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Learning to export and the timing of entry to export markets

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Abstract

Firms that engage in exporting normally enter their first export markets a number of years after beginning to sell locally, then enter subsequent export markets progressively. Standard trade models are essentially static and do not capture these elementary facts about exporting, which biases the estimation of trade patterns and limits understanding of potentially important aspects of firms' exporting behaviour. This paper proposes a model for the timing of entry to new export markets. The model endogenously generates the timing of entry to each market through a learning mechanism: the fixed cost of entry to a given export market is reduced by the experience gained from having entered other markets. 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 than less productive firms. These predictions are confirmed using Swedish firm-level data. The latter prediction in particular is difficult to explain using alternative mechanisms and therefore endorses the learning effect as an explanation for the timing of entry. The model additionally predicts that more productive firms export more widely and that firms of all productivity levels enter nearer markets earlier, which are strong features of the data.

Keywords: firm heterogeneity, fixed costs, export market entry, export timing

JEL classification: D83, F12, F17

1. Introduction

This paper proposes a model for the timing of entry to export markets that is based on experience in the process of entry. The costs of entering a given market are lower the more

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experience a firm has in entering new markets, which provides an incentive for the firm to delay entry. The fixed cost reduction trades-off against foregone exporting revenue to generate the timing of entry endogenously. The model allows for heterogeneity in firm productivity, using the heterogeneous firms framework of Melitz (2003), as well as in the sizes and transport costs associated with the various export destinations. The model generates a number of predictions that are confirmed using Swedish firm-level data, providing evidence for the type of learning mechanism proposed in the model.

The timing of entry is an important aspect of trade patterns that is not captured by standard trade models, which effectively assume that new firms are formed in their mature state, with fully-developed exporting behaviour. In reality, new firms are formed regularly and firms that eventually export often take several years to enter their first export market, then enter new markets progressively. Therefore, what appears to be a non-exporter in the data may simply be a firm that has not yet begun to export. To properly explain exporting patterns, it is necessary to treat the timing of entry. Furthermore, as firms presumably make the decisions about the timing of entry based on some underlying factors that are not currently well understood, the investigation of the delays is potentially informative about the process by which firms become exporters.

The model for the timing of entry proposed in this paper is based on experience in the process of entry to new export markets: the more markets a firm has entered, the more expertise it has about entering new markets and the lower the fixed costs of entry it faces to any given market. The firm therefore has an incentive to delay entry to each 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 a period of foregone revenue. The trade-off between the reduced entry costs and the foregone revenue endogenously generates the timing of entry. If the reduction in entry costs exceeds the foregone revenue, then it is optimal for the firm to delay entry, and vice versa.

The fixed cost of entry reflects 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.³ The fixed cost of entry in the model is decreasing in the number of markets already entered, to reflect the accumulation of knowledge in the required tasks and the potential for the same adaptation to be applied to several markets. Furthermore, the savings are larger in absolute terms if the market subsequently entered is larger.

The model generates a number of predictions about export expansion patterns that are tested and confirmed using Swedish firm-level data. These predictions are as follows: (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, controlling for market size. 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. Therefore, though the fixed cost of entry cannot be observed directly, the empirical tests of these predictions serve as an indirect test of the existence of the learning mechanism.

The predictions each follow intuitively from the model. The fixed costs of entry do not depend on firm productivity, whereas exporting revenues are an increasing function of firm productivity.⁴ Therefore the number of markets for which a firm earns positive exporting revenue is increasing in its productivity. Similarly, the revenue foregone by 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. And the difference between foregoing revenue to the larger rather than the smaller market is greater for more productive firms, while the difference in aggregate fixed costs is identical for all firms, so more productive firms enter larger markets earlier and smaller markets later than less productive firms. The intuition is that as more productive firms earn higher revenues but face the same fixed entry costs, exporting revenues are relatively more important and entry costs relatively less important the more productive the firm. This is reflected in the more productive firms maximising exporting revenue by entering markets earlier and entering the

³ The fixed costs therefore differ between markets, but in contrast to the idiosyncratic fixed costs in Chaney (2008) are an increasing function of market size.

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.

larger of those first, whereas less productive firms enter markets more slowly and begin by exporting to smaller markets.

To focus the model on the market-level pattern of entry, it is assumed that firms are not 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 and realistic channel for the accumulation of experience, but one more informative for the degree of market penetration than for the timing or order of entry. Export markets are defined to be countries (sovereign states) as this is a relatively distinct geographical delimitation, though the model could be applied at other levels. Country borders remain 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.⁵ Furthermore, national media outlets and transport networks that prioritise internal routes favour the country as an appropriate level of aggregation for advertising and the establishment of distribution networks, which the fixed cost of entry is assumed to represent. The empirical results presented below confirm the empirical predictions at the country level, suggesting that this is an important level of aggregation, whatever other levels of aggregation may also be relevant.

The assumption that experience reduces the fixed costs of entering new export markets is part of what the empirical section of this paper aims to verify. There is, however, some existing empirical support for this assumption. The survey responses of UK firms in Kneller and Pisu (2006, 2007) show that exporting experience reduces the perceived barriers to entry to new markets. Morales, Sheu, and Zahler (2011) and Schmeiser (2011) identify exporting patterns that are suggestive of firms learning to export. An alternative to the model proposed here could involve learning about the production process, so exporting would instead improve the productivity of the firm. However, it is at best unclear from the large empirical literature on the topic whether exporting activity affects productivity, so the reduced fixed cost of establishing new export markets is a more intuitive and less ambiguous route for the benefits

⁵ 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).

of experience to accrue.⁶ In any case, the empirical tests conducted below use firm productivity measured in the first year of operation and therefore could not be driven by an effect of exporting on productivity.

This paper contributes to the literature on export market entry in a number of ways. Firstly, it presents a simple explanation for firms delaying entry to new export markets that is supported by empirical evidence. A recently-proposed alternative explanation is based on *ex ante* uncertainty about exporting success, which is described below. Other studies have identified factors that could motivate delayed entry, but do not address this point explicitly. In fact, the model presented here can be interpreted as representing a range of mechanisms in simplified form, so in a sense it synthesises the timing aspects of a range of existing and potential models. Though the mechanism in the model is described as a learning effect, alternative interpretations could include credit, liquidity, or management constraints.⁷ Such alternative explanations would fit with the model as long as the aggregate entry costs were lower if entry to some markets is delayed, and aggregate entry costs were lower if the smaller markets were entered first.

A closely-related alternative explanation for delays in entry to that proposed here concerns uncertainty in exporting profitability, as featured in Nguyen (2011), Eaton, Eslava, Krizan, Kugler, and Tybout (2011), and Albornoz, Calvo Pardo, Corcos, and Ornelas (2012). In these models, an inexperienced firm has limited information about the profitability of exporting that is updated in a Bayesian fashion as the firm gains experience by exporting to new markets. The delays are thus motivated by the benefits of the firm being informed before deciding whether to enter a (potentially unprofitable) market. This type of model also provides a neat explanation of why firms sometimes exit from export markets. By contrast,

⁶ Evidence of a significant effect of exporting on firm productivity has been identified in a few specific cases (e.g. Aw, Chung, and Roberts, 2000; Blalock and Gertler, 2004; Damijan and Kostevc, 2006; Van Biesebroeck, 2006; De Loecker, 2007; Greenaway and Kneller, 2007; Aw, Roberts, and Xu, 2008) but not in others (e.g. 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).

⁷ It may, for instance, be easier for an established exporter to gain access to the credit necessary to expand to a new market, or to cover the expansion with current liquidity. The managers of a firm may have a limited amount of time to dedicate to setting up new export operations, making simultaneous entry more expensive than staggered entry, which would be equivalent to the fixed costs being lower were entry to some markets to be delayed.

the model presented in this paper has a foreseeable improvement from experience in the firm's effectiveness as an exporter.

The second main contribution of this paper is that it demonstrates 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 empirical 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 provides a candidate.

Thirdly, this paper is the first to explain some of the variation in the order of entry to export markets and to attribute this to an underlying factor. Namely, the model predicts that more productive firms enter larger markets earlier and smaller markets later, which is shown to be consistent with the data. This includes selection of the initial export destinations, as less productive firms tend to start exporting to smaller countries. Lawless (2009) modelled the order of entry but assumed idiosyncratic demand and fixed cost parameters, which led to the prediction that all firms enter markets in the same order. Though this prediction has some support in the inter-firm correlation of entry orders she identified using Irish data, and which is also present in the Swedish data, there remains a large amount of variation in entry orders to be explained. Morales, Sheu, and Zahler (2011) and Chaney (2011) identified factors that partly explain elements of the order of entry, namely the tendency for firms that export to certain markets to subsequently enter markets with similar characteristics. However, the between-firm variation in entry orders in these models results entirely from exogenous variation in the sets of markets initially entered, so they do not explain what differentiates a firm that enters one sequence of markets from a firm that enters a different sequence. In contrast, the model presented here explains why the entry orders differ depending on firm productivity, which is supported by the data.

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; and concluding remarks are presented in section 6.

2. Model

The economy in the model is comprised of the firm's home country and I foreign countries that the firm may choose to export to. There are a large number of other firms operating in the economy, so each individual firm does not consider the effects of its export decisions on price levels or the strategies of other firms. To enter any given export market, the firm must sink an initial fixed cost, which is an increasing function of market size and, to reflect experience, a decreasing function of the number of destinations that the firm already exports to. After entering the market, the firm receives a constant revenue stream. The firm has full *ex ante* information about the fixed costs of entry and the levels of exporting revenue associated with all potential export markets. As the fixed cost of entry is decreasing in the number of export destinations, the firm may benefit in the long term by entering markets gradually. The model is outlined in detail in this section.

2.1. Consumers

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

is $U = \left[\int_0^\Omega x_\omega^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$. The consumer price of good ω is denoted p_ω and the income of the individual is denoted Y . The demand of the representative consumer for good ω 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 an index that reflects the overall level of prices.

2.2. Firms

Firms in the model are assumed to be of the increasing returns to scale, heterogeneous productivity type proposed by Melitz (2003), in which each firm realises its productivity after it is formed.⁸ The productivity realisation is expressed in terms of the firm's idiosyncratic per-unit cost of production, a_ω , which defines its productivity, $a_\omega^{1-\sigma}$. Upon realising its productivity, the firm decides whether to produce, implying that it sells its products in the

⁸ 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 important point is that a better firm earns higher profits in all markets. A model based on product quality would generate predictions identical to those presented below.

home market, and what strategy to employ in entering export markets. There is some fixed cost associated with establishing a firm, which in equilibrium offsets the expected operating profits 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 is normalised to one, so the firm maximises profits by setting its output price equal to $p_\omega = a_\omega \sigma / (\sigma - 1)$.

2.3. Export revenues

The firm is faced with I potential export markets, where market i has gross domestic product (GDP) Y_i and an overall level of 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 convenience this is converted to the trade freeness parameter $\phi_i = \tau_i^{1-\sigma}$.

Dropping the subscript ω , when exporting to market i the firm with unit cost parameter a and output price $p = a\sigma/(\sigma - 1)$ receives the following single-period revenues:⁹

$$r(P_i, Y_i) = \phi_i \frac{1/\sigma [\sigma/(\sigma - 1)]^{1-\sigma} a^{1-\sigma}}{P_i^{1-\sigma}} Y_i \quad (1)$$

This expression may be simplified slightly by defining the ‘size’ of an export destination to be its GDP adjusted for the toughness of competition from other firms, $s_i = \alpha P_i^{\sigma-1} Y_i$, which reflects the larger demand for the firm’s exports in markets with fewer competitors or in which competitors sell for higher prices. The variable s_i directly reflects the potential sales volume of a new entrant to market i for a given price.¹⁰ Without loss of generality, parameters are normalised such that $\alpha \equiv 1/\sigma [\sigma/(\sigma - 1)]^{1-\sigma}$, which allows (1) to be simplified to the following:

$$r(s_i) = \phi_i a^{1-\sigma} s_i \quad (2)$$

⁹ The exporting revenue is net of production costs but gross of fixed entry costs.

¹⁰ The sales volume is not identical for markets of all sizes, in contrast to the standard constant elasticity of substitution model with uniform fixed costs for all markets. Fixed costs are increasing in market size, which was shown by Akerman and Forslid (2008) to lead to higher per-firm export volumes to larger markets. In this model the exact characterisation of revenue as a function of market size in general equilibrium would be difficult to obtain due to the complexity of the set of different strategies, which depends on the assumed distribution of firm productivity in each country, and the endogenous fixed cost function explained below. Such an exact solution would not in any case enhance the model, as the solution would be replicable as a particular case of the model here through the choice of subjective parameters.

The fixed costs of exporting are sunk upon entry and the per-unit revenue (2) is strictly positive, so once the firm has entered market i it receives a permanent stream of revenues of $r(s_i)$ in each period from sales to that market. The firm is assumed to 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:

$$R_i = \sum_{t=0}^{\infty} \beta^t r(s_i) = \frac{r(s_i)}{1-\beta} \quad (3)$$

Substituting in (2) yields:

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

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. A number of studies have found positive plant-level fixed costs associated with entry into new export markets (Roberts and Tybout, 1997; Bernard and Wagner, 2001; Bernard and Jensen, 2004; Das, Roberts, and Tybout, 2007). However, there is little evidence of ongoing fixed costs associated with continuing to export; indeed, Das, Roberts, and Tybout (2007) found that such ongoing fixed costs were not significantly different from zero. The model design follows these results, with positive fixed costs incurred to enter a new market but no ongoing fixed costs of exporting.¹¹

The fixed cost of entry into export 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 and n_t is the number of export destinations entered before period t , reflecting the firm's experience as an exporter.¹² As in the demand specification, the market size reflects both GDP and the lack of competition from other firms, factors assumed to be correlated with the difficulty of entering an export market. Experience

¹¹ This restriction precludes one mechanism for firm exit from export markets, in which a firm that exports to an unprofitable market simply to gain experience in setting up export operations would subsequently exit were the ongoing revenue to be negative. Such a feature is, however, beside the point of the current paper.

¹² 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.

accrues after one period, which drives the endogenous timing of entry: firms delay entry to certain markets while they accumulate experience from entry to other markets, if the fixed cost reduction exceeds the foregone revenue. Experience is measured as the number of destinations, so the amount of learning is independent of market size. This simplifies the model without affecting its predictions, which require only that the amount of experience gained be a larger multiple of the fixed cost of entry for smaller markets. Unlike in Arkolakis (2010), the firm does not have the option to enter part of the market and incur only a fraction of the fixed cost.

To generate the theoretical results presented in this paper, the necessary and sufficient conditions on the fixed cost function are that: (1) it be increasing in the size of the market but non-increasing per unit of size, so that $f_s^X > 0$ and $f_s^X \leq f^X / s$; (2) it be a decreasing function of prior exporting experience, so that $f_n^X < 0$; ¹³ and (3) the absolute reduction from experience be greater for larger markets, so that $f_{sn}^X < 0$. The first of these conditions ensures that larger markets are more profitable, which is necessary to generate the variation in entry orders. The second condition is necessary for delayed entry to be optimal. The third condition allows the orders of entry to export markets to be non-uniform, by creating a trade-off between lower overall fixed entry costs and higher foregone exporting revenues if the smaller or larger market is entered first. ¹⁴

To illustrate the type of process that the fixed cost is supposed to represent, a specific, micro-founded functional form for $f^X(s_i, n_i)$ is presented here. Certain tasks associated with entry, such as product adaptation, may be independent of country size, whereas other tasks, such as advertising, are higher for larger countries. For simplicity, it is assumed that elements of the fixed cost of entry may be grouped into a component that does not depend on market size and a component that is a constant multiple of market size. The costs of these components are represented by the constants $\mu > 0$ and $\nu > 0$, respectively. The units are

¹³ It is appropriate to impose convexity on the condition that the fixed entry cost be decreasing in experience, formally $f_{nn}^X > 0$, as the potential benefits of experience would eventually wane and the costs of entry would never become negative. This feature is present in the functional form given in (6).

¹⁴ The implications of the three necessary and sufficient conditions are demonstrated formally in appendix 2.

scaled such that the fixed cost of entry to a market of size s_i for a firm with no exporting experience is $\mu + \nu s_i$.

The fixed cost of entry to a given market is assumed to decrease with the number of markets already entered, as this experience broadens the firm's range of competencies. For instance, product adaptations and advertisements may have characteristics that can be applied to further markets. Many such dimensions of adaptation exist and the fixed cost of entry for a given market is increasing in the degree of adaptation required along each dimension. Formally, to enter market i the firm must adapt along each dimension $k \in [0, K]$ to the value η_i^k . Once the firm has conducted this adaptation, the value η_i^k becomes an element of its competencies in dimension k , denoted $\theta^k = \{\eta_i^k\}_{i \in M}$, where M is the set of markets entered by the previous period and includes the home market by definition. The cost of adapting the product in dimension k is a constant multiple of the difference between η_i^k and the nearest element of the firm's existing competencies θ^k . Each dimension is a unit circle (zero and one are equivalent values) so no country is more central than any other in terms of culture and technology. The values of η_i^k are drawn from $U(0,1)$ distributions and are independent and identically distributed.¹⁵ Where n is the number of markets already entered, the probability distribution for the difference between a new draw of η_i^k and the nearest existing competency in θ^k is $g(z) = 2n(1 - 2z)^{n-1}$. It follows that the total cost of adapting over a continuum of dimensions is proportional to $1/(n + 1)$.¹⁶ The scale-independent and per-unit components of the fixed cost each correspond to a continuum of dimensions, so both are reduced by experience by the same proportion. If the inexperienced firm faces a fixed entry cost of $\mu + \nu s_i$, the expression for the fixed cost of entry is:

$$f^X(s_i, n_t) = \frac{1}{n_t + 1} [\mu + \nu s_i] \quad (5)$$

The functional form in (5) naturally satisfies the necessary and sufficient conditions outlined above for the fixed cost function.

¹⁵ The model therefore differs from Morales, Sheu, and Zahler (2011) in that adaptation is not country-specific.

¹⁶ The derivation of this expression is given in appendix 1.

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 drop out of an export market it has already entered, as the revenue in each period must be positive for the firm to enter in the first place.¹⁷ The overall entry strategy can therefore be expressed as a vector \mathbf{t} of integer values representing the period in which each particular market is entered. That is, the firm enters market i in period t_i , where by convention period zero is the initial period and $t_i = \infty$ 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 \mathbf{t} is therefore:

$$\Pi = \frac{1}{1-\beta} a^{1-\sigma} \sum_{i=1}^m \beta^{t_i} \phi_i s_i - \sum_{i=1}^m \beta^{t_i} f^X(s_i, n_{t_i}) \quad (6)$$

As stated above, the expected profits from operating in the home market and the exporting payoff expressed in (6) 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 optimally chooses the export markets and entry times that maximise net exporting profits (6). The optimal strategy is characterised by the vector of market entry times \mathbf{t}^* .

3.1. Productivity ordering of firms

A relationship between firm productivity and the optimal strategy can be inferred from the expression for the strategy payoff in (6). The payoff is linear and increasing in the productivity factor $a^{1-\sigma}$, as the revenue from each market is proportional to firm productivity while the fixed entry costs are independent of firm productivity. The multiplier on firm productivity is proportional to the term $A = \sum_{i=1}^m \beta^{t_i} \phi_i s_i$, a single variable that combines the

¹⁷ With a positive ongoing fixed cost of exporting this may not hold true, even in the absence of uncertainty, as the firm could enter a market to benefit from that experience even if revenue from exporting to that market is less than the ongoing fixed cost. In such a case the firm would not continue exporting to the market once it had benefited from the experience of establishing the export operation.

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 the strategy characterised by t .¹⁸

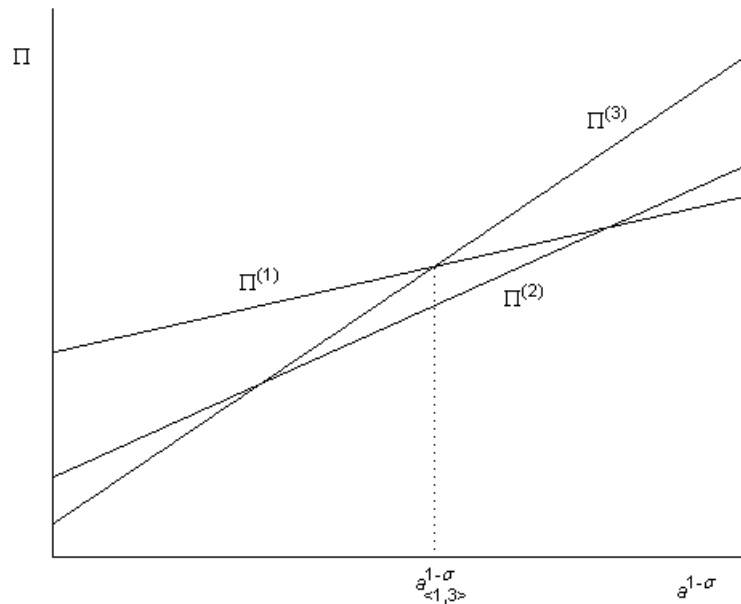


Figure 1. Strategy payoffs as functions of firm productivity levels.

Now consider the three hypothetical strategies illustrated in Figure 1, which are numbered in increasing order of firm productivity so that $A^{(1)} < A^{(2)} < A^{(3)}$. As each strategy payoff is linear in productivity, the payoffs from any given pair of strategies may intersect at most once. If the 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. An example is illustrated in Figure 1, in which $a^{1-\sigma}_{<1,3>}$ represents the threshold between strategies 1 and 3. Identical reasoning applies to any pair of strategies and results in a positive and monotonic ordering, with more aggressive strategies employed by more productive firms. It should be noted that some potential 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. The remainder of this section outlines the features of the optimal strategies that can be inferred from (6).

¹⁸ According to this formulation a strategy is more aggressive if the markets entered are nearer. Though it is not clear how the distances to export markets should be related to the concept of aggressiveness, in the model all firms enter nearer markets rather than or no later than more distant markets, so the distinction is not important.

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. *Under optimal strategies, the time taken to enter a given set of markets is weakly increasing in firm productivity.*

Proof. *See appendix 3.*

The prediction that more productive firms enter markets more quickly results from the trade-off underlying the decision about the timing of entry: delaying entry until other markets have been entered implies reduced fixed entry costs, but also foregone revenue. Firms delay entry if and only if the fixed cost reduction exceeds the foregone revenue. As fixed entry costs are independent of productivity whereas exporting revenues are increasing in productivity, immediate entry is optimal only for the firms above some productivity threshold. This trade-off is illustrated in Figure 2. The same reasoning applies to each export market, so the overall relationship between firm productivity and the time taken to enter a given set of markets is non-increasing. Intuitively, more productive firms earn more exporting revenue from any given market so the foregone revenue is relatively important for these firms, whereas for less productive firms the reduction in fixed entry costs is relatively important.

The home country is considered to be a market from which the firm gains experience. This implies that more productive firms also enter their first export market after a shorter delay.

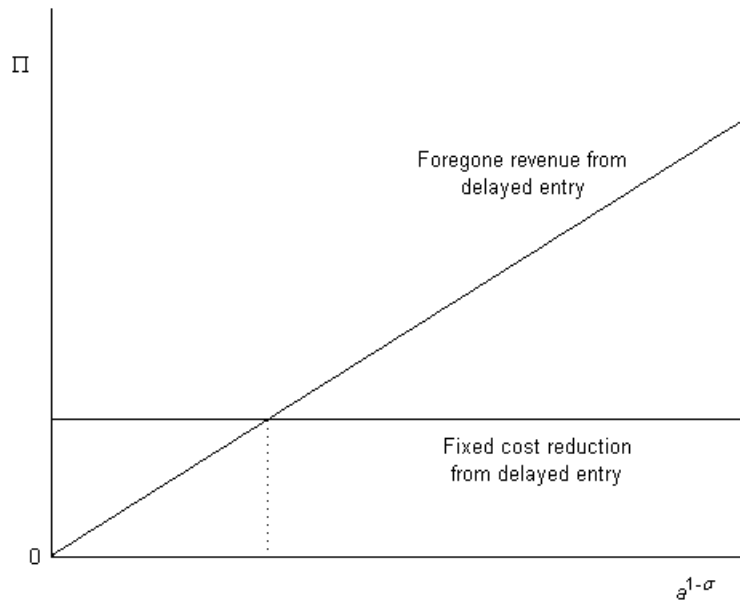


Figure 2. Trade-off involved in delaying entry to an export market, by firm productivity level.

3.3. Order of entry by market size

A novel feature of the model is that it generates endogenous variation in the orders of entry to export markets. Firms have opposing incentives either to (1) enter smaller markets first, to maximise gains from experience in setting up export destinations, or (2) enter larger markets first, to receive higher revenues in the near term. The model generates both types of pattern. It is even possible that some firms enter unprofitable markets, simply in order to gain experience that makes it more profitable to export elsewhere in later periods. The relationship between firm productivity and the optimal order of entry to markets of different sizes is summarised in the following proposition.

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

Proof. See appendix 3.

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, which implies that attaining exporting revenues earlier is relatively important for more productive firms. As less productive firms earn less revenue from each market, the fixed costs of entry are relatively important. This results in more

productive firms entering the larger market first in order to earn more revenue in the earlier period, whereas less productive firms enter the smaller market first in order to benefit from the larger aggregate reduction in fixed entry costs.¹⁹ For parameters that permit both orders to be optimal for some set of firms, the firms that enter the larger market first are necessarily more productive than those that enter the smaller market first.

The pattern outlined in proposition 2 extends to any subset of exporting strategies. Amongst firms that eventually enter the same set of markets, this produces an overall ordering in which more productive firms tend to export to larger markets earlier whereas less productive firms enter smaller markets earlier.²⁰

While the predictions made in proposition 1 may be able to be explained by a number of alternative factors, the prediction made in proposition 2 is more specific. It requires a model of a particular type, similar to that proposed here. Namely, the model must have a benefit that accrues from exporting to some markets, is realised when other markets are subsequently entered, and is increasing in the size of the market subsequently entered.

The prediction that export market entry orders are dependent on firm productivity implies that a degree of variation in entry orders between firms is generated endogenously, a novel feature of the model. Morales, Sheu, and Zahler (2011) and Chaney (2011) generate variation in market entry orders, as firms tend to enter export markets near markets they already export to, which fit with empirical export patterns. However, the variation in export patterns results from randomness in the sets of initial export markets, so these models do not explain why entry orders vary between firms. The learning mechanism could explain part of the heterogeneity in orders of export market entry observed for French firms in Eaton, Kortum, and Kramarz (2008) and for Irish firms by Lawless (2009).

¹⁹ It is trivially not optimal for any firms to enter the smaller market first if the reduction in fixed entry costs from experience is not increasing in market size, as this foregoes higher revenue in the near term without any overall decrease in the fixed costs of entry. This is shown formally in appendix 2.

²⁰ 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.

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.²¹ This relationship is specified in the following proposition.

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

Proof. *See appendix 3.*

The prediction that firms will enter a nearer market before a more distant market is a simple product of discounting: if one market yields a larger net profit, then a higher discounted profit is earned by entering that market earlier. For markets are of different sizes, the nearer market is entered first if the relative distance to that market is below a certain threshold, where the threshold level depends on the sizes of the markets and on firm productivity.

Proposition 3 fits with intuition given the strength of the gravity model of trade in explaining empirical trade patterns, with the two principal factors being market size and distance (Anderson and van Wincoop, 2004). The prediction here is related: not only do firms export more to nearer or otherwise more accessible markets, but they also enter these markets earlier. As with the gravity model, the sizes of markets and other factors not made explicit in the current model also play a role, but in general firms are predicted to begin by exporting to neighbouring countries and then expand to progressively more distant markets.

As outlined in the discussion of proposition 2, the order in which markets of different sizes are entered by different firms is not uniform, but varies depending on firm productivity. Therefore, the model does not generate an ordering of markets based solely on their sizes. However, in general the model predicts that larger markets will yield higher net profits, which is consistent with firms generally entering larger markets earlier.

3.5. Market size and transport costs

This section puts the predictions made in propositions 2 and 3 into context with each other and illustrates how the combination of differences in market sizes and distances affect the

²¹ 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.

order of entry. Figure 3 shows the optimal order of entry to two particular markets, $m1$ and $m2$, as a function of the market sizes and the transport cost parameters. The sizes of $m1$ and $m2$ are denoted s_1 and s_2 , respectively, with $m1$ defined to be the (weakly) smaller of the two markets. The transport cost parameters for the two markets are denoted ϕ_1 and ϕ_2 . The horizontal axis represents the size of $m1$ and the vertical axis represents the transport cost parameter for $m1$. Both the size and transport cost parameters for $m1$ may be compared with the equivalent values for $m2$, which are marked on the respective axes. As $m1$ is defined to be no larger than $m2$, the size of $m2$ defines the maximum value on the horizontal axis. In the interests of clarity, the possibilities of one or both of the markets not being entered or of the two markets being entered simultaneously in the optimal strategy are ignored.

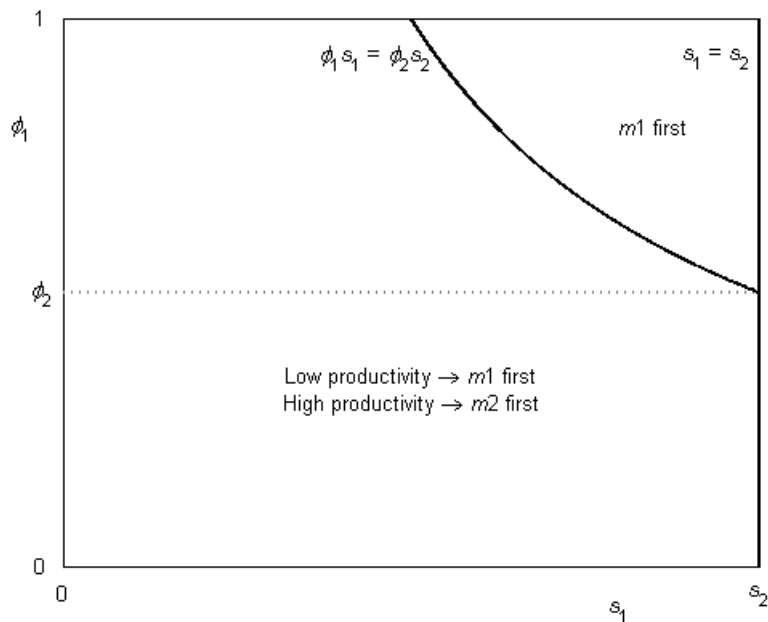


Figure 3. Optimal orders of entry to $m1$ and $m2$ given market sizes and transport costs.

The parameter space in Figure 3 is divided by the line that represents equal exporting revenues, $\phi_1 s_1 = \phi_2 s_2$, into two regions that represent qualitatively different sets of strategies. The discounted sum of the fixed entry costs is strictly higher when entering the larger market first than when entering the smaller market first, as $f_{sn}^X < 0$. The higher entry costs from entering the larger market first are worth incurring if earlier entry to the larger market provides a gain in revenue that at least compensates for the higher fixed costs. This is trivially impossible if the larger market is sufficiently distant relative to the smaller market that it yields less exporting revenue than the smaller market, so no firms enter the larger

market first in cases where $\phi_1 s_1 > \phi_2 s_2$ and the set of such parameters is marked in Figure 3 as “*m1 first*”. For the remaining parameters, all firms above a certain productivity threshold enter the larger market first, whereas firms below the productivity threshold enter the smaller market first. A number of these productivity thresholds are illustrated in Figure 4.²² Effectively, firm productivity would represent a third dimension on this diagram.

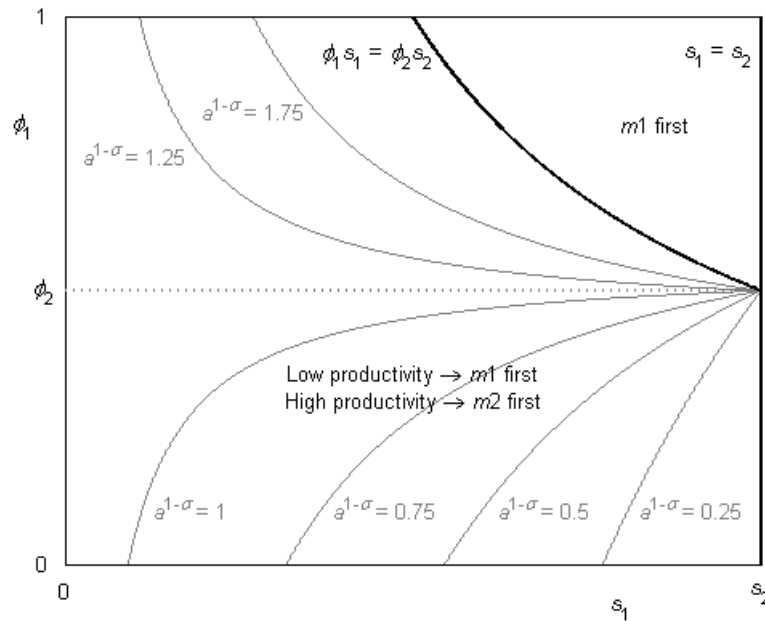


Figure 4. Parameter borders for optimal orders of entry given selected productivity levels. For parameters below each border, *m2* is entered first, for parameters above the border, *m1* is entered first.

For firms with productivity approaching zero, exporting revenues are insignificant compared to fixed entry costs in the decision about which of the markets to enter first, so such firms would simply enter the smaller market first. The productivity threshold at the lower limit of firm productivity would therefore coincide with the line $s_1 = s_2$. For firms with productivity approaching infinity, the fixed entry costs would be insignificant compared with exporting revenues, so the decision of which market to enter first would be based solely on which market yields the highest revenue. The productivity threshold at the upper limit of firm productivity would therefore coincide with the line $\phi_1 s_1 = \phi_2 s_2$. The productivity thresholds for all intermediate levels of productivity vary monotonically between these two lines, with

²² The parameters used in this example are $s_2 = 1$, $\phi_2 = 0.5$, $\beta = 0.9$, and $f^X(s, n) = (1 + s)/(1 + n)$.

all passing through the point where $s_1 = s_2$ and $\phi_1 = \phi_2$ as implied by proposition 3.²³

Several of these thresholds are marked in Figure 4.

As can be seen from Figure 4, the range of parameters for which the larger market ($m2$) is entered first expands as firm productivity increases, always to a superset of the parameters that imply the same pattern for less productive firms. This relationship applies over the full range of productivity values, consistent with proposition 2.

One way of interpreting the productivity thresholds is in terms of the market parameters displayed in Figure 4. Relative to each threshold along a vertical slice of the parameter space, firms with the productivity level reflected by the threshold enter the smaller market ($m1$) first for pairs of markets with higher ϕ_1 values than the threshold and vice versa. That is, if either market is nearer than implied by the productivity threshold, then it is entered earlier.²⁴ As this applies to all productivity levels, the nearer a market is, the more firms enter it before a given alternative, a generalisation of proposition 3 to markets of any relative sizes.

On the other hand, similar generalisations about the order of entry in terms of market sizes cannot be inferred from the model, as is also apparent from Figure 4. For some combinations of transport costs and firm productivity, a market is entered first if it is above a certain threshold size relative to the other market, while in other cases the market size must be below a certain threshold. Due to this irregularity, the model does not generate a general prediction about the order of entry in terms of relative market sizes.

4. Data

The data used in this paper are a panel of Swedish firm-level data supplied by Statistics Sweden (Statistiska centralbyrån) for all years from 1997 to 2007. The data include information on firm characteristics (wages, numbers of employees, investments, inputs, locations of plants and headquarters, and so on) and the amount of exports for each firm in

²³ When the two markets are the same size, the nearer market is entered first by firms of all productivity levels.

²⁴ As the revenue from $m1$ is directly related to its size, the value of ϕ_1 becomes unimportant to the decision of which market to enter first as s_1 approaches zero. For values of s_1 at the lower limit, the order of entry is determined by whether the discounted reduction in the fixed cost of entering $m2$ from experience is greater than one period of revenue from $m2$.

each year by destination country. Data on the GDP levels of each country in 2010 are from the World Development Indicators database of the World Bank. Data on the distances of countries from Sweden are the distance between the principal cities from the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) database.

The sample is restricted to manufacturing firms, in the interests of both internal consistency and consistency with the model, and to firms with at least five employees. The empirical tests conducted in this paper require a sample of new firms, with information on the year of formation of each firm and its year of entry to each export destination. The new firms are identified by restricting the sample to those firms that are not present in the first year of the panel but appear thereafter. To avoid falsely classifying subsidiaries or the divestiture of certain operations as independent firms, an index maintained by Statistics Sweden is used to identify such entities, which are then excluded.²⁵ Firm productivity is estimated in the first year of operation for each firm using the method proposed by Levinsohn and Petrin (2003). Each sample is restricted to firms for which there is enough information in the data to calculate productivity using this method.

The data are aggregated by two-digit manufacturing industry. To avoid spurious variation from industries with few firms, only two-digit industries with at least 50 Swedish firms operating during the relevant period are included in the sample. A small fraction (around 5%) of manufacturing firms operate in more than one industry; these firms 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.

²⁵ The index groups firms that have had common ownership at some stage of their existence. 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. The results are robust to stricter definitions of ‘new’ firms that only include firms that first appear in 1999 or later, as shown in appendix 5.

	Mean	Std. dev.	Minimum	Maximum
Number of employees	54.5	426.7	5	20,963
Payroll (mSEK)	15.4	97.7	0.1	3,820.0
Capital stock (mSEK)	16.4	155.0	0.0	5,360.0
Estimated productivity in first year of operation	12.4	33.2	0.0	1,812.0
Number of export destinations	4.9	10.7	0	129
Value of exports (mSEK)	33.5	298.0	0.0	13,100.0

Note: 3,352 firms in total, of which 2,294 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 interesting to observe which countries most commonly function as export destinations for these firms. Table 2 gives rankings of the 20 most popular destinations for Swedish manufacturing exports in 2007 in terms of the number of exporters and the value of exports. These rankings use a sample of all manufacturing firms, to give an impression of overall Swedish exports rather than only of young firms.

Rank	Country	Number of Swedish exporters	Rank	Country	Value of Swedish exports (bSEK)
1	Norway	4,809	1	Germany	82.94
2	Finland	2,093	2	United States of America	66.72
3	United States of America	1,989	3	United Kingdom	55.81
4	Denmark	1,895	4	Norway	42.30
5	Germany	1,879	5	France	41.71
6	United Kingdom	1,643	6	Belgium	40.06
7	Switzerland	1,626	7	Netherlands	38.30
8	Netherlands	1,463	8	Denmark	28.59
9	France	1,403	9	Italy	27.85
10	Poland	1,310	10	Finland	26.07
11	Belgium	1,228	11	Spain	23.46
12	Italy	1,200	12	Russia	16.66
13	Spain	1,178	13	China	16.36
14	China	1,115	14	Poland	15.05
15	Estonia	989	15	Japan	10.88
16	Austria	963	16	Australia	10.82
17	Japan	935	17	India	8.57
18	Australia	933	18	Canada	8.37
19	Iceland	912	19	Austria	8.24
20	Canada	868	20	Switzerland	7.41

Table 2. Rankings of the 20 most popular export destinations for Swedish manufacturing firms in 2007 by the number of Swedish exporters (left) and by the value of Swedish exports (right).

The rankings in Table 2 confirm the importance of market size and the distance from Sweden in determining the popularity of an export destination, consistent with a gravity model. The most popular markets tend to be either relatively large (e.g. the United States of America, Japan, and China), relatively close to Sweden (e.g. Norway, Finland, and Denmark), or both (e.g. Germany, France, and the United Kingdom). The most popular destination in terms of the number of exporters is Norway, which shares a long land border with Sweden and has

much of its population concentrated in areas close to that border. The most popular destination in terms of the value of exports is Germany, a neighbour of Sweden with vastly higher GDP than Norway, followed by the United States of America, a distant market but the largest in the world in terms of GDP.

5. Results

Propositions 1 through 3 relate to firm productivity, so to test these predictions it is necessary to produce estimates of the productivity levels of all firms. This is done using the method proposed by Levinsohn and Petrin (2003), which 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.²⁶ 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. The remainder of this section outlines the empirical tests of the three propositions stated above.

5.1. Proposition 1

The prediction in proposition 1 is that firms with higher productivity levels enter export markets more quickly. That is, all else being equal, a more productive firm begins exporting sooner and then adds new export markets at a faster rate than a less productive firm. This relationship is tested by regressing the delay before entry to each export market on firm productivity. The delays are measured as the years since firm formation for the first market

²⁶ The Levinsohn-Petrin method is a variation of that proposed by Olley and Pakes (1996), which instead uses investments to proxy for unobserved productivity. The principal advantage of the Levinsohn-Petrin method over Olley-Pakes is that it produces productivity estimates for a larger number of firms, as each method relies on nonzero amounts for the respective proxy variable, nonzero values being more common for intermediate inputs than for investments. The productivity estimates from the two methods are highly correlated and lead to qualitatively similar results, as indeed does productivity estimated as value added per worker, so the results appear not to be dependent on the choice of productivity measure in any case. This is demonstrated for Table 6 in the robustness checks presented in appendix 5; reproductions of the other regression tables using these alternative productivity estimates can be supplied upon request. The Levinsohn-Petrin and Olley-Pakes techniques contain some strong assumptions and have been criticised for a number of identification issues. Akerberg, Caves, and Frazer (2006) note that the strict monotonicity of the proxy variable in terms of unobserved productivity is necessary to completely correct for endogeneity. Furthermore, if the firm sets the levels of the proxy and the variable input simultaneously, and both are deterministic functions of state variables and unobserved productivity, then the coefficient on the variable input is unidentified. If the proxy and the variable input are set in different periods, then an endogeneity problem remains. They propose an alternative method to address these problems, which is developed further by Wooldridge (2009).

and as the years since entry to the previous market for the second market onwards.²⁷ The following equation is estimated:

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

where $t_{\omega,n}$ denotes the year of operation in which firm ω enters its n th export market, $\beta_{prod,n}$ is the coefficient on productivity for the delay before entry to the n th export market, z_{ω} is the (log) productivity of the firm as measured in its first year of operation, $\gamma_{j,n}$ is the fixed effect for industry j , and $\varepsilon_{\omega,n}$ is the error term. By definition $t_{\omega,0}$ is the period of formation of firm ω , so the delay before entry to the first export market is measured from the time at which the firm is formed. Equation (7) is estimated using a Poisson model, as the delays are constrained to be nonnegative and their distribution in the data resembles an exponential distribution. The productivity coefficients from ordinary least squares estimation of (7) are included for comparison. The productivity coefficients are given in Table 3 and are stated separately for the delay before commencement of exporting, the delay between entry times to each successive pair of markets, and the combination of these.

Delay before entry to	Productivity coefficient		Number of observations
	(Poisson)	(OLS)	
First market	-0.381*** (-5.42)	-0.236*** (-4.79)	2,294
Second and later markets	-0.471*** (-7.31)	-0.126*** (-7.81)	24,688
All markets	-0.501*** (-8.17)	-0.152*** (-8.54)	26,982

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

Table 3. Productivity coefficients for the delay before the commencement of exporting and between entry times to all consecutive pairs of markets.

The productivity coefficients displayed in Table 3 are each negative and strongly significant, confirming the prediction made in proposition 1: more productive firms begin exporting

²⁷ It would also be possible to regress the number of markets entered in each year of operation on firm productivity, which yields qualitatively similar results, but this would falsely identify entry to a larger number of markets as faster entry: if a firm went on to enter a larger number of markets than another firm, then it would be identified as entering more markets per year, even if both firms added their export destinations at exactly the same rate.

sooner and then go on to add further markets more quickly than less productive firms.²⁸ The coefficients for individual industries are presented in appendix 4. In order to test for the possibility of these results being driven by the size or other characteristics of the firm rather than productivity, (7) is estimated using labour, capital, and capital intensity in log values as additional independent variables. The resulting coefficients are displayed in Table 4.

Delays before entry to all export markets						
	(Poisson)	(Poisson)	(Poisson)	(Poisson)	(Poisson)	(Poisson)
Productivity	-0.501*** (-8.17)	-0.348*** (-6.26)	-0.359*** (-6.51)	-0.377*** (-6.47)	-0.341*** (-6.08)	-0.481*** (-7.76)
Number of employees		-0.315*** (-14.53)			-0.253*** (-7.35)	
Wages			-0.263*** (-13.39)			
Capital				-0.172*** (-11.99)	-0.053** (-2.34)	
Capital intensity						-0.098*** (-4.25)
Number of observations	26,982	26,982	26,977	26,893	26,893	26,893

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

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

The results in Table 4 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, the coefficient on firm productivity remains negative and strongly significant with their inclusion.

5.2. Proposition 2

The prediction made in proposition 2 is 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. This prediction is not straightforward to test empirically, due to the difficulty of isolating strategies comparable in all aspects other than entry times to a given pair of markets. To test the proposition, the analysis conducted here includes firstly a test of the corollary that the first

²⁸ These results are robust to changes in the sample of firms, such as setting a minimum year of formation after 1998 or a maximum year of formation before 2007, to the inclusion of year-of-formation fixed effects, and to a minimum export amount or duration of exporting to each destination, as demonstrated in appendix 5.

markets entered are larger for more productive firms, followed by tests of entry orders to particular pairs of markets in which the other aspects of the entry strategies are controlled for.

To test the relationship between firm productivity and the size of the n th market entered, the following equation is estimated:

$$GDP_{\omega,n} = \beta_{prod} z_{\omega} + \gamma_{j,n} + \varepsilon_{\omega,n} \quad (8)$$

where $GDP_{\omega,n}$ is the (log) GDP of the n th export market that firm ω enters, z_{ω} is the (log) productivity of the firm as measured in its first year of operation (with coefficient β_{prod}), $\gamma_{j,n}$ is the fixed effect for industry j , and $\varepsilon_{\omega,n}$ is the error term.²⁹ The results from the estimation of (8) for each of a selection of ordinal markets are given in Table 5. Though it is not practical to include the coefficients for all markets in a table, the productivity coefficients for the full range of markets from the first to the thirtieth are plotted in Figure 5.

	Market size in terms of GDP								
	1st market entered	2nd market entered	4th market entered	6th market entered	8th market entered	10th market entered	15th market entered	20th market entered	30th market entered
	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)
Productivity	0.577*** (7.46)	0.475*** (4.78)	0.265*** (3.57)	0.238*** (2.65)	0.114 (1.26)	-0.022 (-0.25)	-0.190 (-1.21)	0.060 (0.38)	-0.048 (-0.26)
R ²	0.117	0.079	0.048	0.033	0.037	0.045	0.030	0.057	0.047
Number of observations	2,294	1,704	1,199	987	875	779	586	436	264

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

Table 5. Productivity and distance coefficients on the size of the first, second, etc. markets entered.

²⁹ In cases where the firm enters more than one market in the same year, the size of the market is taken from the largest market entered in the period, so that entry to a small market as well as a large market is not confused for the firm managing only to enter the smaller market.

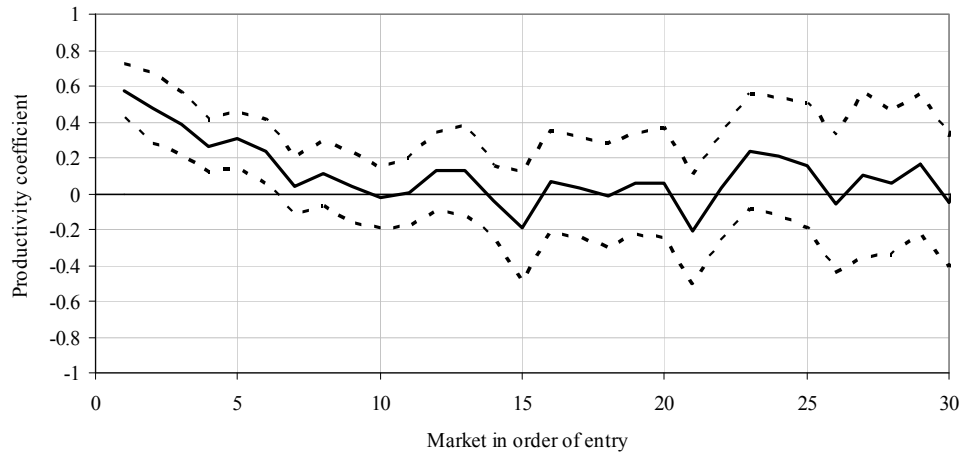


Figure 5. Productivity coefficients on the sizes of the first thirty markets entered (solid line) and the upper and lower limits of the 95% confidence interval (dotted lines).

The results displayed in Table 5 and Figure 5 indicate that the sizes of the initial markets entered are increasing in firm productivity, but that this relationship disappears for later markets. This is in line with the theory, as the first markets entered are larger for more productive firms as they are less concerned with gaining experience in smaller markets before entering the larger markets. For later markets, those entered by the more productive firms would be smaller amongst firms that all enter the same markets, but this effect is muddled by the diversity of factors at play in the selection of later markets, which may include low-productivity firms entering small markets further abroad to gain experience before entering larger markets nearby. The samples are also more homogeneous for later markets, as less productive exporters enter fewer markets and are therefore not included in the samples of entry to lower-ranked markets.

More specifically, 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. Testing this proposition presents a challenge: restricting the sample to firms employing 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 and unobservable heterogeneity across firms. 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. To control for other differences between the strategies,

fixed effects representing the sets of all continents exported to are included in the regressions. Only firms that eventually export to both markets are included, a condition that excludes firms that attempt to export to a ‘trial market’ but are unsuccessful and subsequently cease to export: a possible manifestation of firms testing their uncertain exporting productivity rather than of the learning mechanism proposed in this paper. Though it is difficult to completely separate the effects of the two mechanisms, excluding these temporary exporters reduces potential false confirmation of the learning mechanism. Also excluded are many of the firms that simply fill occasional orders but do not establish themselves as exporters in either type of market, which would be irrelevant to the theory proposed above.

When comparing export markets, certain geographical, cultural, and institutional differences are endemic and difficult to deal with. One of the benefits of comparing the entry order for a specific pair of markets is that it includes a natural solution to this problem: as the geographical, cultural, and institutional differences between markets apply to all firms, these are simply captured in the constant terms.

The analysis is conducted using two sets of definitions for the ‘small’ and ‘large’ export markets. The first restricts attention to EU countries and compares the entry times to the smaller neighbours of Sweden with the entry times to all larger markets. The reason for focusing on EU markets is that within-EU exports are only included in the data for firms that have total exports to EU countries of at least 1.5 million SEK in the same year, which could distort the comparison of entry times to EU and non-EU countries. The second part of the analysis uses pairs of markets that are similar to each other in culture and distance from Sweden, but different in size, where both markets are either inside or outside of the EU.

In the first part of this analysis, the ‘small’ EU markets are comprised of Denmark, Finland, Lithuania, Latvia, and Estonia (henceforth the ‘neighbouring’ markets).³⁰ 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. To be comprehensive, the set of ‘large’ markets tested includes all countries in the EU with higher levels of GDP

³⁰ Germany and Poland are not used because they are substantially larger than Sweden, while Estonia, Latvia, and Lithuania are not used because these countries acceded to the EU during the period of the data, so exports to these markets may not be consistent over time. In any case, the results are robust to the inclusion of these countries as neighbours.

than any of the neighbouring 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:³¹

$$I_{\omega}^{(t_S < t_L)} = e^v / (e^v + 1) \quad (9)$$

$$v = \beta_{prod} z_{\omega} + \gamma_j + \delta_{\omega} + \varepsilon_{\omega}$$

where $I_{\omega}^{(t_S < t_L)}$ is an indicator variable for firm ω (in industry j) entering at least one of the small (neighbouring) markets before entering the large market,³² z_{ω} is the (log) productivity of firm ω as measured in its first year of operation (with coefficient β_{prod}), γ_j is the fixed effect for industry j , δ_{ω} is the fixed effect for the set of continents exported to, and ε_{ω} is the error term.³³ The productivity coefficients from the estimation of (9) are displayed in the first two columns of Table 6. The second column uses the fixed effects for the sets of continents exported to.

The prediction made in 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 there is not necessarily a linear relationship between firm productivity and the number of small markets, the relationship is estimated using an ordered logistic model, fitting the following equation:

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

where N_{ω} is the number of neighbouring markets that firm ω (in industry j) enters before entering the US market and the other variables are defined as in equation (9). Equation (10)

³¹ The logistic model is appropriate to evaluating the factors influencing a choice between two discrete options. It imposes a specific structure on the regressions and therefore is not always applicable. However, probit and ordinary least squares regressions using the same variables yield qualitatively similar results, as demonstrated in appendix 5.

³² 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. This is reasonable because firms that enter the two types of markets simultaneously are not able to gain exporting experience before entering the large market, just as with firms that enter the large market then the neighbouring markets. In any case this assumption is not crucial, as the results also hold if firms that enter the large market in the same year that they enter their first neighbouring market are excluded.

³³ 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.

is estimated for the same large markets as equation (9) and using the same destination continent fixed effects. The resulting productivity coefficients are displayed in the third and fourth columns of Table 6.

Large EU market	Productivity coefficient for:				Number of observations
	Prior entry to neighbouring EU market(s) (I_{ω})		Number of prior neighbouring EU markets (N_{ω})		
	(Logit)	(Logit)	(Ologit)	(Ologit)	
Germany	-0.361** (-2.23)	-0.265 (-1.46)	-0.345** (-2.17)	-0.233 (-1.27)	784
France	-0.637** (-2.33)	-0.636** (-2.57)	-0.644** (-2.41)	-0.637** (-2.54)	583
United Kingdom	-0.430** (-2.32)	-0.336* (-1.68)	-0.441** (-2.37)	-0.343* (-1.75)	680
Italy	-0.653*** (-2.72)	-0.620*** (-2.61)	-0.593*** (-2.70)	-0.566** (-2.45)	512
Spain	-0.645** (-2.27)	-0.703** (-2.15)	-0.549** (-2.24)	-0.574** (-2.17)	516
Netherlands	-0.495*** (-2.61)	-0.525** (-2.56)	-0.502** (-2.55)	-0.516** (-2.48)	603
Belgium	-0.639*** (-2.73)	-0.620** (-2.56)	-0.434** (-2.21)	-0.417** (-2.04)	504
Poland	-0.168 (-0.91)	-0.213 (-1.06)	-0.069 (-0.40)	-0.090 (-0.49)	645
Austria	-0.207 (-1.01)	-0.159 (-0.74)	-0.197 (-1.08)	-0.146 (-0.75)	431
Greece	-0.385 (-1.12)	-0.245 (-0.66)	-0.307 (-0.96)	-0.232 (-0.71)	273
Set of export continent fixed effects	No	Yes	No	Yes	

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

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

Table 6 confirms the prediction made in proposition 2. Negative coefficients in Table 6 imply a negative relationship between firm productivity and entry to at least one neighbouring market before entry to the large market (I_{ω}), in the first two columns, and between firm productivity and the number of neighbouring markets entered before entry to the large market (N_{ω}), in the third and fourth columns. The coefficients are negative and significant for all but three of the larger EU markets, the only exceptions being the smallest of those markets, which naturally fit the least well with the theory. This confirms the prediction made in proposition 2: firms that enter neighbouring markets before entering each of these large markets are, in general, less productive than firms that enter the large market

first, and less productive firms enter a larger number of neighbouring markets before entering the large market.

These findings are consistent with lower-productivity firms gaining experience by exporting to a smaller market, in which inefficiencies in setting up the operations would incur smaller losses, before expanding to export to a larger market. The inclusion of destination continent fixed effects reduces the power of the tests, as it excludes some firms, but there is no clear overall effect on the magnitudes. The productivity coefficients therefore do not seem to be an artefact of differences between broadly different exporting patterns. 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, as shown in appendix 5.

It would be reasonable to suspect that these results may be driven by the geographical or cultural proximity of the neighbouring markets to Sweden, rather than by their small size in comparison to the larger markets. To address this point, the second set of tests of proposition 2 is conducted using pairs of markets that are similar in terms of culture and distance from Sweden, but where one market is substantially larger than the other. The most reliable way to control for distance in terms of the cost of transporting goods is to choose pairs of countries that neighbour each other, while avoiding pairs of countries where one hosts a major port that would serve both countries. Under these restrictions there are a limited number of pairs of countries that have sufficiently many observations for Swedish manufacturing exporters to obtain meaningful results. A handful of such pairs of markets from different regions are analysed. These pairs of markets have relatively large 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’ 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 eventually export to both markets but enter them in different periods. The first sample allows comparison of firms that enter the smaller market first with all other firms that export to the large market. The second sample allows comparison of firms that enter the small market before the large market with all other firms that export to both. The third sample allows a direct comparison of firms that enter the small market then the large market with firms that enter the two markets in the

opposite order. For brevity, the fixed effects for the sets of continents or regions exported to are not included. The productivity coefficients from these regressions are shown in Table 7.

Small market	Large market	Productivity coefficient		
		(Logit)	(Logit)	(Logit)
Belgium	France	-0.719** (-2.48) [544]	-0.920*** (-2.67) [388]	-0.993* (-1.88) [114]
Belarus	Russia	-1.218 (-1.63) [156]	-1.565* (-1.94) [27]	-1.336 (-1.56) [23]
Canada	United States of America	-0.340* (-1.80) [981]	-1.143*** (-3.64) [428]	-1.123*** (-2.87) [196]
Uruguay	Argentina	-0.453 (-0.61) [77]	-1.239 (-1.02) [36]	-0.887 (-0.73) [21]
New Zealand	Australia	-0.919** (-2.04) [312]	-1.397** (-2.17) [143]	-1.207 (-1.32) [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; * significant at 10% level, ** significant at 5% level, *** significant at 1% level

Table 7. Productivity coefficients for entry to the small market before the large market for each specified pair of markets.

The productivity coefficients displayed in Table 7 are consistent in sign with the theory but not significant for all of the samples, which may be due to small sample sizes. The productivity coefficients are significant for Canada and the US and for New Zealand and Australia, pairs of countries with strong cultural similarities but that are isolated from other similar countries.³⁴ The coefficients for Belgium and France are also significant. As with the neighbouring and large EU markets, the productivity coefficients are larger in magnitude and more significant when the sample is restricted to firms that eventually enter the small market, as firms that enter only the large market are less productive on average than firms that export to both markets. The coefficients for Belarus and Russia and for Uruguay and Argentina are

³⁴ The relationship between firm productivity and the order of entry to Canada and the United States is treated in more detail in appendix 6, with comparisons of all six of the strategies (as defined above) that are possible in a scenario where there are two potential export markets.

negative in magnitude but not significant, as few Swedish firms export to these combinations of markets; results consistent with many pairs of similar markets in these and other regions. Restricting the sample to firms that enter both markets or to firms that enter the markets in different periods has no overall effect on the magnitude of the coefficients.

While the model was shown in the tests of proposition 1 to correctly predict the relationship between firm productivity and the speed of entry, the confirmation of proposition 2 supports the proposed learning mechanism as the explanation for this relationship. Among firms that export to a given pair of markets, lower productivity firms are shown here to tend to export to the smaller market first and then to the larger market. This pattern is difficult to explain in the absence of a benefit that: (1) accrues from exporting; (2) applies when further export markets are entered; and (3) is increasing in the size of the market subsequently entered.

The learning mechanism proposed in this paper satisfies these conditions, as could the uncertainty models of Nguyen (2011), Eaton, Eslava, Krizan, Kugler, and Tybout (2011), and Albornoz, Calvo Pardo, Corcos, and Ornelas (2012). These models could explain some of the empirical results presented above, in particular the speed of entry. However, the Swedish data show that firms that export first to a smaller market and then to a larger market are more productive than firms that export only to the larger market. This feature of the data is consistent with the learning mechanism presented here, for some parameters, but the reverse of what a model based on firms learning about uncertain exporting profitability would predict. Furthermore, the number of small markets entered before a large market is found to be decreasing in firm productivity, which is predicted by the model presented here does not fit as well with a model of uncertain exporting profitability. Another candidate mechanism would be a credit or management constraint that makes it more costly to enter markets simultaneously: this could explain the empirical results presented here, but only to the extent that it is equivalent to the learning mechanism presented above.

5.3. Proposition 3

Proposition 3 predicts that nearer markets will be entered no later than more distant markets. To test this proposition, the ranks of the markets in the export entry orders of firms are regressed on the distances to the markets. The order of entry to new export markets by each firm is observed and each of these is assigned a rank $r_{\omega,i}$, 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 with the distance and GDP variables in logs:

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

where $r_{\omega,i}$ is the rank of market i in the order of entry for firm ω , $dist_i$ is the (log) distance from Sweden to country i (with coefficient β_{dist}), GDP_i is the (log) GDP of market i (with coefficient β_{GDP}), $\beta_{distGDP}$ is the coefficient on the interaction between distance to and 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 quartile of firm productivity levels. The results of the estimation of (11) using ordinary least squares are shown in Table 8.

	Rank in market entry order							
	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)
Distance	6.378*** (59.26)		6.692*** (64.23)	26.715*** (11.56)	4.087*** (26.69)	5.233*** (27.54)	4.690*** (25.41)	8.148*** (35.05)
GDP		-3.433*** (-38.64)	-3.629*** (-41.25)	2.207*** (3.56)				
Distance-GDP				-0.712*** (-8.85)				
Productivity quartile					1st	2nd	3rd	4th
Number of observations	26,982	26,982	26,982	26,982	5,325	6,843	6,380	8,434

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

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

The results in Table 8 are consistent with the prediction made in proposition 3. The coefficient on distance is positive in the position of the firm 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 coefficient on distance is positive and highly significant. The results also hold for each productivity quartile. Overall, there results strongly support the prediction made in proposition 3.

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 type of exporting 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 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 at 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 for proposition 2, suggests that the learning effect is relevant. If firms did not gain from the experience of exporting, then there would be no incentive for lower productivity firms to begin by exporting to smaller markets and progress to larger markets whereas higher productivity firms enter the same markets in the opposite order. The potential for such an effect to be driven by productivity improvements from exporting, an alternative explanation, is excluded as productivity is measured in the first year of operation for each firm. Furthermore, this mechanism explains part of the variation in export entry orders in the Swedish data, and could also explain part of the variation observed in French data by Eaton, Kortum, and Kramarz (2008) and in Irish data by Lawless (2009).

Entry into 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 included in Nguyen (2011), Eaton, Eslava, Krizan, Kugler, and Tybout (2011), and Albornoz, Calvo Pardo, Corcos, and Ornelas (2012), in which firms may enter some markets to test their exporting profitability before deciding whether to expand further, is a reasonable and intuitive treatment of exporting uncertainty. It would be possible to expand the model presented here to include such an uncertainty mechanism, though the predictions presented above would continue to hold. Furthermore, it is doubtful whether such an extension would

generate any predictions beyond those contained in the current paper and those cited above. Nevertheless, as both the learning mechanism presented here and the uncertainty mechanism are intuitive and have empirical support, a more comprehensive model of export market expansion would include both mechanisms. Similarly, the tendency for firms to enter markets similar to their existing export destinations identified in Morales, Sheu, and Zahler (2011) and Chaney (2011) reflects a correlation between entry costs for similar markets, which would also be a desirable feature for a more detailed model.

The results presented in this paper have potential implications for the design of policy. In particular, the potential for exporting experience in a small market to ease subsequent entry to larger markets suggests that trade facilitation may have a greater return if conducted in countries that are smaller and nearer to the home market, 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. By directly promoting exports to any given market, exports are indirectly promoted to other markets. When the market for which exports are promoted is small relative to the markets subsequently entered, the overall return may be higher for any given level of investment in export promotion.

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Appendix 1

Over each dimension k , competencies in θ^k that have previously been adapted for are distributed around the unit circle as independent, $U(0,1)$ random variables. The next value to be adapted for, η_i^k , is then drawn from a $U(0,1)$ random variable. The shortest distance from any given point on the circle to each component of θ^k is distributed as a $U(0,1/2)$ random variable. Therefore, the distance between η_i^k and each component of θ^k has the same distribution as the distance between zero and each component of θ^k . Where n markets have previously been entered, the cumulative distribution function of the distance from η_i^k to the nearest component of θ^k is:

$$\begin{aligned}
 G(z) &= \Pr\left(Z \leq \min\left(\{\theta_i^k, 1 - \theta_i^k\}_{i=1, \dots, n}\right)\right) \\
 &= 1 - \Pr\left(Z > \theta_1^k \cap Z < 1 - \theta_1^k\right) \cdot \dots \cdot \Pr\left(Z > \theta_n^k \cap Z < 1 - \theta_n^k\right) \\
 &= 1 - (1 - 2z) \cdot \dots \cdot (1 - 2z) \\
 &= 1 - (1 - 2z)^n
 \end{aligned}$$

The probability density function is therefore:

$$g(z) = 2n(1 - 2z)^{n-1}$$

Over the continuum of K dimensions of adaptation, the aggregate distance of adaptation is proportional to the expected value of Z :

$$\begin{aligned}
E(Z) &= \int_0^{1/2} zg(z)dz = \int_0^{1/2} 2nz(1-2z)^{n-1} dz = -z(1-2z)^n \Big|_0^{1/2} + \int_0^{1/2} (1-2z)^n dz \\
&= \left[-\frac{1}{2(n+1)}(1-2z)^{n+1} \right]_0^{1/2} = \frac{1}{2(n+1)}
\end{aligned}$$

Appendix 2

This appendix demonstrates formally the implications of the three necessary and sufficient conditions on the functional form of $f^X(s_i, n_t)$. To begin with, the net profit from market i within the strategy characterised by \mathbf{t} is separated from the strategy payoff (6):

$$\pi_i = \beta^{t_i} \left[\frac{1}{1-\beta} \phi_i a^{1-\sigma} s_i - f^X(s_i, n_t) \Big|_{t=t_i} \right] \quad (12)$$

Equation (12) is the net profit that the firm gains from market i . This should, however, be interpreted with caution, as the contribution that exporting to market i makes to aggregate net profit should also take account of the reductions in the fixed costs of entering further markets.

Condition 1

The first condition is that the fixed cost of entry function be increasing in market size and non-increasing per unit of market size, so that $f_s^X > 0$ and $f_s^X \leq f^X/s$. Dividing (12) by the market size s_i yields:

$$\frac{\pi_i}{s_i} = \beta^{t_i} \left[\frac{1}{1-\beta} \phi_i a^{1-\sigma} - \frac{f^X(s_i, n_t) \Big|_{t=t_i}}{s_i} \right] \quad (13)$$

While the partial derivative of (12) in terms of market size s_i is:

$$\frac{\partial \pi_i}{\partial s_i} = \beta^{t_i} \left[\frac{1}{1-\beta} \phi_i a^{1-\sigma} - \frac{df^X(s_i, n_t) \Big|_{t=t_i}}{ds_i} \right] \quad (14)$$

Combining (13) and (14) yields:

$$\frac{\partial \pi_i}{\partial s_i} - \frac{\pi_i}{s_i} = \beta^{t_i} \underbrace{\left[\frac{f^X(s_i, n_t) \Big|_{t=t_i}}{s_i} - \frac{df^X(s_i, n_t) \Big|_{t=t_i}}{ds_i} \right]}_{\geq 0} \quad (15)$$

The right hand side of (15) is nonnegative because of the condition that the fixed cost function exhibit nonnegative economies of scale, or $f_s^X \leq f^X/s$. It follows that whenever the net exporting profit π_i is positive, $\partial \pi_i / \partial s_i$ is positive (strictly provided a market of zero size would yield negative profit). Net exporting profit is therefore increasing in market size.

Condition 2

The second condition is that the fixed cost of entry function be decreasing in the number of markets entered, so that $f_n^X < 0$. The partial derivative of (12) in terms of the period of entry t_i is:

$$\frac{\partial \pi_i}{\partial t_i} = \underbrace{\ln(\beta)\pi_i}_{<0} - \beta^{t_i} \left[\underbrace{\frac{df^X(s_i, n_t)}{dn_t}}_{<0} \underbrace{\frac{dn_t}{dt_i}}_{\geq 0} \right] \quad (16)$$

The sign of $\ln(\beta)\pi_i$ is negative when market i is profitable, which reflects discounting when entry to the market is delayed. The expression inside the square brackets in (16) is weakly negative, as the fixed entry costs are strictly decreasing if associated with prior entry to more markets but constant if no other markets are entered. The trade-off between these two factors determines the net benefit of delaying entry. If the fixed entry cost were not reduced by experience, so $df^X(s_i, n_t)/dn_t = 0$, then the expression in the square brackets in (16) would be zero and the overall benefit of delaying entry, $\partial \pi_i / \partial t_i$, would be strictly negative for $\pi_i > 0$. Then it would never be optimal to delay entry and firms would simply enter all profitable export markets immediately.

Condition 3

The third condition is that the reductions in the fixed costs from experience be larger for larger markets, so that $f_{sn}^X < 0$. Consider two export markets i and j , for which $s_j > s_i$. Consider two strategies, a and b , which are identical except that the entry times to markets i and j are reversed, such that $t_j^a = t_i^b < t_i^a = t_j^b$. The difference in payoffs between these two strategies comes directly from (12):

$$\pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} a^{1-\sigma} \left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \left[\phi_j s_j - \phi_i s_i \right] - \underbrace{\left[\beta^{t_j^a} \left[f^X(s_j, n_{t_j^a}) - f^X(s_i, n_{t_j^a}) \right] - \beta^{t_i^a} \left[f^X(s_j, n_{t_i^a}) - f^X(s_i, n_{t_i^a}) \right] \right]}_{>0} \right] \quad (17)$$

If $f_{sn}^X = 0$, then (17) simplifies to:

$$\pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} \underbrace{a^{1-\sigma}}_{>0} \left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \left[\phi_j s_j - \phi_i s_i \right] \right] \quad (18)$$

The relative sizes of and distances to markets i and j are parameters, so the difference between $\phi_i s_i$ and $\phi_j s_j$ has the same sign for all firms. The sign of (18) is therefore identical for all firms, so all enter markets i and j in the same order. If $f_{sn}^X < 0$, then (17) can be signed as follows:

$$\pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} \underbrace{a^{1-\sigma}}_{>0} \left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \left[\phi_j s_j - \phi_i s_i \right] - \underbrace{\left[\beta^{t_j^a} \left[f^X(s_j, n_{t_j^a}) - f^X(s_i, n_{t_j^a}) \right] - \beta^{t_i^a} \left[f^X(s_j, n_{t_i^a}) - f^X(s_i, n_{t_i^a}) \right] \right]}_{>0} \right] \quad (19)$$

If $\phi_j s_j \leq \phi_i s_i$, then (19) is strictly negative and strategy b is trivially preferred by all firms, as entering the smaller market first implies lower overall fixed entry costs and higher overall exporting revenues. If $\phi_j s_j > \phi_i s_i$, then the sign of (19) depends on the parameters and firm productivity: for $a^{1-\sigma}$ above some threshold it is positive and vice versa. Therefore, firms enter the two markets in different orders depending on their productivity. However, this is only possible if the cross-derivative on the fixed cost function is negative, so $f_{sn}^X < 0$.

Appendix 3

Proof of proposition 1

As demonstrated in Figure 1, the aggressiveness level $A = \sum_{i=1}^m \beta^{t_i} \phi_i s_i$ of the optimal strategy is weakly increasing in firm productivity. Where all markets concerned are of positive size, are finitely costly to transport goods to, and are entered within finite time, the effect on A of entering market i earlier, so $t_i^1 < t_i^0$, is to increase A by $\left[\beta^{t_i^1} - \beta^{t_i^0} \right] \phi_i s_i > 0$. The same reasoning applies to all markets, so A is decreasing in the number of periods it takes to enter a given set of markets. As firm productivity levels are weakly increasing in the aggressiveness

levels of the strategies they adopt, the time taken to enter a given set of markets must be weakly decreasing in firm productivity.

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 orders but are otherwise identical in terms of the markets entered and the timing of entry. Strategy a involves entering the larger market first and strategy b involves entering the smaller market first, so $t_j^a = t_i^b < t_i^a = t_j^b$. The difference between the combined net profits from markets i and j under the two strategies is:

$$\pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} a^{1-\sigma} \left[\beta^{t_j^a} - \beta^{t_i^a} \right] [\phi_j s_j - \phi_i s_i] - \underbrace{\left[\beta^{t_j^b} [f^X(s_j, n_{t_j^b}) - f^X(s_i, n_{t_j^b})] - \beta^{t_i^b} [f^X(s_j, n_{t_i^b}) - f^X(s_i, n_{t_i^b})] \right]}_{\Omega > 0} \quad (20)$$

The term defining the difference between the fixed costs of entry in (20), denoted Ω , is strictly positive as $\beta^{t_j^a} > \beta^{t_i^a}$ and $[f^X(s_j, n_{t_j^a}) - f^X(s_i, n_{t_j^a})] \geq [f^X(s_j, n_{t_i^a}) - f^X(s_i, n_{t_i^a})]$. Now it is easiest to consider two cases separately. In the first case $\phi_j s_j \leq \phi_i s_i$, which makes it straightforward to sign (20):

$$\pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} a^{1-\sigma} \left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \underbrace{[\phi_j s_j - \phi_i s_i]}_{\leq 0} \right] - \underbrace{\Omega}_{>0} < 0 \quad (21)$$

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. Therefore, all firms enter these two markets in the same order: the smaller, nearer market i first then market j . In the second case $\phi_j s_j > \phi_i s_i$, so the components of (20) can be signed as:

$$\pi_{i,j}^a - \pi_{i,j}^b = \frac{1}{1-\beta} a^{1-\sigma} \left[\underbrace{\left[\beta^{t_j^a} - \beta^{t_i^a} \right]}_{>0} \underbrace{[\phi_j s_j - \phi_i s_i]}_{>0} \right] - \underbrace{\Omega}_{>0} \quad (22)$$

The sign of (22) depends on the parameters and on firm productivity. The multiplier on $a^{1-\sigma}$ in (22) is strictly positive, so if the parameters are such that 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 firms below the threshold.

Proof of proposition 3

Suppose that there is a monotonically increasing relationship between distance and the cost of transporting goods. The partial derivative of the net profit from market i (12) in terms of the transport cost parameter ϕ_i is:

$$\frac{\partial \pi_i}{\partial \phi_i} = \beta^{t_i} \left[\frac{1}{1-\beta} a^{1-\sigma} s_i \right] \quad (23)$$

The right hand side of (23) is strictly positive for any $a^{1-\sigma}$, reflecting that the net profit from an export market is strictly decreasing in the distance to that market. All else equal, due to discounting 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 4

The industry-by-industry productivity coefficients from the regressions run on equation (7) are displayed in Table 9. These are analogous to the results displayed in Table 3, but from separate regressions run on the firms from each individual industry.

Industry code	Industry	Productivity coefficient		
		First market	Second and later markets	All markets
		(Poisson)	(Poisson)	(Poisson)
20	Wood, cork, and cane products excluding furniture	-0.305* (-1.69) [203]	-0.591** (-2.53) [1,029]	-0.593*** (-3.38) [1,232]
21	Pulp and paper	-0.382 (-1.36) [59]	-0.645** (-2.30) [1,068]	-0.640*** (-2.76) [1,127]
22	Publishing, graphic and recorded media	-0.513** (-2.47) [221]	-0.419*** (-2.98) [985]	-0.472*** (-3.61) [1,206]
24	Chemicals and chemical products	-0.607** (-2.08) [111]	-0.476** (-1.99) [2,303]	-0.481** (-2.10) [2,414]
25	Rubber and plastic products	-1.052* (-1.83) [153]	-0.477** (-2.02) [2,166]	-0.537** (-2.34) [2,319]
26	Non-metallic mineral products	-0.465 (-1.06) [73]	-0.467 (-1.29) [566]	-0.511 (-1.49) [639]
27	Steel and metal production	-1.190*** (-2.79) [82]	-0.473* (-1.75) [1,217]	-0.542* (-1.92) [1,299]
28	Metal products excluding machinery and equipment	-0.687*** (-3.05) [478]	-0.821*** (-4.35) [2,716]	-0.887*** (-4.74) [3,194]
29	Machinery not included in other categories	-0.485*** (-2.86) [334]	-0.612*** (-6.80) [5,744]	-0.637*** (-7.16) [6,078]
31	Other electrical machinery and products	-0.040 (-0.18) [135]	-0.416*** (-2.62) [1,955]	-0.408** (-2.50) [2,090]
32	Telecommunications products	-0.010 (-0.07) [74]	-0.724*** (-4.23) [943]	-0.611*** (-4.22) [1,017]
33	Precision instruments, medical and optical instruments, clocks	-0.639*** (-3.99) [84]	-0.434*** (-2.86) [1,766]	-0.550*** (-3.80) [1,850]
34	Motor vehicles, trailers, semitrailers	-0.069 (-0.27) [79]	-0.247 (-1.26) [683]	-0.235 (-1.24) [762]
35	Other transport equipment	0.277 (1.36) [49]	-0.172 (-1.32) [431]	-0.142 (-1.13) [480]
36	Furniture, other manufacturing	-0.511* (-1.93) [116]	-0.318 (-1.36) [928]	-0.421* (-1.78) [1,044]
37	Recycling	0.032 (0.05) [43]	-0.779*** (-3.19) [188]	-0.648*** (-3.12) [231]
	All	-0.168*** (-2.68) [2,294]	-0.288*** (-7.46) [24,688]	-0.290*** (-7.72) [26,982]
	All with industry fixed effects	-0.381*** (-5.42) [2,294]	-0.471*** (-7.31) [24,688]	-0.501*** (-8.17) [26,982]

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

Table 9. Productivity coefficients for the delay before the commencement of exporting and between entry times to all consecutive pairs of markets, for firms in each manufacturing industry.

The productivity coefficients displayed in Table 9 are negative and significant for most industries, supporting the prediction made in proposition 1. The productivity coefficient for all industries is negative and strongly significant whether or not industry fixed effects are included in the regressions. However, the magnitude of the coefficient is only consistent with those for the individual industries if industry fixed effect are included. This is because of substantial differences between industries in the magnitudes of estimated productivity levels, meaning that it is appropriate to use industry fixed effects when comparing firms in different industries.

Appendix 5

This appendix contains robustness checks for the empirical tests of the propositions conducted above. To begin with, the fundamental criterion for the definition of a ‘new’ firm is that it not appear in the first year of the data. One potential problem is the possibility of some firms being temporarily inactive in 1997 and thus misclassified as being ‘new’. Another is the potential for selection bias resulting from the short period of time for which firms formed in the last years of the panel are observed. To check for these possibilities, Table 3 is reproduced using several alternative definitions of ‘new’ firms, with the results displayed in Table 10. The assumptions used are as follows: column 1 uses year of formation fixed effects; columns 2 through 7 vary the latest year of formation; column 8 uses the same assumptions as in Table 3; and columns 9 through 12 vary the earliest year of formation.

Delay before entry to	Productivity coefficients											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
First market	-0.349*** (-5.01)	-0.486*** (-4.89)	-0.470*** (-5.07)	-0.390*** (-4.50)	-0.374*** (-4.76)	-0.347*** (-4.81)	-0.351*** (-4.96)	-0.381*** (-5.42)	-0.355*** (-4.65)	-0.295*** (-4.12)	-0.237*** (-2.88)	-0.230*** (-2.62)
Second and later markets	-0.465*** (-7.31)	-0.552*** (-8.05)	-0.537*** (-8.14)	-0.430*** (-6.02)	-0.461*** (-6.68)	-0.463*** (-7.01)	-0.463*** (-7.18)	-0.471*** (-7.31)	-0.429*** (-6.96)	-0.397*** (-5.76)	-0.358*** (-5.12)	-0.415*** (-5.56)
All markets	-0.499*** (-8.12)	-0.593*** (-8.95)	-0.578*** (-9.21)	-0.469*** (-6.73)	-0.495*** (-7.46)	-0.493*** (-7.83)	-0.492*** (-8.01)	-0.501*** (-8.17)	-0.459*** (-8.00)	-0.416*** (-6.70)	-0.373*** (-5.72)	-0.413*** (-5.94)
Minimum YOF	1998	1998	1998	1998	1998	1998	1998	1998	1999	2000	2001	2002
Maximum YOF	2007	2001	2002	2003	2004	2005	2006	2007	2007	2007	2007	2007
YOF fixed effects?	Yes	No	No	No	No	No	No	No	No	No	No	No
Numbers of observations	2,294 24,688 26,982	1,263 16,674 17,937	1,494 18,790 20,284	1,715 20,389 22,104	1,922 22,404 24,326	2,069 23,301 25,370	2,191 23,971 26,162	2,294 24,688 26,982	1,955 20,559 22,514	1,607 16,152 17,759	1,307 11,988 13,295	1,031 8,014 9,045

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

Table 10. Reproduction of Table 3 with year of formation fixed effects and with the sample restricted to various minimum and maximum years of formation.

The results displayed in Table 10 support the results displayed in Table 3. The coefficients are consistently negative and significant, in line with the theory, for all specifications, and do not vary widely in magnitude. The only substantial difference is that when fewer years of formation are used, the smaller sample size reduces the power of the tests.

Table 11 gives 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 11 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 through 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 through 12 use value added per worker, OLS, and the Olley and Pakes (1996) method to estimate productivity.

Large EU market	Productivity coefficient											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Germany	-0.361** (-2.23) [784]	-0.222** (-2.33) [784]	-0.052** (-2.13) [784]	-0.391** (-2.39) [750]	-0.395* (-1.89) [646]	-0.834*** (-2.90) [369]	-0.417 (-1.63) [436]	-0.357** (-2.03) [475]	-0.727*** (-2.91) [322]	-0.160 (-1.25) [1,181]	0.037 (0.24) [1,155]	-1.318* (-1.82) [603]
France	-0.637** (-2.33) [583]	-0.369*** (-2.63) [583]	-0.112*** (-2.80) [583]	-0.482* (-1.95) [544]	-0.710** (-2.19) [435]	-0.815* (-1.77) [241]	-1.037*** (-2.96) [306]	-0.495*** (-2.79) [353]	-1.004*** (-3.34) [249]	-0.376** (-2.56) [868]	-0.264* (-1.66) [847]	-2.889*** (-3.39) [412]
United Kingdom	-0.430** (-2.32) [680]	-0.258** (-2.37) [680]	-0.072** (-2.32) [680]	-0.454** (-2.31) [645]	-0.262 (-1.22) [567]	-0.281 (-1.03) [321]	-0.387 (-1.22) [376]	-0.176 (-0.97) [420]	-0.389 (-1.40) [290]	-0.156 (-1.17) [1,031]	0.043 (0.27) [1,005]	-1.093 (-1.15) [531]
Italy	-0.653*** (-2.72) [512]	-0.395*** (-2.87) [512]	-0.126*** (-2.80) [516]	-0.704** (-2.28) [477]	-0.784* (-1.95) [406]	-0.343 (-0.92) [189]	-1.036*** (-2.69) [272]	-0.523** (-2.29) [319]	-1.110*** (-3.56) [228]	-0.366** (-2.48) [754]	-0.187 (-1.18) [742]	-1.603* (-1.82) [370]
Spain	-0.645** (-2.27) [516]	-0.379** (-2.56) [516]	-0.129*** (-2.65) [516]	-0.590** (-1.96) [471]	-0.645* (-1.93) [356]	-1.728*** (-3.52) [186]	-1.164*** (-2.94) [254]	-0.572*** (-3.09) [317]	-1.321*** (-3.55) [214]	-0.441*** (-2.85) [755]	-0.329** (-2.13) [738]	-2.941*** (-3.33) [363]
Netherlands	-0.495*** (-2.61) [603]	-0.297*** (-2.61) [603]	-0.089** (-2.50) [603]	-0.505*** (-2.58) [561]	-0.391* (-1.79) [458]	-0.845** (-2.11) [227]	-0.860*** (-2.61) [321]	-0.162 (-0.91) [375]	-0.445* (-1.84) [259]	-0.256** (-2.00) [915]	-0.105 (-0.71) [897]	-1.654** (-2.15) [464]
Belgium	-0.639*** (-2.73) [504]	-0.383*** (-2.76) [504]	-0.112*** (-2.67) [504]	-0.416* (-1.84) [464]	-0.710*** (-2.66) [349]	-1.127*** (-3.15) [180]	-0.735* (-1.80) [238]	-0.232 (-1.16) [308]	-0.668** (-2.33) [226]	-0.527*** (-3.45) [754]	-0.331* (-1.94) [748]	-3.147*** (-3.15) [365]
Poland	-0.168 (-0.91) [645]	-0.103 (-0.90) [645]	-0.037 (-0.91) [645]	-0.180 (-0.92) [558]	-0.191 (-0.87) [406]	-0.372 (-1.33) [195]	-0.055 (-0.18) [286]	-0.242 (-1.19) [404]	-0.263 (-0.96) [294]	-0.051 (-0.43) [944]	0.195 (1.38) [923]	-1.612** (-2.40) [474]
Austria	-0.207 (-1.01) [431]	-0.133 (-1.09) [431]	-0.045 (-1.01) [431]	-0.370 (-1.47) [383]	-0.439 (-1.38) [277]	-0.513 (-0.95) [119]	-0.596* (-1.77) [215]	-0.516** (-2.04) [265]	-0.745* (-1.86) [184]	-0.104 (-0.72) [652]	0.004 (0.03) [659]	-1.742** (-2.22) [313]
Greece	-0.385 (-1.12) [273]	-0.222 (-1.25) [273]	-0.082 (-1.21) [275]	-0.179 (-0.70) [247]	0.221 (0.77) [166]	-1.201 (-1.56) [66]	-0.558 (-1.01) [133]	-1.141** (-2.47) [167]	-1.157** (-2.51) [123]	-0.095 (-0.55) [399]	0.076 (0.42) [391]	-1.542* (-1.73) [194]
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	Olley-Pakes

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

Table 11. Reproduction of the first column of Table 6 using various alternative assumptions.

The results in Table 11 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 results that are qualitatively similar, so the results are not driven by any restriction implied by the use of the logistic model. Setting minimum amounts on exports has the benefit of removing potentially noisy small exports, but the only apparent effect is to reduce the power of the tests rather than to affect the magnitude 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 a reasonable restriction, as an ongoing exporting relationship may nevertheless not involve shipments each year.

The alternative productivity assumptions do not qualitatively change the results, besides reducing 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 results are qualitatively similar when using value added per worker, OLS, or Olley-Pakes estimates of productivity, suggesting that the results are not simply a product of idiosyncrasies of the Levinsohn-Petrin method of estimating productivity.

Appendix 6

Restricting our attention to two possible export markets, there are six possible strategies. These strategies are: (1) export to neither market; (2) export to the smaller market only; (3) export to the larger market only; (4) export first to the smaller market then enter the larger market; (5) export first to the larger market then enter the smaller market; or (6) begin exporting to both markets in the same period. According to the theory, these strategies are ordered from least to most aggressive (with the exception of strategies 3 and 4, for which the relationship is ambiguous). This appendix extends the empirical tests of proposition 2 to a comparison between each pair of these six strategies for one particular pair of export markets: Canada and the United States.

The approach used here is to test, using the logistic regression model described by equation (9), the choice of each strategy against each of the lower-numbered (generally less aggressive) alternatives. In each case, the sample is limited to those firms that adopt one of the two strategies in question. The results of these regressions are displayed in Table 12. Here the choice being tested for is of a more aggressive strategy over a less aggressive strategy, so positive productivity coefficients are consistent with the theory (with the exception of the choice between strategies 3 and 4, for which the theory does not provide a definite prediction).

Alternative strategy	Productivity coefficient for choice of:				
	Strategy 2	Strategy 3	Strategy 4	Strategy 5	Strategy 6
Strategy 1	0.456 (0.80) [2,251]	0.272* (1.84) [2,886]	0.097 (0.23) [2,309]	1.403*** (4.87) [2,429]	1.870*** (6.48) [2,503]
Strategy 2		-0.120 (-0.41) [565]	-0.468 (-0.77) [73]	0.813* (1.94) [192]	0.990*** (2.64) [260]
Strategy 3			-0.064 (-0.31) [591]	0.662*** (3.49) [711]	0.897*** (3.96) [785]
Strategy 4				1.123*** (2.87) [196]	1.217*** (3.44) [270]
Strategy 5					0.380 (1.58) [390]

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

Table 12. Productivity coefficients for the choices between pairs of potential strategies.

Most of the productivity coefficients in Table 12 are positive and none are negative, supporting the ordering of strategies implied by the theory. One insignificant productivity coefficient relates to the choice between strategies 3 and 4, which is ambiguous in the model, and two have relatively small sample sizes. In general, the more aggressive strategies are employed by significantly more productive firms. This relationship is also apparent from the productivity distributions of the firms that employ each of the six strategies. The cumulative density functions of firms that employ each of the six strategies are plotted in Figure 6, with average productivity levels weighted to correct for inter-industry differences in productivity.

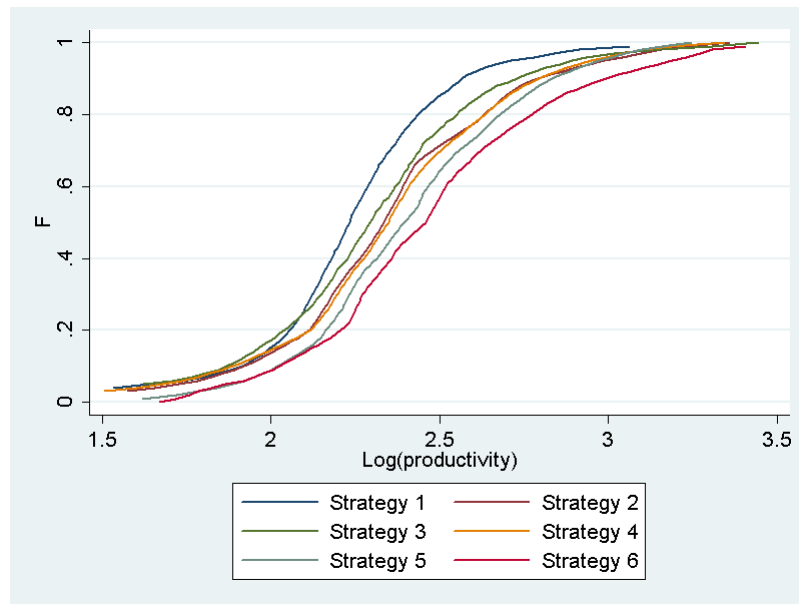


Figure 6. Cumulative density functions of firm productivity levels for the six potential strategies.

From Figure 6 it is possible to observe that, for most pairs of strategies, firms that adopt the more aggressive strategy are generally more productive. However, what is striking in Figure 6 is that this relationship holds for a wide range of productivity quantiles. On the other hand, there is clearly no strict sorting of firms into strategies by productivity level, as all of the distributions overlap.