing in the size of the markets subsequently entered.

3.4. Transport costs and the order of entry

The model implies a strict relationship between the distances, in terms of transport costs, to a pair of otherwise identical markets and the order in which the markets are entered.[14] This relationship is specified in the following proposition.

Proposition 3. *All firms enter a nearer market (lower transport costs) no later than a more distant market (higher transport costs) of the same size.*

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[13] Such a pattern is related to the theory that less productive exporters begin by exporting small volumes by Rauch and Watson (2003), which could correspond either to exporting progressively larger amounts to the same markets, entering progressively larger export markets, or some combination of both.

[14] Henceforth, the term ‘distance’ is used as shorthand for the costliness of transporting goods to a given market. To avoid confusion, it is used only in contexts where the two concepts intersect.

Proof. *See Appendix 1.*

The prediction in Proposition 3 is a simple result of discounting: if one market yields a larger net profit, then a higher overall discounted profit is earned by entering that market earlier. The nearer the market, the more exporting revenue is gained there, and the earlier the firm will enter. For markets of different sizes, the nearer market is entered first if the relative distance to that market is below a certain threshold, the level of which depends on the sizes of the markets and on firm productivity. Market size and other factors not made explicit in the model would play a role, but firms are predicted to generally begin by exporting to neighbouring countries and then expand to progressively more distant markets.

Proposition 3 is driven by the reductions in fixed entry costs from experience, which are necessary to generate delays in entry, and by the transport costs that are increasing in distance, which make nearer markets more profitable.

4. Data

The primary data source is a panel of Swedish firm-level data supplied by Statistics Sweden (*Statistiska centralbyrån*) that covers the period from 1997 to 2007. The data include firm characteristics such as wages and the numbers of employees, as well as the amounts of exports by destination country for each firm in each year. The dataset is completed with country-level information from other sources. The gross domestic product (GDP) levels are the 2010 figures from the World Development Indicators database of the World Bank. The distances of countries from Sweden are the distances between the principal cities from the CEPII (*Centre d'Etudes Prospectives et d'Informations Internationales*) database.

The sample is restricted to manufacturing firms, for internal consistency and consistency with the model, and to firms with at least five employees. The empirical tests require a sample of new firms, which are identified by restricting the sample to firms that are not present in the first year of the panel but appear thereafter. To avoid false classification of subsidiaries or the divestiture of certain operations as independent firms, an index maintained by Statistics

Sweden is used to identify and exclude such entities.[15] Firm productivity is estimated in each firm's first year of operation using the method proposed by Levinsohn and Petrin (2003).

The data are aggregated by two-digit manufacturing industry. Only two-digit industries with at least 100 Swedish firms operating during the period are included in the sample. As the Swedish subsidiaries of foreign firms may choose their export destinations based on the strategies of their parent entities, foreign-owned firms are excluded. Around 5% of manufacturing firms operate in more than one industry and these are excluded due to potential complications in characterising productivity levels and market entry orders. Table 1 presents summary statistics for the main firm-level variables in the sample.

	Mean	Std. dev.	Minimum	Maximum
Number of employees	22.76	264.12	5	20,963
Payroll (mSEK)	6.22	53.00	0.02	3,820.00
Capital stock (mSEK)	6.02	73.40	0.00	5,360.00
Estimated productivity in first year of operation	10.86	23.40	0.01	1,812.05
Number of export destinations	2.37	6.76	0	129
Value of exports (mSEK)	10.40	143.00	0.00	10,100.00

Note: 6,941 firms in total, of which 3,577 engage in exporting; firm productivity estimated using the Levinsohn and Petrin (2003) method, measured in the first year of operation; annual figures given for all other variables, for all years from 1998 to 2007 the firm was operating

Table 1. Summary statistics for the sample of new Swedish manufacturing firms formed 1998 to 2007.

The empirical tests conducted in this paper concern the destinations of Swedish manufacturing exports. It is therefore relevant which countries most commonly serve as export destinations for these firms. Table 2 gives rankings of the 10 most popular destinations for exports from the new Swedish manufacturing firms in the sample, in terms of the number of exporters and the value of exports across the ten years of the panel. The rankings in Table 2 confirm the importance of the gravity factors – market size and the distance from Sweden – in determining the popularity of an export destination. The most popular markets tend to be either relatively large, relatively close to Sweden, or both.

[15] The index groups firms that have or have had common ownership. In Statistics Sweden terminology, the index is the set of "FAD" codes. Firms with FAD codes that were present in 1997 are excluded. Where multiple firms have the same FAD code, all but the first to appear are excluded.

Rank	Country	Number of Swedish exporters
1	Norway	3,000
2	United States of America	1,157
3	Finland	1,054
4	Switzerland	910
5	Denmark	848
6	Germany	814
7	Poland	734
8	United Kingdom	696
9	Estonia	604
10	Netherlands	602

Rank	Country	Value of Swedish exports (bSEK)
1	Germany	36.44
2	United States of America	36.44
3	Norway	28.90
4	United Kingdom	28.68
5	Belgium	17.89
6	Denmark	17.00
7	Netherlands	15.65
8	China	15.57
9	France	15.29
10	Finland	15.26

Table 2. Rankings of the most popular export destinations for the firms in the sample, in terms of the number of Swedish exporters (left) and the value of Swedish exports (right).

5. Results

The propositions concern firm productivity, which is estimated using the method proposed by Levinsohn and Petrin (2003). This method uses intermediate inputs to proxy for the "transmitted" component of productivity and thereby to solve the endogeneity problem associated with firms increasing variable factor inputs in response to positive productivity shocks. The Levinsohn-Petrin method is applied using value added as the measure of firm output and productivity is estimated separately for each two-digit industry.[16]

As the positive relationship between firm productivity and exporting revenues on any given market is crucial to the predictions of the model, it is worth testing whether this relationship holds in the data. Table 3 presents the coefficients on firm productivity estimated from an equation of the following form:

$$E_{\omega,i} = \beta_{prod} z_{\omega} + \gamma_j + \gamma_i + \varepsilon_{\omega,i} \tag{6}$$

In (6), $E_{\omega,i}$ is the (log) value or the (log) weight of firm ω's exports to country *i*, z_{ω} is the (log) productivity of firm ω as measured in its first year of operation, γ_j is the fixed effect for industry *j*, γ_i is the fixed effect for country *i*, and $\varepsilon_{\omega,i}$ is the error term. The results in Table 3 indicate a clear positive relationship between firm productivity and both the value and weight of exports to a given country, which supports this basic feature of the model.

[16] To test the sensitivity of the results to the method of estimating productivity, some robustness checks that use alternative methods are presented in Appendix 2, including the method proposed by Wooldridge (2009) that incorporates the Ackerberg, Caves, and Frazer (2006) criticism of the potential simultaneity problems that remain with the Levinsohn and Petrin (2003) method.

	Export value		Export weight	
	(OLS)	(OLS)	(OLS)	(OLS)
Productivity	0.495***	0.813***	0.675***	0.830***
	(5.96)	(6.57)	(5.30)	(5.90)
Destination fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	No	Yes	No	Yes
Number of observations	27,425	27,425	27,335	27,335

Note: t-statistics in parentheses; robust standard errors, clustered by firm; *,**, *** denote significance at 10%, 5%, 1%

Table 3. Relationships between firm productivity and the value and weight of exports by destination.

The remainder of this section outlines the empirical tests of the three propositions.

5.1. Proposition 1

Proposition 1 predicts that firms with higher productivity levels begin exporting sooner and then add new export markets at a faster rate. This relationship is tested by estimating a Poisson model, with the delays measured as the years since the formation of the firm for the first market and as the years since entry to the previous market for the second market onwards. As all firms face the same set of potential markets, the test effectively concerns the delays controlling for the set of export markets, so market-level variables such as market size and distance are not relevant. The model that is estimated is the following:

$$t_{\omega,n} - t_{\omega,n-1} = \exp\left(\beta_{prod,n} z_{\omega} + \gamma_j + \varepsilon_{\omega,n}\right) \quad (7)$$

In (7), $t_{\omega,n}$ denotes the year of operation in which firm ω enters its nth export market, where by definition $t_{\omega,0}$ is the period of formation of firm ω, z_{ω} is the (log) productivity of the firm as measured in its first year of operation, γ_j is the fixed effect for industry j, and $\varepsilon_{\omega,n}$ is the error term. The Poisson model is used because the delays are by definition nonnegative and their distribution in the data is skewed towards zero. For comparison, the productivity coefficients are also estimated using ordinary least squares (OLS):

$$t_{\omega,n} - t_{\omega,n-1} = \beta_{prod,n} z_{\omega} + \gamma_j + \varepsilon_{\omega,n} \quad (8)$$

The results of the estimation of (7) and (8) are displayed in separate columns of Table 4. The first row shows the productivity coefficients for the delay between the formation of the firm and the commencement of exporting. The subsequent rows show the coefficients for the delays between entry to the first and the second export markets and each incremental market up to the fifth, then in five- and ten-market increments for later markets. The second-last row uses the delays between entry to all pairs of consecutive markets and the last row combines these delays with the delay before the commencement of exporting. As the delays in (7) are effectively in logs whereas in (8) they are in absolute values, the magnitudes of the two sets of coefficients are not directly comparable.

The productivity coefficients displayed in Table 4 are all negative in magnitude, consistent with the prediction made in Proposition 1: more productive firms begin exporting sooner and then add further export markets more quickly. The standard errors become large for the later markets as fewer firms enter those numbers of markets and so the numbers of observations are lower. As such, though the relationship is strongly significant for the first few markets and for the aggregation of all incremental markets, it is not significant or is weakly significant for some higher-level increments.

Delay	Productivity coefficient		Number of observations
	(Poisson)	(OLS)	
Before entry to first market	-0.221*** (-4.37)	-0.160*** (-4.09)	3,577
Between entry to 1st and 2nd markets	-0.212*** (-3.48)	-0.139*** (-3.06)	2,228
Between entry to 2nd and 3rd markets	-0.360*** (-4.59)	-0.176*** (-4.67)	1,671
Between entry to 3rd and 4th markets	-0.384*** (-4.52)	-0.147*** (-4.29)	1,379
Between entry to 4th and 5th markets	-0.207** (-2.10)	-0.054** (-2.03)	1,174
Between entry to 5th and 10th markets	-0.301*** (-3.95)	-0.295*** (-4.00)	787
Between entry to 10th and 20th markets	-0.174 (-1.26)	-0.212 (-1.20)	403
Between entry to 20th and 30th markets	-0.431** (-2.37)	-0.488** (-2.32)	224
Between entry to 30th and 40th markets	-0.406* (-1.74)	-0.538 (-1.57)	132
Before entry to 2nd market onwards	-0.380*** (-7.57)	-0.113*** (-7.57)	23,871
Before entry to each new market	-0.386*** (-8.74)	-0.142*** (-8.42)	27,448

Note: t-statistics in parentheses; robust standard errors, clustered by firm; *,**, *** denote significance at 10%, 5%, 1%

Table 4. Productivity coefficients for the delay before the commencement of exporting and between entry times to all consecutive pairs of markets.

The relationship between firm productivity and the speed of entry therefore appears to apply well beyond the first markets entered, an aspect of the export expansion patterns that distinguishes the learning mechanism proposed here from the uncertainty mechanism of Nguyen (2012). While it is intuitive that a new exporter would have uncertainty about its profitability in new markets that could be reduced by experimentation, this is difficult to imagine for firms that have already entered a large number of markets. Indeed, though the smaller sample sizes result in large standard errors, this relationship appears to hold beyond at least the 30^{th} market entered, by which time the firm necessarily has tested its products in a range of different export markets. However, the relationship is entirely consistent with a mechanism in which entering each new market expands the range of adaptation of the firm's products and the extent of the distribution network in ways that reduce the costs of entering further markets.

In quantitative terms, the relationship between firm productivity and the delays can be understood from the following observations from the data. For firms in the bottom productivity quartile of each industry that export within the timeframe of the sample, the mean length of time between the founding of the firm and entry to the first export market is nine months, and new export destinations are added at a rate of one every nine months. For firms in the top productivity quartile, exporting begins after three months and a new export destination is added every four and a half months. It should be noted, however, that the sample is truncated to a maximum firm age of nine years and that later exporting behaviour is not observed, so these figures may underestimate the actual delays.

To test whether these results could be driven by the size or capital intensity of the firm rather than by productivity, equation (7) is estimated using log labour, capital, and capital intensity as additional independent variables. The resulting coefficients are displayed in Table 5 and they further support the prediction made in Proposition 1. While the number of employees, wages, capital, and capital intensity all contribute to the speed of entry, or at least appear to as each of these factors is positively correlated with firm productivity, the coefficient on productivity remains negative and strongly significant with their inclusion.

	Delays before entry to each additional export market					
	(Poisson)	(Poisson)	(Poisson)	(Poisson)	(Poisson)	(Poisson)
Productivity	-0.386*** (-8.74)	-0.287*** (-6.89)	-0.294*** (-7.16)	-0.323*** (-7.49)	-0.287*** (-6.86)	-0.378*** (-8.51)
Number of employees		-0.262*** (-14.64)			-0.237*** (-7.93)	
Wages			-0.210*** (-13.08)			
Capital				-0.127*** (-10.66)	-0.020 (-1.04)	
Capital intensity						-0.067*** (-3.45)
Number of observations	27,448	27,448	27,443	27,349	27,349	27,349

Note: t-statistics in parentheses; robust standard errors; *,**, *** denote significance at 10%, 5%, 1%

Table 5. Productivity coefficients for the delay before the commencement of exporting to all consecutive pairs of markets.

5.2. Proposition 2

Proposition 2 predicts that more productive firms enter a larger market before a smaller market whereas less productive firms enter the same markets in the opposite order, where all other aspects of the firms' export entry strategies are the same. The difficulty in testing this proposition is that restricting the sample to firms that employ strategies that are identical except for the entry times to two particular markets leaves only a small number of firms, because of the large number of potential markets. To obtain a reasonably-sized sample, more variation between strategies must be permitted. The approach used here is to test the order of entry between one or more given 'small' markets and a given 'large' market, controlling for regional-level exporting patterns.

The analysis is conducted using two sets of definitions of 'small' and 'large' export markets. The first restricts attention to EU countries and compares entry times to the smaller neighbours of Sweden with the entry times to each of the larger markets. The second uses pairs of markets that are similar to each other in culture and distance from Sweden but different in size. EU and non-EU markets are treated separately because they are not measured consistently in the data, as within-EU exports are only reported for firms that have total exports to EU countries of at least 1.5 million SEK.

In the first part of this analysis, the 'small' EU markets are comprised of the smaller of Sweden's neighbours: Denmark, Finland, Lithuania, Latvia, and Estonia. Each of these countries would serve as an appropriate market for Swedish firms to gain experience in exporting, due to their proximity to Sweden and relatively small sizes. The 'large' markets tested are all countries in the EU with higher GDP than any of these small EU countries. The sample is restricted to firms that enter the relevant large market and at least one of the neighbouring markets during the period of the data. The following logistic model is fitted:

$$
\begin{aligned}
I_{\omega}^{(t_S<t_L)} &= e^{v}/\left(e^{v}+1\right) \\
v &= \beta_{prod} z_{\omega} + \gamma_j + \delta_k + \varepsilon_{\omega}
\end{aligned}
\tag{9}
$$

In (9), $I_{\omega}^{(t_S<t_L)}$ is a logic variable for firm ω (in industry j) entering at least one of the small markets before entering the large market,[17] z_{ω} is the (log) productivity of firm ω as measured in its first year of operation, γ_j is the fixed effect for industry j, δ_k is the fixed effect for the set of continents exported to, and ε_{ω} is the error term.[18] The productivity coefficients from the estimation of (9) are displayed in the first two columns of Table 6, with the fixed effects for the sets of continents included in the second column.

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[17] This combines firms that enter the large market first with firms that enter the neighbouring and large markets simultaneously, comparing both with firms that enter the neighbouring markets then the large market. Firms that enter the two types of markets simultaneously are not able to gain exporting experience before entering the large market, as with firms that enter the large market first. In any case this assumption is not crucial, as the results hold if firms that enter the large market in the same year that they enter their first neighbouring market are excluded.

[18] Continents are defined according to the United Nations M.49 definitions. The continents are Europe, Asia, Africa, North America (including Central America and the Caribbean), South America, and Oceania.

Large EU market	Productivity coefficient for: Prior entry to neighbouring EU market(s) (I_ω)		Number of prior neighbouring EU markets (N_ω)		Number of observations
	(Logit)	(Logit)	(Ologit)	(Ologit)	
Germany	-0.064 (-0.41)	0.056 (0.30)	-0.037 (-0.23)	0.091 (0.46)	766
France	-0.478** (-2.09)	-0.390* (-1.73)	-0.494** (-2.11)	-0.412* (-1.74)	542
United Kingdom	-0.279 (-1.59)	-0.218 (-1.10)	-0.273 (-1.48)	-0.189 (-0.89)	656
Italy	-0.543** (-2.47)	-0.494** (-2.26)	-0.474** (-2.24)	-0.422* (-1.91)	483
Spain	-0.564** (-2.22)	-0.494** (-2.00)	-0.460** (-2.10)	-0.409* (-1.93)	488
Netherlands	-0.319* (-1.80)	-0.284 (-1.46)	-0.315 (-1.64)	-0.281 (-1.37)	575
Belgium	-0.564** (-2.53)	-0.574** (-2.31)	-0.350* (-1.91)	-0.346 (-1.63)	479
Poland	-0.068 (-0.38)	-0.118 (-0.59)	0.023 (0.13)	-0.001 (-0.00)	608
Austria	-0.161 (-0.86)	-0.121 (-0.57)	-0.149 (-0.85)	-0.120 (-0.61)	404
Greece	-0.032 (-0.14)	0.064 (0.23)	-0.001 (-0.00)	0.073 (0.25)	252
Set of export continent fixed effects	No	Yes	No	Yes	

Note: t-statistics in parentheses; robust standard errors; *,**, *** denote significance at 10%, 5%, 1%

Table 6. Productivity coefficients for entry to at least one neighbouring EU market (Denmark, Finland, Lithuania, Latvia, or Estonia) and for the number of those markets entered before entry to each specified large EU market.

Proposition 2 also implies a negative correlation between firm productivity and the number of 'small' markets entered before entry to a 'large' market, all else being equal. As the relationship between firm productivity and the number of small markets is not necessarily linear, it is estimated using an ordered logistic model that fits the following equation:

$$N_\omega = \beta_{prod} z_\omega + \gamma_j + \delta_k + \varepsilon_\omega \qquad (10)$$

The variable N_ω is the number of neighbouring markets that firm ω (in industry j) enters before entering the large market. The other variables are defined as in equation (9). The results of the estimation of (10) are displayed in the third and fourth columns of Table 6, with the fixed effects for the sets of continents included in the fourth column.

Table 6 supports the prediction made in Proposition 2. The coefficients are almost uniformly negative in sign and significant in around half of the specifications. This indicates that lower-productivity firms are more likely to enter at least one small market before entry to a large market and generally enter more small markets before entering a large market. These findings are consistent with lower-productivity firms gaining experience by exporting to smaller markets before expanding to export to larger markets. The inclusion of export continent fixed effects reduces the power of the tests, but has no clear effect on the magnitudes of the coefficients. The robustness checks presented in Appendix 2 indicate that these results are robust to alternative methods of estimating firm productivity, measurement of productivity in periods other than the first year of operation, and minimum export amounts and durations.

To treat the possibility that these results are driven by the geographical or cultural proximity of the neighbouring markets to Sweden, rather than by their small size, the second set of tests of Proposition 2 is conducted using pairs of markets that are similar to each other in terms of culture and distance from Sweden. There are few pairs of countries with sufficiently many observations of Swedish manufacturing exporters to obtain meaningful results, a handful of which are analysed here. These pairs have relatively high numbers of observations, but the results are otherwise representative of other potential pairs of markets.

Equation (9) is estimated for these pairs of countries using a logistic model, with the dependent variable indicating entry to the 'small' market before entry to the 'large' market. Three samples are used: all firms that eventually export to the large market, all firms that eventually export to both the small and the large market, and all firms that enter the two markets in different periods. The first allows comparison of firms that enter the small market first with all other firms that export to the large market. The second allows comparison with all other firms that export to both markets. The third sample allows a direct comparison of firms that enter the two markets in the opposite orders. The productivity coefficients are shown in Table 7.

The productivity coefficients displayed in Table 7 are negative in sign and therefore consistent with the prediction in Proposition 2, but generally not significant possibly because of the small sample sizes. The productivity coefficients are significant for some specifications for Belarus and Russia, Canada and the United States of America, and New Zealand and Australia. The coefficients for Belgium and France are not significant, which may be due to their location amongst other similar countries. The coefficients for Uruguay and Argentina are negative in sign but not significant, though the sample sizes are particularly small. Similar results emerge for other pairs of markets in these regions.

Small market	Large market	Productivity coefficient		
		(Logit)	(Logit)	(Logit)
Belgium	France	-0.298 (0.82) [547]	-0.394 (0.99) [378]	-0.456 (0.86) [119]
Belarus	Russia	-0.662 (0.85) [155]	-1.575* (1.66) [24]	-1.368 (1.34) [20]
Canada	United States of America	-0.174 (0.86) [1,149]	-0.800*** (2.61) [430]	-0.511 (1.40) [201]
Uruguay	Argentina	-0.352 (0.47) [80]	-0.737 (0.64) [35]	-0.715 (0.73) [22]
New Zealand	Australia	-0.518* (1.78) [348]	-1.076* (1.83) [145]	-1.058 (1.31) [60]
Only firms eventually exporting to the large market		Yes	Yes	Yes
Only firms eventually exporting to the small market		No	Yes	Yes
Only firms entering the two markets in different years		No	No	Yes

Note: t-statistics in parentheses; numbers of observations in square parentheses; robust standard errors; *,**, *** denote significance at 10%, 5%, 1%

Table 7. Productivity coefficients for entry to the small market before the large market for selected pairs of markets.

5.3. Proposition 3

Proposition 3 predicts that nearer markets will be entered no later than more distant markets, all else being equal. To test this proposition, the order of entry is regressed on the distance from Sweden. Each markets is assigned a rank $r_{\omega,i}$ for each firm, where $r_{\omega,i} = 1$ if country i is the first export market entered by firm ω, $r_{\omega,i} = 2$ if country i is the second export market entered by firm ω, and so on. The following equation is estimated using ordinary least squares:

$$r_{\omega,i} = \beta_{dist} dist_i + \beta_{GDP} GDP_i + \beta_{distGDP} \left(dist_i \cdot GDP_i \right) + \gamma_j + \varepsilon_{\omega,i} \qquad (11)$$

In (11), $dist_i$ is the (log) distance from Sweden to country i, GDP_i is the (log) GDP of market i, γ_j is the fixed effect for industry j, and $\varepsilon_{\omega,i}$ is the error term. Equation (11) is estimated using different combinations of the distance and GDP variables and for each firm productivity quartile within each two-digit industry. The results of the estimation are shown in Table 8.

	Rank in market entry order							
	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)
Distance	5.135*** (56.77)		5.596*** (61.14)	24.271*** (11.67)	4.028*** (21.20)	2.451*** (21.03)	4.625*** (28.84)	5.856*** (37.12)
GDP		-2.550*** (-32.21)	-2.883*** (-36.18)	2.516*** (4.55)				
Distance·GDP				-0.662*** (-9.17)				
Productivity quartile					1st	2nd	3rd	4th
Number of observations	27,448	27,448	27,448	27,448	4,753	4,275	6,813	11,607

Note: t-statistics in parentheses; robust standard errors; *,**, *** denote significance at 10%, 5%, 1%

Table 8. Distance and market size coefficients for the ranks of markets in terms of the order of entry.

The results in Table 8 support the prediction made in Proposition 3. The coefficient on distance is positive in the position of the market in the order of entry and is highly significant for all specifications of the model, whether or not destination GDP is controlled for or the interaction term is included. The results also hold for each productivity quartile, with no obvious trend in the magnitudes of the coefficients across the quartiles, and appear therefore not to be driven by productivity differences.

The coefficient on the size of the market is negative in Table 8, which is consistent with the model as larger markets are more profitable and so tend to be entered earlier. Table 8 therefore represents an extension of the basic gravity model results to the timing of entry.

6. Conclusion

Experience in exporting has been shown to reduce the costs of entering further export markets. By integrating this observation into an otherwise standard trade model, this paper offers a simple framework for understanding the strategic decision made by a firm that is planning to begin exporting and has several potential export markets. The model generates a diversity of export expansion strategies through a simple and intuitive mechanism based on the costs of entry to new export markets.

The model produces novel and intuitive predictions about the relationships between firm characteristics and the types of export entry pattern employed. In particular, more productive firms are predicted to enter new export destinations at a faster rate and to enter larger markets earlier and smaller markets later. In addition, firms generally enter nearer markets first and then expand to progressively more distant markets. These predictions are tested and confirmed using a firm-level panel of Swedish manufacturing data from the period from 1997 to 2007.

The learning mechanism proposed in this paper, in which the fixed cost of entering a new export market is reduced by experience in setting up export operations, is powerful in explaining the export expansion patterns of Swedish firms. In particular, the model offers an intuitive explanation for the timing of entry to export markets and for the orders of market entry, as reflected in the predictions outlined above. Importantly, the effect of productivity on the order of entry, identified in the empirical tests of Proposition 2, suggests that the learning effect is relevant. If firms did not gain from the experience of exporting, then it would be difficult to explain entry patterns in which lower productivity firms begin by exporting to smaller markets and progress to larger markets whereas higher productivity firms do the opposite. Furthermore, the learning mechanism explains part of the variation in the orders of entry in the Swedish data.

Entry to new export markets is naturally associated with a measure of uncertainty, a feature that would ideally be included in a more complete model. The mechanism proposed by Nguyen (2012), in which firms gain information about their exporting profitability by entering new markets, is a reasonable and intuitive treatment of exporting uncertainty. While the two mechanisms have similar implications for the exporting behaviour of firms, the data contain evidence that the mechanism proposed here is relevant in a way that is distinct from the uncertainty mechanism. Nevertheless, as the two mechanisms are intuitive and have empirical support, a more comprehensive model of export expansion would include both. The tendency for firms to enter markets similar to their existing export destinations identified by Morales, Sheu, and Zahler (2011) and Chaney (2011) suggests a directionality in learning between markets that would also be a desirable feature of an expanded model.

The results presented in this paper have potential implications for policy design. In particular, the possibility of exporting experience at the country level being relevant to the ease of entry to subsequent markets suggests that trade facilitation may have a multiplier effect and may have a greater return if conducted to promote exports to smaller and nearer countries, as these markets are easier to enter for firms close to the productivity threshold for exporting. If the fixed costs of entering further markets are thereby decreased, then these firms may go on to enter markets that would not otherwise have been profitable.

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Appendix 1

Proof of Proposition 1

As shown in Figure 1, strategies with higher levels of A are employed by more productive firms. Where market i is of positive size and is finitely costly to transport products to, the ceteris paribus effect of entering the market earlier, so $t_i^1 < t_i^0$, is to increase A by $\left[\beta^{t_i^1} - \beta^{t_i^0}\right]\phi_i s_i > 0$. Therefore, A is decreasing in the time it takes to enter each market.

Proof of Proposition 2

Consider two potential export destinations, i and j, with $s_j > s_i$. Consider two strategies, a and b, that involve entering markets i and j in opposite periods but are otherwise identical. In strategy a the larger market is entered first while in strategy b the smaller market is entered first, so $t_j^a = t_i^b < t_i^a = t_j^b$. The difference between the net payoffs of strategies a and b is:

$$\Pi^a - \Pi^b = \pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} a^{\sigma-1} \left[\left[\beta^{t_j^a} - \beta^{t_i^a} \right] \left[\phi_j s_j - \phi_i s_i \right] \right] \\ - \underbrace{\left[\beta^{t_j^a} \left[f^X\left(s_j, n_{t_j^a}\right) - f^X\left(s_i, n_{t_j^a}\right) \right] - \beta^{t_i^a} \left[f^X\left(s_j, n_{t_i^a}\right) - f^X\left(s_i, n_{t_i^a}\right) \right] \right]}_{\Psi > 0} \tag{12}$$

It is possible to sign the aggregated term Ψ for the following reasons. Firstly, the fixed cost of entry to the larger market exceeds that of entry to the smaller market for any level of experience, so the two terms in the square brackets that represent the differences between the fixed costs of entry are both strictly positive. Secondly, due to the assumption that $f_{sn}^X < 0$, so that prior entry to other markets reduces the fixed cost more in absolute terms for the larger market, the absolute difference between the fixed costs of entry to the two markets is greater in the earlier period t_j^a, when the firm has less experience. In algebraic terms this relationship is $f^X\left(s_j, n_{t_j^a}\right) - f^X\left(s_i, n_{t_j^a}\right) > f^X\left(s_j, n_{t_i^a}\right) - f^X\left(s_i, n_{t_i^a}\right)$. Lastly, $\beta^{t_j^a} > \beta^{t_i^a}$ by definition as t_j^a is the earlier of the two periods, which makes it straightforward to sign Ψ.

Consider now the case where $\phi_j s_j \leq \phi_i s_i$, which makes it straightforward to sign (12):

$$\Pi^a - \Pi^b = \frac{1}{1-\beta} a^{\sigma-1} \underbrace{\left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \underbrace{\left[\phi_j s_j - \phi_i s_i \right]}_{\leq 0} \right]}_{\leq 0} - \underbrace{\Psi}_{>0} < 0 \tag{13}$$

The difference between the strategy payoffs is strictly negative for all productivity levels, so for this pair of markets strategy *a* cannot be optimal for any firm, and all firms enter markets *i* and *j* in the same order. If instead $\phi_j s_j > \phi_i s_i$, the components of (12) can be signed as:

$$\Pi^a - \Pi^b = \frac{1}{1-\beta} a^{\sigma-1} \underbrace{\left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \underbrace{\left[\phi_j s_j - \phi_i s_i \right]}_{>0} \right]}_{>0} - \underbrace{\Psi}_{>0} \tag{14}$$

The sign of (14) depends on the parameters and on firm productivity. The right-hand side of (14) is clearly increasing in productivity, so if each strategy is optimal for some firms, then strategy *a* must be optimal for firms above some productivity threshold and strategy *b* optimal for all other firms.

Proof of Proposition 3

The net profit from market *i* is:

$$\pi_i = \beta^{t_i}\left[\frac{1}{1-\beta}\phi_i a^{\sigma-1}s_i - f^X(s_i,n_t)\Big|_{t=t_i}\right] \quad (15)$$

The partial derivative of the net profit from market *i* (15) with respect to ϕ_i is:

$$\frac{\partial \pi_i}{\partial \phi_i} = \beta^{t_i}\left[\frac{1}{1-\beta}a^{\sigma-1}s_i\right] > 0 \quad (16)$$

The right hand side of (16) is strictly positive for any $a^{\sigma-1}$, as the net profit from an export market is strictly decreasing in the distance to that market. It is optimal to enter the more profitable market first, so among markets of identical size it is optimal to enter the nearest market earlier than the more distant markets.

Appendix 2

Table 9 shows the results for robustness checks on the empirical tests of Proposition 2. The table reproduces the productivity coefficients on entry to at least one neighbouring EU market before entry to each large EU market from Table 6 using various alternative assumptions. Analogous exercises for the other empirical tests yield similar results. The assumptions used in Table 9 are as follows: column 1 uses the same assumptions as in Table 6; columns 2 and 3 estimate the same coefficients using a probit model and ordinary least squares, respectively; columns 4 to 7 put various lower limits on export amounts and durations; columns 8 and 9 vary the year in which productivity is measured; and columns 10 to 12 use value added per worker, OLS regressions, and the method proposed by Wooldridge (2009) to estimate productivity.

The results in Table 9 show that each of the alternative assumptions produces results similar to those produced in Table 6. The use of either a probit model or ordinary least squares produces coefficients of the same sign and similar levels of significance, so the results appear not to be driven by a restriction implied by the use of the logistic model. Setting minimum amounts on exports removes potentially noisy small exports and leads to smaller sample sizes, which reduces the power of the tests but has no obvious effect on the magnitudes of the coefficients. Similarly, restricting the sample to exports that continue uninterrupted for at least three years has no discernible effects on the magnitudes of the coefficients. In any case this may not be an appropriate restriction, as an ongoing exporting relationship may nevertheless not involve shipments each year.

Large EU market	Productivity coefficient											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Germany	-0.064	-0.039	0.037	-0.135	-0.145	-0.403	-0.417*	0.021	-0.501*	-0.160	0.037	-0.346***
	(-0.41)	(-0.42)	(0.24)	(-0.68)	(-0.63)	(-1.27)	(-1.65)	(0.11)	(-1.68)	(-1.25)	(0.24)	(-5.77)
	[766]	[766]	[1,155]	[720]	[598]	[298]	[491]	[448]	[299]	[1,181]	[1,155]	[1,190]
France	-0.478**	-0.285**	-0.264*	-0.380	-0.647**	-1.540**	-0.808**	-0.333*	-0.794**	-0.376**	-0.264*	-0.310***
	(-2.09)	(-2.25)	(-1.66)	(-1.57)	(-2.31)	(-2.47)	(-2.00)	(-1.80)	(-2.29)	(-2.56)	(-1.66)	(-5.38)
	[542]	[542]	[847]	[503]	[390]	[168]	[341]	[324]	[222]	[868]	[847]	[875]
United Kingdom	-0.279	-0.167	0.043	-0.181	-0.106	-0.177	-0.386	-0.040	0.082	-0.156	0.043	-0.322***
	(-1.59)	(-1.62)	(0.27)	(-0.89)	(-0.48)	(-0.62)	(-1.26)	(-0.24)	(0.28)	(-1.17)	(0.27)	(-5.63)
	[656]	[656]	[1,005]	[615]	[507]	[252]	[422]	[396]	[270]	[1,031]	[1,005]	[1,039]
Italy	-0.543**	-0.334**	-0.187	-0.659**	-1.071***	-0.537	-0.929***	-0.333	-0.609*	-0.366**	-0.187	-0.304***
	(-2.47)	(-2.57)	(-1.18)	(-2.51)	(-3.60)	(-1.34)	(-2.64)	(-1.53)	(-1.69)	(-2.48)	(-1.18)	(-5.17)
	[483]	[483]	[742]	[431]	[337]	[138]	[306]	[287]	[200]	[754]	[742]	[771]
Spain	-0.564**	-0.338**	-0.329**	-0.779***	-1.125***	-1.184**	-1.107***	-0.381**	-0.934**	-0.441***	-0.329**	-0.305***
	(-2.22)	(-2.46)	(-2.13)	(-2.98)	(-2.92)	(-2.30)	(-2.87)	(-2.42)	(-2.46)	(-2.85)	(-2.13)	(-5.56)
	[488]	[488]	[738]	[427]	[298]	[127]	[283]	[280]	[192]	[755]	[738]	[767]
Netherlands	-0.319*	-0.188*	-0.105	-0.413**	-0.259	-0.559	-0.949***	-0.156	-0.439	-0.256**	-0.105	-0.247***
	(-1.80)	(-1.78)	(-0.71)	(-1.99)	(-1.16)	(-1.42)	(-3.00)	(-0.85)	(-1.50)	(-2.00)	(-0.71)	(-4.42)
	[575]	[575]	[897]	[538]	[415]	[172]	[366]	[344]	[239]	[915]	[897]	[930]
Belgium	-0.564**	-0.351***	-0.331*	-0.321	-0.956***	-0.841*	-0.735**	-0.163	-0.776**	-0.527***	-0.331*	-0.348***
	(-2.53)	(-2.63)	(-1.94)	(-1.36)	(-2.84)	(-1.80)	(-2.06)	(-0.81)	(-2.33)	(-3.45)	(-1.94)	(-5.32)
	[479]	[479]	[748]	[414]	[288]	[130]	[265]	[282]	[201]	[764]	[748]	[777]
Poland	-0.068	-0.040	0.195	-0.099	-0.138	-0.714*	-0.048	-0.057	0.045	-0.051	0.195	-0.213***
	(-0.38)	(-0.37)	(1.38)	(-0.50)	(-0.63)	(-1.93)	(-0.15)	(-0.28)	(0.14)	(-0.43)	(1.38)	(-4.42)
	[608]	[608]	[923]	[510]	[347]	[144]	[310]	[375]	[283]	[944]	[923]	[957]
Austria	-0.161	-0.104	0.004	-0.602**	-1.040***	0.011	-0.523	0.211	-0.177	-0.104	0.004	-0.252***
	(-0.86)	(-0.90)	(0.03)	(-2.41)	(-2.59)	(0.02)	(-1.62)	(0.80)	(-0.48)	(-0.72)	(0.03)	(-4.29)
	[404]	[404]	[639]	[342]	[239]	[80]	[240]	[215]	[148]	[652]	[639]	[661]
Greece	-0.032	-0.018	0.076	-0.177	0.400	-0.792	-0.498	-1.233***	-1.106**	-0.095	0.076	-0.133**
	(-0.14)	(-0.13)	(0.42)	(-0.67)	(1.13)	(-0.78)	(-0.96)	(-2.89)	(-2.23)	(-0.55)	(0.42)	(-2.09)
	[252]	[252]	[391]	[211]	[124]	[39]	[145]	[141]	[106]	[399]	[391]	[407]
Regression technique	Logit	Probit	OLS	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Logit
Minimum export size	-	-	-	10000	100000	1000000	-	-	-	-	-	-
Minimum export duration	-	-	-	-	-	-	3 years	-	-	-	-	-
Year of operation for firm productivity	First	First	First	First	First	First	First	Third	2000	First	First	First
Productivity estimation technique	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Levinsohn-Petrin	Value added per worker	OLS	Wooldridge (2009)

Note: *t*-statistics in parentheses; numbers of observations in square parentheses; robust standard errors; *,**, *** denote significance at 10%, 5%, 1%

Table 9. Reproduction of the first column of Table 6 using various alternative assumptions.

The alternative productivity assumptions do not consistently change the signs or significance levels of the coefficients, besides what could be attributed to the reductions in the sample size. The results are not changed by using the productivity estimate from the firm's third year of operation, which captures some of the firm's development in the first years that it operates, or using the estimate for 2000, an arbitrarily-chosen year. Finally, the coefficients are similar in sign and if anything greater in significance when using value added per worker, OLS, or Wooldridge (2009) estimates of productivity, suggesting that the results are not simply a product of idiosyncrasies of the Levinsohn-Petrin method of estimating productivity.