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How to Combine High Sunk Costs of Exporting and Low Export Survival

AgriFood economics centre

How to combine high sunk costs of exporting and low export survival?*

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Abstract

In endeavouring to explain the empirical puzzle that the sunk costs of exporting are important, but that, at the same time, trade flows do not, on average, survive for very long, this paper explores the concepts of core and peripheral markets. First, it illustrates that if the importance of sunk costs as well as the expected future returns from exporting are different, depending on whether the export decision refers to a core or a peripheral market, it is plausible that while firms will tend to stay on the core market for a long time, they will enter and exit the peripheral market much more frequently. Second, using firm-product-destination-specific export data for all firms in the Swedish food chain for the period 1997-2007, an empirical test is carried out to ascertain whether there is support for the hypothesis that trade duration will be longer for core markets. Employing two variables that capture different aspects of the core/periphery dimension, it is found that firms will indeed tend to stay longer in their core markets, while export decisions regarding peripheral markets are much less long-term. The conclusion, therefore, is that the empirical puzzle can be explained by taking into account the fact that the trade hysteresis literature builds on data on the core market decision to export or not, and that the trade survival literature also includes data on decisions to stay in or exit peripheral markets.

JEL classification: F10; F14
Keywords: Sunk Costs; Trade Duration; Survival; Core v. Peripheral Markets; Sweden; Firm-Level Data; Discrete-Time Hazard Models

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1 Introduction

It has been empirically established for some time now that sunk costs of exporting are important. Typically, empirical papers in the sunk cost literature assess the importance of sunk costs indirectly, by studying if past export performance is important in determining current export decisions. For instance, Roberts and Tybout (1997) use data on exports for Colombian manufacturing plants, and find that plants that exported in the preceding year are 60 per cent more likely to export this year. In another seminal paper, Bernard and Jensen (2004) find that past export experience increases the probability of exporting by about 30 per cent for American manufacturing plants. Gullstrand (2011) confirms the importance of sunk costs by using a data set of Swedish firm-destination specific exports in the food and beverage sector. The general conclusion from these and other papers in the sunk cost literature is therefore that sunk costs matter in international trade. A direct implication of this is that we expect to see export hysteresis, i.e. once a firm has decided to export, it will tend to remain an exporter.

While the sunk cost literature suggests that firms will tend to continue exporting once they have begun, there is simultaneously another strand of literature which suggests that international trade is very short-lived. Over the last few years, a literature, focusing on the duration of trade flows, has emerged. Using both country- and firm-level data, it has found clear evidence that trade flows on average have very low survival rates. For instance, Hess and Persson (2011), using bilateral country-product-level imports for EU countries, suggest a median duration of merely one year. Other papers, employing country data and similarly finding short durations include Besedeš and Prusa (2006a, 2006b, 2011), Besedeš (2008, 2011), Nitsch (2009), Fugazza and Molina (2009) and Brenton et al. (2010).[1] Recently, yet another strand of literature, applying duration analysis to firm-level trade data, has also started to emerge. In general, this literature has confirmed the finding from the country-level literature that trade is very short-lived. For instance, using data on Peruvian exports, Volpe-Martincus and Carballo (2008) find a median duration of exports of merely one year. In other words, the typical scenario for Peruvian firms that begin to export is to exit the market within the first year. Other papers confirm similar findings of very short export duration for a range of samples. Examples are Sabuhoro *et al* (2006), Görg, Kneller and Muraközy (2007), Freund and Pierola (2010), Ilmakunnas and Nurmi (2010), Cadot *et al* (2011), Creusen and Lejour (2011), Jaud and Kukenova (2011), Tovar and Martínez (2011), Békés and Muraközy (2012) and Esteve-Pérez *et al*. (2012).

[1] For a detailed overview of these studies, see Hess and Persson (2011). Hess and Persson (2012) offer a discussion and analysis of the methodology used in the literature.

Thus, while the sunk cost literature finds strong evidence that sunk costs of exporting are important and that export flows should therefore tend to be long-lasting once they start, the literature on trade duration provides equally strong evidence that trade is in fact typically very short-lived. The goal of this paper is to offer an explanation why both strands of literature may be correct; it does so by outlining a theoretical framework which can predict the results in both strands of the literature, and then by putting this to the test with empirical data.

So, briefly, how can we reconcile these apparently conflicting empirical facts? We argue that a key to explaining how sunk costs of exporting can be important, at the same time as trade overall exhibits low survival rates, is to distinguish between core and peripheral markets, where core markets are defined by firms' most important export products and destinations. We offer a theoretical framework where the importance of sunk costs of exporting as well as expected future returns from exporting are lower in peripheral markets, implying that firms will more easily exit these markets after an entry. At the same time, the importance of sunk costs and future returns still matter a lot in core markets, suggesting that once exporting has begun, it will last a longer time in those markets. Noting that the trade hysteresis literature builds on data on the firm's decision to export or not, which of course will correspond to a core market decision, it is therefore reasonable that these export decisions will be long-lasting. By contrast, the trade survival literature also includes data on decisions to stay in or exit peripheral markets, and therefore the average trade survival should be shorter if only core market exports are considered.

To see whether this theoretical explanation holds when put to the test with empirical data, we estimate a discrete-time duration model on a sample of Swedish firm-product-destination-specific export data for the period 1997-2007. The concept of core and peripheral markets is incorporated into the model, which also contains a rich set of firm-, product- and destination-specific variables. Using this framework, we test whether it is indeed the case that export flows relating to the firm's most important products or destinations survive for a longer period than export flows relating to peripheral markets. To offer a brief preview of the results, we do indeed find evidence supporting this hypothesis.

The rest of the paper is organized as follows. We begin by discussing a theoretical framework for explaining the duration of export decisions, and also outline why the strands of literature on sunk costs and trade durations do not actually study export decisions at the same level. In Section 3, we describe the empirical strategy and present the data. Section 4 offers the empirical results, and Section 5 summarizes and concludes the paper.

2 Theoretical Framework

In order to shed some light on the question of why there is a discrepancy between the literature on sunk costs of exporting and the literature on export duration, we will now discuss a theoretical framework. We start by describing the firm's decision on whether or not to export, and then narrow the focus and discuss the firm's decision to export in any given product-destination combination.

2.1 Export decision at the firm level

In the last decade, the fast growing literature on firm export behaviour has combined two real world characteristics, firm heterogeneity and sunk costs of exporting, in order to more fully explain the observed trade pattern that exporting is a rare and persistent activity, and that it is correlated with good performance. The most frequently used theoretical framework to explain this pattern is the seminal work of Melitz (2003), who presents a static-industry equilibrium model where firms select into exporting after they have discovered their ability to overcome a sunk cost of exporting.

However, in order to capture the export decision of a firm as a dynamic process of entering, proceeding and exiting the export market, we will use Roberts and Tybout (1997) as our point of departure.[2] In other words, our model is rooted in the literature on *entry and exit decisions under uncertainty* (Dixit, 1989a, 1989b, 1992; Sutton, 1991), where both entry and exit costs create hysteresis. The uncertainty in these types of models creates an option value, implying that firms may incur short-run losses by continuing an unfavourable activity (such as exporting) if there is a possibility – given the information available to the firm today – that the activity will become favourable in the future (Dixit, 1989a).

Following Roberts and Tybout (1997), our starting point is that each firm compares its gross profit from exporting and not exporting each year, conditioned on exogenous market (p_t) and firm characteristics (s_{it}). In addition, firms adjust their gross profits for sunk costs of entry or exit, which leads to the following export profit function conditioned on the firm's export history (using the same notation as in Roberts and Tybout, 1997):

$$R_{it}(\mathbf{Y}_{it}^{(-)}) = Y_{it}[\pi_{it}(p_t, s_{it}) - F_i^0(1 - Y_{i,t-1}) - \sum_{j=2}^{J}(F_i^j - F_i^0)\tilde{Y}_{i,t-j}] - X_i Y_{i,t-1}(1 - Y_{it}), \qquad (1)$$

[2] Note that Ilmakunnas and Nurmi (2010) have applied this approach in order to investigate export market entry and exit.

where $R_{it}(.)$ is the gross profit depending on whether firm *i* exports (Y_{it} = 1) or not (Y_{it} = 0) in period *t*, $\mathbf{Y}^{(-)}$ is the firm's historical export decisions, π_{it} is the profit from exporting, F_i^0 is a sunk-entry cost, F_i^j is the re-entry cost (assumed to be lower than the entry cost), $\tilde{Y}_{i,t-j}$ summarises the firm's export experience, and X_i is the exit cost.[3] The sunk costs of entry may be costs related to adjustments due to a different product standard on the export market, setting up a distribution network and/or marketing. Exit costs are related to costs due to contractual obligations towards buyers as well as retailers, or lay-offs on the export market (as long as the firm owns a unit on that market) or in the domestic production unit (e.g. due to over capacity as sales fall).

The next step is that the firm is assumed to maximise the present value of its future profits at time *t* with the help of an infinitive sequence of export decisions ($\mathbf{Y}^{(+)}$=$\{Y_{i,t+j}|j>0\}$), which implies that the firm's manager maximises the following payoff:

$$V_{it}(\Omega_{it}) = \max_{Y_{it}^{(+)}} E(\sum_{j=t}^{\infty} \delta^{j-t} R_{ij} \mid \Omega_{it}), \tag{2}$$

where Ω_{it} is a firm-specific information set and δ is the discount rate. The last step used by Roberts and Tybout (1997) is to solve this maximization problem with Bellman's equation and from that infer that firm *i* will be in the export market in *t* if:

$$\begin{aligned} &\pi_{it}(p_t, s_{it}) + \delta[E_t(V_{i,t+1} \mid Y_{it} = 1) - E_t(V_{i,t+1} \mid Y_{it} = 0)] \geq \\ &F_i^0 - (F_i^0 + X_{it})Y_{i,t-1} + \sum_{j=2}^{J} (F_i^0 + F_i^j)\tilde{Y}_{i,j-1}, \end{aligned} \tag{3}$$

which implies that firm *i* exports as long as the profit from exporting today, plus the expected future pay-off of exporting today is greater than the cost of entering (as long as the firm did not export in *t-1*) or the costs of exiting (as long as the firm did export in *t-1*). Since the duration literature is concerned with the exit decision, we will focus on that. In other words, the sunk entry costs have already been covered. This leaves us with the following exit decision:

$$\pi_{it}(p_t, s_{it}) + \delta[E_t(V_{i,t+1} \mid Y_{it} = 1) - E_t(V_{i,t+1} \mid Y_{it} = 0)] < -X_{it}, \tag{4}$$

[3] Note that $\tilde{Y}_{i,t-j} = (Y_{i,t-j} \prod_{k}^{j-1} (1 - Y_{i,t-k}))$ takes the value one if the firm exported j years ago and zero otherwise.

which indicates that the firm continues with its export activity as long as the expected profit is larger than the exit cost. Hence the exit decision is influenced by the magnitude of the exit costs as well as the market, firm and product characteristics (**p** and **s**) through the extra income (π) and the expected future values (V) from continuing exporting compared to exit today.

2.2 Export decision at the firm-product-destination level

The theory outlined so far fits nicely with the empirical literature on measuring the importance of sunk costs of exporting and export hysteresis, since that literature focuses on the firm's decision to export or not (see Roberts and Tybout, 1997; Bernard and Jensen, 2004) or, in some cases (see e.g. Gullstrand 2011), the firm's decision to export to a particular destination or not. However, by contrast, the export survival literature focuses on the question of whether or not a firm (or country) will continue exporting a particular product to a particular destination. We therefore expand our theoretical framework to take this dimension into account.

As in Bernard et al (2010), we assume that a firm maximises its profit for each product-destination separately and define firm *i*'s gross profit as $\pi_{ipmt,} = (\mathbf{p}_{mt}, \mathbf{s}_{ipmt})$, where *m* is the export destination and *p* the product exported. This leads us to the following export exit decision:

$$\pi^{*}_{ipmt} = \pi_{ipmt}(p_{mt}, s_{ipmt}) + \delta[E_t(V_{ipm,t+1} \mid Y_{ipmt} = 1) - E_t(V_{ipm,t+1} \mid Y_{ipmt} = 0)] < -X_{ipmt}, \qquad (5)$$

which differs from equation (4) just by the subscripts indicating that the decision is taken at a firm-product-destination level and not at the firm level.

What are the implications of studying export decisions at this much more disaggregated level? We contend that it makes it possible to highlight that sunk costs and expected future returns from exporting are not equally important in all export decisions. More specifically, we maintain that sunk costs and expected future returns matter a lot for export decisions relating to the firm's core – i.e. the most important export decisions and/or products – but are less important for export decisions relating to peripheral export flows. In the following, we will discuss how sunk costs of exporting arise and what determines expected future returns from exporting, and then outline why these factors are more important for export decisions relating to core markets.

Sunk costs

The fundamental driver behind export hysteresis in models with uncertainty about the future is that exporting is related to sunk costs. The sunk costs – which can be specific to the firm,

destination or product or any combination of these three dimensions – can arise in several ways. Examples of irreversible costs firms can face when they export include investments in marketing and advertising, wholesale and retail distribution on the foreign markets, and costs related to exit or temporary shutdowns due to lay-offs or contractual obligations. Are these costs equally important for all product-destination combinations? We argue that they are not.

Starting with the costs of marketing and advertising, these costs are often assumed to be positively related to the size of the market of the firm (see Arkolakis, 2010). Firms are assumed to face increasing marginal costs of marketing when they reach out to a greater number of consumers (given the size of the total market), which implies that the return from exporting is greater for smaller trade volumes. [4] Hence, the importance of sunk costs is lower for less important export decisions. In addition, firms' sunk costs of marketing are to a large extent related to the firm level rather than a specific product or destination, since some of the overhead resources devoted to marketing may be used by all products and at all destinations penetrated by the firm. This possibility is considered in Arkolakis and Muendler (2011), who introduce economies of scope in entry costs. In this line of thinking, a firm may face lower entry costs for a new product into a particular market if it already exports other products to this destination (or exports the same product to other destinations). So, one implication of considering the firm's export decisions, not at the overall firm level but rather for each individual product-destination combination, is that we may expect the importance of sunk costs of exporting to increase with the importance of the export flow.

Similar relationships may be found for the other sunk costs of exporting. The increased power of retailers (see Dobson *et al*, 1999) implies, for example, that manufacturers and retailers bargain over exclusivity arrangements, and this is related to irreversible legal costs. Such agreements may also lead to exit costs if they include an obligation regarding the quantity of goods to be sold and therefore, by extension, some type of break-up fee if the exporting firm leaves a particular market. In addition, the increased market power of retailers also suggests, as indicated by Dobson *et al* (1999), that retailers charge manufacturing firms for accessing prime shelf-space (i.e. slotting allowances) as well as for local advertising (market development funds). Finally, temporary or exit costs due to lay-offs may also affect the firm since a substantial drop in export sales may result in the firm facing idle capacity, and it may therefore have to downsize. All these costs are also related to the importance of the export flow, since more peripheral ones may take advantage of the arrangements already in place in the top export markets, as well as low exit

[4] See also Sutton (1991), who discusses sunk costs of advertising as well as the importance of advertising for food and beverage.

costs due to a negligible role in the firm's total production, or for downstream distributers. Small peripheral export flows may also work as test balloons initiated by the exporting or importing firm before any agreement or advertising is in place.

Expected returns from continuing exporting

The export decision is also affected by the expected returns from continuing exporting, which becomes important as soon as we believe that firms are influenced by "brand loyalty" or consumer inertia (see Fishman and Rob, 2003). In a situation where consumers face a search cost in order to learn the price of a new seller or product, they will tend to favour the one they have bought before. Thus, firms that stay on a particular market tend to keep their consumer base and, in turn, a bigger stock of consumers tends to increase the returns from new products or innovations (Fishman and Rob, 2003). Leaving a particular market therefore implies that loyal consumers have to find other suppliers, and that a firm has to start over with a small consumer base if it would like to re-enter in the future. In other words, a big stock of loyal consumers means that the expected future returns, from supplying a destination with a product by continuing exporting, increase compared to exiting today and re-entering in the future (given that there are sunk cost of re-entry).

Difference between core and periphery matters for persistency of export decisions

A main conclusion from the discussion above is that sunk costs of exporting and expected returns from continuing exporting will be more important for a firm's core markets than for more peripheral markets. Keeping in mind that the aim is to draw conclusions about how long firms will tend to stay in the export market, how is this export survival affected by the distinction between core and periphery? If, as we have argued, the importance of sunk costs (i.e. exit and re-entry costs) is expected to be lower on peripheral markets (again defined as the firm's least important export destination and/or product), then the export decision in equation (5) collapses into $\pi_{impt}(.) > 0$ for an extremely peripheral market. In other words, for very peripheral markets, history does not matter (see Roberts and Tybout, 1997). A firm will therefore enter such a market if a temporary opportunity for profit arises, but can leave quickly again if its exports cease to be profitable. If we instead consider the core market (i.e. the most important trade flow), the importance of sunk costs of exporting and consumer loyalty in equation (5) persists. Therefore, it follows that once the decision has been taken to enter a core export market, the firm can be expected to remain there for a longer time.

To summarize our theoretical discussion; by studying a firm's export decision for each individual product-destination combination separately, we can illustrate that export flows to core markets can be expected to survive for a longer period than export flows to peripheral markets. By contrast, if we instead focus on the overall decision by the firm to continue exporting at all, then all decisions will by definition refer to core markets, and one would therefore expect that exporting activities will last for a long time once they have started.

3 Empirical Analysis

Having derived hypotheses about how export flows to core markets can be expected to survive for a longer time period than export flows to peripheral markets, the goal is now to test these theoretical predictions.

3.1 Empirical strategy

As in most empirical studies of firms' export decisions (see e.g. Roberts and Tybout, 1997; Bernard and Jensen, 2004), we make use of a reduced form of the export decision instead of developing a structural model with a specific profit function and a specific process generating the underlying variables.[5] Since the aim is to capture the relationship between the duration of a firm-product-destination export decision and the characteristics of the product, the firm and the destination, we follow the literature on trade duration and estimate a duration model. Interestingly, it has been common to use continuous-time duration models in the trade duration literature, and in particular the Cox proportional hazards model, to estimate determinants of the hazard of trade flows dying. As outlined theoretically and shown empirically by Hess and Persson (2012), this is not appropriate.[6] They therefore recommend the use of discrete-time duration models, such as logit or probit models, with proper controls for unobserved heterogeneity.[7] We follow their advice, and focus on a random effects logit model, using a random effects probit

[5] See Das et al (2007) for an exception when it comes to a structural model in order to model the export decision.

[6] Noting that observations on trade duration are typically discrete (since they are grouped into yearly intervals), Hess and Persson (2012) outline three major problem with the popular Cox model when applied to the typically very large trade data sets. First, when there are many so-called ties, i.e. observations with the same spell length, the Cox model can lead to biased coefficients and standard errors. Due to the fact that we usually only observe trade values once a year, or possibly once a month, this is a serious problem when dealing with trade durations. Second, it is difficult to control properly for unobserved heterogeneity, even though not doing so can bring about spurious duration dependence. Third, the Cox model makes a restrictive assumption about proportional hazards, which is unlikely to hold empirically.

[7] The papers that do not use the Cox model tend to use a discrete-time complementary log log (cloglog) model instead. Hess and Persson (2012) note that this is not a good solution, because the cloglog model makes the same questionable assumption of proportional hazards.

model as a robustness test. Hence the probability of a trade spell being completed by $t+1$ (conditional on the spell having continued until t), i.e. the hazard $h_{ipm}(t)$, becomes:

$$P(T_{ipm} < t+1 \mid T_{ipm} \geq t) = \Lambda(\beta Z_{ipmt} + \gamma_s + \nu_{ipm}) = h_{ipm}(t), \quad (6)$$

where Z_{ipmt} is a vector consisting of firm, product and/or market characteristics as well as calendar time indicators, γ_s is the baseline hazard (specified as spell dummies) indicating the likelihood of exiting after the firm-product-destination export flow has survived for s periods, and ν_{ipm} is unobserved heterogeneity modelled as a random effect. Hence, we investigate how the expected profit from exporting a particular product to a given market varies with exogenous firm-product-destination-time characteristics, which in turn decides whether the firm will continue exporting or not.

3.2 Data

To test the theoretical predictions, we use data from Statistics Sweden on export activities for firms in the Swedish food chain for the period 1997-2007. The export data is firm-product-destination-specific at the 8-digit level.[8] In addition to export information, we have detailed information about *inter alia* employment, sales, ownership, capital, costs of raw material, wages and location in Sweden. While we do have information about exports of all firms for the whole period, some other firm-specific data are only available from 2003, which implies that our regression sample consists of 5 years (2003-2007), while our export duration information covers 11 years (1997-2007). Table A1 in the Appendix presents some descriptive figures for our sample, which consists of all firms (regardless of size) from all parts of the food chain (from farms and food producers to wholesalers and retailers).

The food chain is an interesting case study since it is an important part of the Swedish economy. It employs around 6 per cent of all employees in Sweden, and food processing ranks as the third largest manufacturing industry. When it comes to export performance, the food chain resembles the behaviour of firms in other sectors and countries. That is, few exporters and a skewed export pattern (see Gullstrand, 2011). The share of exporters in all parts of the food chain was around 15 per cent in 2003. The exception to this pattern was the upstream agricultural sector where only around one per cent exported. While noting that it would be interesting to repeat the

[8] The product codes of the Combined Nomenclature have been used and we employ keys between years to make all codes consistent over time.

analysis for other data sets, we do believe that the firms in our sample are representative of Swedish firms overall, and that the conclusions we draw therefore apply more generally.

The variable we focus on is the duration of export flows defined by the number of consecutive years a firm exports a specific product (at the 8-digit level) to a specific destination. One such observation of uninterrupted exports is referred to as an export spell. Since there is no way of knowing the true duration of trade flows already in place in 1997 when our trade data begin, we only include trade flows that started in 1998 or later. In other words, we disregard left-censored spells. Note, however, that firms may enter and exit the export market for a particular product-destination combination, only to then re-enter again later, so multiple spells are allowed for a given firm-product-destination combination.[9]

Table 1. The distribution of spell length for different aggregation levels

	8-digit level		6-digit level		4-digit level	
Spell length	No. of spells	Share of spells (%)	No. of spells	Share of spells (%)	No. of spells	Share of spells (%)
1	69415	68.8	57665	68.8	42476	67.8
2	15733	15.6	12976	15.5	9846	15.7
3	6336	6.3	5271	6.3	4093	6.5
4	3726	3.7	1801	3.5	2283	3.6
5	2135	2.1	1242	1.5	1301	2.1
Total	100847		83782		62588	

Source: Own calculations.

As illustrated in Table 1, Swedish firm-level export flows from the food chain are, in general, very short-lived. The vast majority of all spells – almost 69 per cent – last at most one year, and only around 15 per cent of all new export flows survive for more than 2 years. In other words, our data confirms the findings in other papers using firm-level trade data. Interestingly, if we increase the level of aggregation so that we consider products defined at the 6-digit or even 4-digit levels,

[9] Since it could be argued that such multiple spells are not independent, we include dummy variables in the regression model to capture whether the firm has exported the same product to the same destination once, twice or three times before.

the same pattern remains: almost all spells are very short-lived. This finding, which corresponds to similar findings using country-level data in, for instance, Hess and Persson (2011), suggests that the observed short durations are not some data artefact but indeed capture a relevant economic phenomenon.

While nothing much happens to the duration of the observed export spells when we alter the level of product aggregation, the initial value of export flows does seem to be strongly associated with the duration of the export spells, which is in accordance with previous findings in the literature (see for instance Besedeš and Prusa, 2006b and Besedeš, 2008). As illustrated in Table 2, when we divide trade flows into four categories based on the initial value of exports, spell lengths tend to be longer for larger trade flows. Specifically, while 79 per cent of trade flows starting with a value of less than 3000 SEK (corresponding to the 1st quintile) survive at most one year, the corresponding number for the trade flows that begin with values greater than around 100,000 SEK is less than 50 per cent. So, based on these descriptive measures, the larger the initial export value, the longer the duration. This is a good sign, because large export flows will define the firm's core markets.

Table 2. The distribution of spell length for different export-value quintiles

	1st quintile, upper limit 3' SEK	2nd quintile, upper limit 17' SEK	3rd quintile, upper limit 101' SEK	4th quintile
Spell length	Share of spells (%)	Share of spells (%)	Share of spells (%)	Share of spells (%)
1	79.0	72.7	64.3	48.9
2	12.9	14.6	17.0	20.6
3	3.9	5.7	7.6	10.1
4	1.7	3.0	4.7	7.2
5	1.1	1.6	2.3	4.6

Source: Own calculations.

Lastly, Table 3 contains some firm characteristics by spell period in order to show differences between the first year of exporting a product compared to the last year, and whether firm-product exports lasting for only one year differ from the more prolonged export flows. The average characteristics of firms exporting for the first year seem to be in line with those of firms in their final year of exporting. Firms entering and exiting the same year are, however, a bit different. On average, they are smaller when it comes to the number of employees, but at the same time high-

performers since they are more productive. They are also more international since they export a larger share of their sales (on average 39 per cent), although they do not reach out to more markets or export a greater number of products. This is an indication that short-lived export flows are linked to other export decisions. In addition, we find that 95 per cent of the firms, with an export duration of only one year, exported to another destination as well (either the same product or another one).

Table 3. Summary statistics of firm characteristics by spell period

Spell category	No of employees	TFP	Export intensity	No of destinations	No of products
First year	521	1.62	0.29	16	76
First & last year	364	1.84	0.39	15	59
Last year	455	1.57	0.28	17	81

Source: Own calculations.

3.3 Explanatory variables

When applying equation (6) to our data on Swedish firm exports, we incorporate a large set of covariates. We begin by focusing on the variables of main interest, namely those capturing various aspects of the core/periphery dimension. Thereafter, we present other firm and product characteristics as well as market characteristics, which are added to the model as control variables. See Table A1 in the Appendix for definitions and descriptive figures of the variables used.

Capturing the core and periphery

As argued in the theoretical framework, sunk costs of exporting and expected returns from continuing exporting should be more important for a firm's core markets than for more peripheral markets. From this, it follows that export flows to core markets can be expected to survive for a longer period than export flows to peripheral markets. To test whether this hypothesis holds empirically, we incorporate variables designed to capture the concepts of core and periphery. First, we include the inverted ratio of the product's total exports to the total exports of all products (i.e. the inverse of how large a share of the firm's total exports the given product represents). The interpretation of this variable is that it captures the *relative unimportance of the product* in the firm's total trade, so the larger the variable, the more peripheral the product in the total exports sale of the firm. Since, all else equal, peripheral products are expected to survive for

a shorter time, we expect a positive sign in the regression results (i.e. a positive effect on the hazard).

Second, we also include the inverted ratio of the destination's total exports to the total exports to all destinations (i.e. the inverse of how large a share of the firm's total exports the given destination represents). Constructed in a similar way to the product variable just discussed, this variable should be interpreted as the *relative unimportance of the destination* in the firm's total trade, so the larger the variable, the more peripheral the specific destination for the firm. Again, we expect a positive sign in the regression results, because peripheral destinations should experience a higher hazard of the export flow dying.

The two variables presented above are at the focus of our empirical investigation, because they correspond very closely to the theoretical concepts of core and periphery discussed in the theoretical framework. However, one could argue that there is intuitively also a geographical dimension to the core/periphery distinction. In order to capture this in an alternative specification, we replace the relative unimportance of the destination with the *relative distance to the core market*, defined as the distance to the destination relative to the trade-weighted distance of all export flows. While capturing another aspect of the core/periphery dimension, the variable is still expected to have a positive sign, because the larger the variable, the more peripheral the market in terms of both sales and geography, and, therefore, the higher the hazard of a given export flow dying.

Firm and product characteristics

In addition to the variables capturing whether the particular export flow relates to a core or a peripheral market, we also include a large set of control variables. The most important variable when it comes to the firm's ability to export is the *productivity* level of the firm, which we measure with the help of a multilateral productivity index as in Aw et al (2003). The significance of productivity in firms' export decisions is underscored theoretically in Melitz (2003) and Bernard et al (2003) and empirically in Wagner (2007). In this setting, productivity differences capture differences in export revenues since highly productive firms can expect larger revenues. In addition to productivity, we include *firm size* measured as the number of employees, since larger firms may reflect a greater number of loyal consumers as discussed in Fishman and Rob (2003). Further, the empirical literature has shown that the size of the firm is important when it comes to exporting (see e.g. Bernard and Jensen, 2004).

Another firm-level dimension that may matter for the survival of export flows is related to ownership. We therefore use dummy variables to control for whether the *firm itself owns at*

least one foreign firm, or it is *owned by a foreign firm*. Multinational corporations are often found to be different to other firms; for instance, they are generally thought to be more productive in ways that are not necessarily captured by the productivity term. We therefore expect the variables connected to foreign ownership to have negative coefficients.

The size of the firm is not the only variable capturing variations in brand loyalty, and this loyalty should also be influenced by the *time* that the firm has spent exporting a product to a particular market. In addition, this time should also reflect the firm's experience in exporting the product to that market. Both these aspects are expected to have a positive effect on the decision to stay in the export market. Therefore, it is reasonable to interpret the spell dummies (i.e. the baseline hazard) as a wider and wider gap between the expected future pay-offs from continuing exporting compared to exiting the market, since firms add up product-destination experience as well as new customers as they prolong their product-market participation. In addition to spell dummies in order to capture experience and increased brand loyalty, we incorporate the *sequence of exporting* a product to a particular market by adding dummies for whether the current trade spell is the second, third or even fourth time that the same firm exports the same product to the same market. Just as earlier export experiences tend to increase the probability of entering a product-destination (see Roberts and Tybout, 1997; Bernard and Jensen, 2004; Gullstrand, 2011), earlier product-destination experiences may prolong the duration of an export activity.

When it comes to product-specific characteristics, we use product indicators in order to control for different *types of goods*. We use 16 binary product variables based on the BEC-classification codes, which implies that exporting products are classified as various types of consumer goods, intermediate goods and capital goods.[10] We also incorporate dummies capturing which *industry* the firm belongs to at the 3-digit level, as well as the *location* of the majority of the firm's workforce. The importance of incorporating the locality of the firm when it comes to firms' export decisions is reflected in the literature on export externalities (see Greenaway and Kneller, 2007), which shows that firms in localities with a larger number of exporters are more likely to export.

Market characteristics

The survival of export flows is also influenced by market variables (see e.g. Besedeš and Prusa, 2011, Hess and Persson 2011), since changed market variables reflect changes in the expected pay-offs of export activity. We include the *GDP* of each export destination since it will influence

[10] As presented below, our data sample relates to exports from Swedish firms in the food chain. While it may seem counterintuitive for food chain firms to export capital goods, some firms have many plants that cover many different types of industries.

the expected revenue of that market through increased competition on a larger market as well as through a greater export opportunity (this ambiguity is discussed in Melitz and Ottaviano, 2008). The *distance* to the market is also incorporated, which has been shown to be important when it comes to the export decision, because it influences the cost of reaching a particular market (or cultural distances). Hence we assume it will have a negative impact on the survival of an export activity, as increased variable trade costs imply lower expected profits from exporting. We therefore use a specification where we include the gravity of a destination (i.e. GDP deflated by distance) in order to capture these effects.[11] Tariffs and other politically determined trade barriers constitute another source of variable trade costs. To capture these, we control for whether the country of destination is within the same *regional trade agreement*, as well as whether it belongs to any of the developing countries of the *ACP* and *GSP*.[12] Finally, to capture as much unobserved heterogeneity among importing countries as possible, we include 22 *regional dummies* according to the UN classification of countries.

4 Empirical Results

Table 4 below presents the results from our baseline model, a logit model with random effects at the firm-product-destination level. The first column contains results from our main specification, and the following column then shows results where the definition of core and periphery has been modified.

We begin by focusing on the variables of main interest, namely those designed to capture various aspects of the core-periphery dimension. Starting with the *relative unimportance of the product*, measured as the inverse of how large a share of the firm's total exports the product represents, this variable has a positive and significant effect on the hazard. In other words, trade flows relating to products that are less important to a firm tend to survive for a shorter time than trade flows relating to the firm's core products. This is the effect we expect. The variable, *relative unimportance of the destination*, defined as the inverse of how large a share of the firm's total exports each destination represents, also has a positive and significant coefficient. The

[11] This simple specification is used for convenience to reduce the overall number of explanatory variables, and it should be noted that including the terms separately does not change any conclusions – full results are available upon request.

[12] African, Caribbean and Pacific (ACP) countries have enjoyed preferential market access to Sweden since its EU membership in 1995, while other developing countries are offered less advantageous preferential market access under the Generalized System of Preferences (GSP). The reasons for controlling for these preferential arrangements, although they are one-way preferences, is that restrictive rules of origin – and in particular regarding cumulation of origin – could force these exporters to import intermediate products from EU countries such as Sweden in order to be able to apply for preferential tariff treatment.

interpretation of this result is that trade flows relating to destinations that are less important for the firm will tend to survive for a shorter period of time, or, put differently, that trade flows to the firm's most important destinations tend to have a longer duration. Again, this is the result we expect if the theoretical discussion above is valid.

Table 4. Regression results

Explanatory variables	*Baseline*	*Modified baseline*	*Baseline (Probit)*
Core v. periphery			
Relative unimportance of product	0.10***	0.10***	0.06***
	(0.00)	(0.00)	(0.00)
Relative unimportance of destination	0.06***		0.04***
	(0.00)		(0.00)
Relative distance to core market		0.11***	
		(0.00)	
Firm and product characteristics			
TFP	-0.32***	-0.31***	-0.19***
	(0.00)	(0.00)	(0.00)
Firm size (# employees)	-0.05***	-0.05***	-0.03***
	(0.00)	(0.00)	(0.00)
Owns foreign firm	-0.41***	-0.39***	-0.24***
	(0.00)	(0.00)	(0.00)
Foreign owner	-0.15***	-0.14***	-0.09***
	(0.00)	(0.00)	(0.00)
Second try	-0.27***	-0.27***	-0.17***
	(0.00)	(0.00)	(0.00)
Third try	-0.37***	-0.36***	-0.22***
	(0.00)	(0.00)	(0.00)
Fourth try	-0.66***	-0.66***	-0.41***
	(0.00)	(0.00)	(0.00)
Spell1	2.73***	2.97***	1.67***
	(0.00)	(0.00)	(0.00)
Spell2	1.11***	1.34***	0.63***
	(0.00)	(0.00)	(0.00)
Spell3	0.44***	0.68***	0.25***
	(0.01)	(0.00)	(0.01)
Spell4	0.27	0.50***	0.16
	(0.12)	(0.00)	(0.66)
Spell5	0.06	0.28	0.04
	(0.59)	(0.12)	(0.70)
Spell6	-0.11	0.12	-0.05

	(0.59)	(0.56)	(0.66)
Spell7	-0.64***	-0.42*	-0.33***
	(0.00)	(0.07)	(0.00)
Spell8	-0.64***	-0.42	-0.27**
	(0.01)	(0.11)	(0.05)
Spell9	-1.12***	-0.89**	-0.52***
	(0.00)	(0.03)	(0.00)
Market characteristics			
Importer GDP/distance	0.02***	-0.01	0.02**
	(0.01)	(0.24)	(0.02)
To RTA	-0.25***	-0.24***	-0.15***
	(0.00)	(0.00)	(0.00)
To ACP	-0.83***	-0.77***	-0.45***
	(0.00)	(0.00)	(0.00)
To GSP	0.14**	0.13*	0.09**
	(0.04)	(0.08)	(0.04)
Loglikelihood	-42963	-43034	-42980
Number of observations	81159	81159	81159

Note: Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels and figures between parentheses are *p*-values based on the random effect (on the firm-product-destination dimension) logit model (in the last column, the logit model is replaced with a probit model). All regressions include calendar time dummies, 14 export product dummies, 17 industry belonging dummies, 21 localisation dummies in Sweden and 22 regional destination dummies.

Thus, so far, the results are entirely consistent with the theoretical framework, and regardless of whether we interpret the concept of core and periphery from the perspective of products or destinations, we find that once firms have started to export to the core, they will tend to continue doing so, while export decisions relating to the periphery are typically more short-term. Does this conclusion hold if we consider other ways of interpreting the core and periphery? As argued above, even though it is natural to consider sales (by product or destination) when discussing differences between core and periphery, one could also interpret the concept from a geographical perspective. In the second column of Table 4, we therefore replace the *relative unimportance of the destination* with the *relative distance to core market* (defined as distance to the destination relative to the trade-weighted distance of all export flows). Again, this variable has the expected positive and significant coefficient, suggesting that the exact way to define core and periphery is not decisive in determining whether one finds an effect.

In addition to the variables of main interest, we also include a large number of control variables. The results regarding these will now be briefly discussed. Starting with characteristics of the firm or product, most of the variables are significant and have the expected sign. The firm's

productivity, measured by total factor productivity, has the expected negative effect on the hazard.[13] The size of the firm also has the expected negative sign; in other words, productive firms and large firms with many employees will tend to have longer export duration than unproductive and small firms.

Firms that themselves own foreign firms face a statistically significantly lower hazard of their export flows dying, as do firms that are owned by foreign firms. This suggests that multinational corporations reduce the probability of trade flows dying quickly, which in turn may indicate a complementary relationship between trade and FDI.[14]

The model includes dummy variables capturing whether the firm has exported the same product to the same market one, two or three times before during the studied time period. These dummies all have significantly negative coefficients, suggesting that the hazard falls for repeated exports. Further, the conditional hazard (i.e. the spell time dummies) has the expected shape since it drops quickly the first year and then levels out after 3-4 years of exporting. Hence, when a firm stays on a particular market, the probability of an exit falls over time. Explanations for this could include learning by exporting (as discussed in Ilmakunnas and Nurmi, 2010), and an increasing number of loyal consumers (as discussed in Fishman and Rob, 2003).

Besides firm and product characteristics, there are also control variables aiming to capture market heterogeneity. Starting with the destination country's gravity (i.e. GDP divided by the distance to the destination), this variable somewhat unexpectedly has a positive impact on the probability of exiting. This is neither in line with our expectations nor other studies. One explanation may be that the GDP of the destination country is a bad proxy for the market size of a particular product faced by the exporting firm if taste differs across countries. This is particularly true in our specification, since we capture the importance of a particular market with both our core-periphery variables. Therefore, given our specification, it can be argued that gravity of a country captures the fact that firms are more likely to export a larger number of products (new and old) to a market with a higher potential, and hence there is a higher turnover on these markets.[15]

Exports to destinations within the same regional trade agreement face a lower hazard, as do shipments to ACP countries, while export flows to countries eligible for EU preferences under the GSP scheme have a significantly larger hazard of dying. While somewhat unexpected, we

[13] In addition to the main TFP measure which is presented above, we have also used an alternative TFP based on Olley and Pakes (1996), and the results are the same.

[14] Unfortunately, the ownership data is firm-specific and does not vary by product or export destination. This implies that one should be cautious not to make too strong interpretations of these results.

[15] Note that if we exclude our core-periphery variables, the gravity of a country has a negative but insignificant impact on the probability of exiting.

note that the variable is only significant at the five per cent level in the baseline specification (with even lower levels of significance in several of the robustness regressions), which, given the very large number of observations in the sample, implies that the result should not be taken too seriously. As outlined above, we also include a large set of dummies for the type of good, industry, location in Sweden and exporter country region. Due to space constraints, we do not report full results in the table, but they are available upon request.[16]

Robustness

We have also performed several robustness analyses. First, we have tried an alternative estimation method. In the third column of Table 4, a probit rather than a logit model has been used. Reassuringly, the results are very similar. Further, we have tested adjusting the sample by changing the definition of a product and allowing different types of trade to have separate effects (results are reported in Table A2 in the Appendix). In columns 1 and 2 of Table A2, we have increased the level of aggregation so that products are defined at the 6-digit and 4-digit levels, respectively. This does not change our conclusions regarding the core and periphery, and has surprisingly small effects on the control variables. In columns 3 and 4, we then consider only exports of consumer goods and intermediate goods, respectively. The reason for separating these trade flows is that, theoretically speaking, we may expect vertical trade to be different. Specifically, the exchange of goods between upstream and downstream firms may lead to costly contracts or relationship-specific investment as soon as we face a holdup problem (see Antràs, 2003), and this could have an impact on the survival of trade flows. However, we do not find any strong support for a different underlying model of vertical trade in our results. Most variables have very similar results across the various specifications and samples; that having a foreign owner only matters for trade in consumer goods is one of the few noteworthy differences. Specifically, and most importantly, the results regarding the variables capturing the core and periphery are very similar. In other words, none of our robustness regressions change the main results: Export flows to peripheral markets do have a shorter duration.

[16] We note, however, that some interesting patterns may be observed. The location in Sweden is important and firms located in the county of Scania stand out as those with the longest duration of export flows, which is in line with the fact that we find a cluster of food processors in this region. The regional destination dummies are not as diverse as the location dummies but export flows to Sub-Saharan Africa survive for a shorter period compared to export flows to the other regions (keeping all other variables equal). In addition, export of processed food, the lion's share of the total exports in this value chain, seems to have longer survival, which is in line with Arkolakis and Muendler (2011) since processed foods constitute the top products of the food chain. When it comes to industry belonging, we note that the survival of exports from upstream firms (i.e. the agricultural sector) is much lower compared to all others.

5 Summary and Conclusions

In our search for an explanation of the apparent empirical puzzle of sunk costs of exporting being important at the same as the duration of trade flows is on average very short, we explore the concepts of core and peripheral markets. We illustrate that if the importance of sunk costs as well as the expected future revenues are different, depending on whether the export decision refers to a core or a peripheral market, it is plausible that while firms will tend to stay on the core market for a long time, they will enter and exit the peripheral market much more frequently.

Using data on export activities for all firms in the Swedish food chain for the period 1997-2007, we test whether we can find evidence for the hypothesis that trade duration will be longer for core markets. Employing variables that capture different aspects of the core-periphery dimension, we find that firms will indeed tend to stay longer in their core markets, while export decisions regarding peripheral markets are much less long-term.

Does this reconcile the robust finding of the importance of sunk costs of exporting and the on average short duration of export flows? We argue that it does. The empirical literature on export hysteresis focuses on the firm's *decision to export or not*. Since this decision will always concern a core market, it is entirely consistent with our results that firms will tend to continue to export once they have started.

On the other hand, the literature on trade duration has focused on the decision to continue to export or to exit the market for *a given product in a given market*. In this case, the firm may very well continue to export the same product to other markets, or export other products to the same or other markets; so, even if they decide to exit, firm trade does not have to become zero. Therefore, the duration literature actually builds on observations from different kinds of decisions. Some really do relate to the (core market) decision to export anything at all, which leads to longer trade durations. Many other observations refer to decisions to stay in or leave peripheral markets, and here we should expect to observe short trade durations. Altogether, the finding of very short trade durations in the trade survival literature suggests that a majority of the observations are the result of the latter type of export decision.

As noted in the introduction, the direct goal of this paper has been to offer a plausible mechanism for explaining how the two strands of literature - on sunk costs and trade durations - can both be right even though they seemingly draw contradictory conclusions. We believe that we have been able to identify such a mechanism, and thereby hope to have made a contribution to both these strands of literature. In a broader perspective, we would further argue that this paper

makes a wider contribution to the research on trade durations by being very explicit about an underlying model for determining how long firms trade.

6 References

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Appendix

Table A1. Variable definitions and descriptive figures

Variable	*Definition*	*Mean*	*Standard deviation*
Core v. Periphery			
Relative unimportance of product	The inverted ratio of the product's total exports to the firm's total exports of all products. A product is defined by the CN code at the 8-digit level.	0.14	0.28
Relative unimportance of destination	The inverted ratio of the destination's total exports to the firm's total exports to all destinations.	0.37	0.39
Relative distance to core market	The distance to destination relative to the trade-weighted distance of all export flows	1.34	1.78
Firm and product characteristics			
TFP	Multilateral index defined as in Aw et al (2003)	1.68	8.89
Firm size	Number of employees	433	1140
Owns foreign firm	1 if the firm owns foreign firms, 0 otherwise	0.49	0.50
Foreign owner	1 if the firm is owned by foreign firm, 0 otherwise	0.28	0.45
Second try	1 if the firm has exported the same product to the same market once before, 0 otherwise	0.14	0.35
Third try	1 if the firm has exported the same product to the same market twice before, 0 otherwise	0.02	0.13
Fourth try	1 if the firm has exported the same product to the same market three times before, 0 otherwise	0.001	0.03
Market characteristics			
Importer GDP/distance	Destination GDP deflated by the distance from Sweden	517	563
To RTA	1 if the destination is in the same Regional Trade Agreement (RTA), 0 otherwise	0.84	0.36
To ACP	1 if the destination country is offered preferential market access to the EU under the fourth Lomé Convention or Cotonou Agreement as an African, Caribbean or Pacific (ACP) country, 0 otherwise	0.01	0.10
To GSP	1 if the destination country is offered preferential market access to the EU under the Generalized System of Preferences (GSP), 0 otherwise	0.08	0.27

Table A2. Results from alternative specifications

Explanatory variables	*Logit using 6-digit products*	*Logit using 4-digit products*	*Exports of consumer goods*	*Exports of intermediate goods*
Core v. periphery				
Relative unimportance of product	0.02***	0.01**	0.11***	0.11***
	(0.00)	(0.05)	(0.00)	(0.00)
Relative unimportance of destination	0.08***	0.09***	0.08***	0.05***
	(0.00)	(0.00)	(0.00)	(0.00)
Firm and product characteristics				
TFP	-0.25***	-0.22***	-0.46***	-0.02
	(0.00)	(0.00)	(0.00)	(0.61)
Firm size (# employees)	-0.06***	-0.07***	-0.04***	-0.13***
	(0.00)	(0.00)	(0.00)	(0.00)
Owns foreign firm	-0.35***	-0.33***	-0.42***	-0.35***
	(0.00)	(0.00)	(0.00)	(0.00)
Foreign owner	-0.08***	-0.08***	-0.15***	0.03
	(0.00)	(0.00)	(0.00)	(0.47)
Second try	-0.35***	-0.41***	-0.23***	-0.32***
	(0.00)	(0.00)	(0.00)	(0.00)
Third try	-0.55***	-0.54***	-0.28***	-0.42***
	(0.00)	(0.00)	(0.00)	(0.00)
Fourth try	-0.69***	-0.49	-0.29	-1.51***
	(0.00)	(0.14)	(0.33)	(0.00)
Spell1	4.25***	4.27***	2.02***	2.74***
	(0.00)	(0.00)	(0.00)	(0.00)
Spell2	2.72***	2.86***	0.50**	1.00***
	(0.00)	(0.00)	(0.03)	(0.00)
Spell3	2.28***	2.41***	-0.18	0.48*
	(0.00)	(0.00)	(0.44)	(0.08)
Spell4	2.01***	2.23***	-0.39*	0.37
	(0.00)	(0.00)	(0.09)	(0.18)
Spell5	1.95***	2.10***	-0.51**	-0.08
	(0.00)	(0.00)	(0.03)	(0.79)
Spell6	1.68***	1.94***	-0.63**	-0.26
	(0.00)	(0.00)	(0.02)	(0.42)
Spell7	1.29***	1.46***	-1.14***	-0.85**
	(0.00)	(0.00)	(0.00)	(0.03)
Spell8	1.26***	1.22**	-1.11***	-1.01*
	(0.00)	(0.02)	(0.00)	(0.06)
Spell9	0.73	0.71	-1.61***	-0.57
	(0.24)	(0.50)	(0.00)	(0.38)
Market characteristics				
Importer GDP/distance	0.03***	0.01	0.04***	-0.01

	(0.00)	(0.20)	(0.00)	(0.90)
To RTA	-0.29***	-0.29***	-0.18***	-0.38*
	(0.00)	(0.00)	(0.00)	(0.08)
To ACP	-1.03***	-1.11***	-0.83***	-0.05
	(0.00)	(0.00)	(0.00)	(0.93)
To GSP	0.08	0.08	0.13	0.23*
	(0.26)	(0.35)	(0.16)	(0.08)
Loglikelihood	-35549	-27525	-28399	-12077
Number of observations	67537	50699	52577	23144

Note: Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels and figures between parentheses are *p*-values based on random effect (on the firm-product-destination dimension) logit model. All regressions include time dummies, 14 export product dummies, 17 industry belonging dummies, 21 localisation dummies in Sweden and 22 regional destination dummies.