WORKING PAPER

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Sanne Hiller, Philipp J.H. Schröder, and Allan Sørensen

University of Lüneburg
Working Paper Series in Economics

No. 262

January 2013

www.leuphana.de/institute/ivwl/publikationen/working-papers.html

ISSN 1860 - 5508

Export market exit and firm survival: theory and first evidence

Sanne Hiller* Philipp J.H. Schröder† Allan Sørensen‡

January 2013

Abstract

This paper deploys a dynamic extension of the Melitz (2003) model to generate predictions on export market exit and firm survival in a setting where firms endogenously make exit decisions. The central driver of the model dynamics is the inclusion of exogenous economy wide technological progress. The model predicts – inter alia – that a higher relative productivity not only increases the likelihood of exporting, but also the chances of firm survival and continued export market engagements. We relate these predictions to the empirical stylized facts of export market exit and firm survival based on Danish firm-level data. We find strong evidence that firms experience a decline in market share prior to export market exit and prior to death and that the firms discontinuing their exporting activity or closing down tend to be small. Overall, our empirical results support the central predictions from the model.

JEL: F12, F15, O33, L11, L16
Keywords: Intra-industry trade, entry/exit, heterogeneous firms, technological change.

*Department of Economics, Leuphana University of Lüneburg. Tel.: +49 4131 6770 , E-mail: shiller@leuphana.de.

†Aarhus University, School of Business and Social Sciences, Department of Economics and Business, Denmark. Tel.: +45 8716 4971, E-mail: psc@asb.dk.

‡Aarhus University, School of Business and Social Sciences, Department of Economics and Business, Denmark. Tel.: +45 87164989, E-mail: allans@asb.dk.

Acknowledgements: Philipp Schröder acknowledges financial support from the Tuborg Foundation.
A revised version of this paper is forthcoming in a collected volume edited by C. Kowalczyk and B.J. Christensen.

1 Introduction

Industry dynamics, and the associated reallocation patterns, have moved center stage in the theoretical and empirical international economics literature. Yet, while the main thrust of the literature has been on entry and market serving modes, much less attention has been paid to the patterns of firm death, and more importantly export market exit. In fact, the workhorse model of heterogenous firms trade (Melitz, 2003) abstracts from exit decision altogether. Instead it introduces random death, such that exit probabilities are unrelated to firms' characteristics. While this is a reasonable assumption for many applications, it gives little guidance for designing empirical investigations into export market exit patterns and firms survival – which at least since the introduction of Stigler's (1958) survivor principle are central performance characteristics of firms within the field of industrial organization. Moreover, data on firm survival and export market exit is widely available in micro data sets (see e.g. Eaton et al., 2008).

The present chapter attempts to close this gap. We use the highly trackable dynamic extension of the Melitz (2003) model provided in Schröder and Sørensen (2012) to replicate several theoretical insights on firm survival and export market exit dynamics that apply in heterogeneous firms trade settings. From the model we find, inter alia, that higher productivity firms survive longer, and that low productivity is associated with high probabilities of export market exit. Furthermore, among the exiting and dying firms young firms account for the lions share, similarly the model predicts that export market exit and/or firm death are preceded by shrinking sales (i.e. shrinking market shares).

Subsequently, we contrast these theoretical findings to the empirical regularities. Our empirical work corroborates the general predictions from theory. First, we find that the market share of firms declines prior to firm death and export market exit. Secondly, we observe that exiting firms or exiting exporters are small. Thirdly, our results suggest that small firms constitute the largest share of exits in a given cohort. Fourth, our empirical findings suggest the productivity distribution of survivors first-order dominates the one of exits on both domestic and export markets. Somewhat in contrast to theoretical predictions we find that empirically fewer than half of all firms that stop their export market activities continue their domestic activity. Finally, the theoretical prediction on the initial size distributions between stayers and exits is not mirrored in the data, which highlights that the clear link between size and productivity that is presumed in the theoretical model is, at least in our data, not present.

The key model mechanism at the center of the theoretical model by

Schröder and Sørensen (2012) that we apply in this chapter is the inclusion of exogenous technological progress into the standard Melitz (2003) model augmented with Pareto distributed productivities. This extension generates an analytically solvable dynamic framework that preserves all the established novelties of Melitz (2003) while adding endogenous export market exit and closure decisions of firms. Instead of random death, the competition forces are the transmitting channel between technological progress and firm export market exit and survival. In the presence of technological progress and vintage capital properties, the arrival of new (younger) competing producers, that draw their productivity from an improved distribution, squeezes the market share of existing producers such that incumbent firms eventually will exit the various markets.

There is a number of other theoretical models that explicitly address issues of dynamics, including firm death and export market exit, in heterogeneous firms trade settings. Rich exit dynamics are generated by the inclusion of some firm-specific random process affecting productivity, e.g. Impullitti et al. (2012) and Arkolakis (2009). Alternatively, firms may uncover firm-specific innovation advances that secure firm growth or the absence of which causes firm exit once a good innovation draw is lacking, see for example Atkeson and Burstein (2007) and Constantini and Melitz (2007) who deal with the joint innovation and export decision of firms. Yet, while these works focus on several dimensions of industry dynamics, they all derive dynamics from an intra-firm process, such as a random productivity development, that is paired with a constant exogenous firm death probability, as evoked in Melitz (2003). In contrast, the model of Schröder and Sørensen (2012) that we apply in the present chapter highlights a different – but no doubt central – channel of firm exit dynamics initially suggested by Dasgupta and Stiglitz (1981): technological progress, paired with vintage capital, competition and creative destruction. Survival and export market exit is thus exogenous to the firm, deterministic but specific to the economy. Most importantly, the model generates rich predictions that can be directly contrasted to the empirical regularities.[1]

Our empirical approach follows the standard methodologies used in the empirical international trade literature. Our data is based on detailed firm-level data provided by Statistics Denmark. The data covers the time period from 1996 to 2007, allowing us to analyze four different exit cohorts. We focus on a manufacturing panel, which is based on 3080 Danish firms. Given the

[1]Note that several of the dynamic Melitz extensions cited above generate very similar theoretical predictions to the ones we highlight here, i.e. firms with lower market shares or lower productivity are more likely to exit.

rich Danish data on firms, we are able to estimate TFP using the method suggested by Levinsohn and Petrin (2003) and to conduct non-parametric Kolmogorov-Smirnov tests comparing exit and survivor cohorts. Previous empirical work has established a clear link between productivity and firms survival. For example, empirically, high productivity firms survive longer, most firm closures are young firms, larger size entrants have lower exit probabilities, more productive exporters are more likely to continue to export compared to less productive exporters, and firms are regularly observed to withdraw from some markets while staying active on others (see for example Jovanovic, 1982; Dunne et al., 1988; Caves, 1998; Klepper, 2002; Farinas and Ruano, 2005; Wagner, 2009 and 2011; and Eaton et al., 2008. Our empirical findings are broadly in line with these previous works.

The next two sections introduce several testable theoretical predictions of Schröder and Sørensen (2012) and provide sketches of the central modeling items and proofs. Section 4 introduces our data and empirical research design. Section 5 contains our empirical findings. Section 6 concludes.

2 The Theoretical Predictions

We draw upon the Schröder and Sørensen (2012) extension of Melitz (2003), which includes dynamic firm-level behavior of exit in a situation of continuous technological progress. Progress is modeled as exogenous and continuous improvements in the productivity distribution that is available to firms prior to entering the market. With this simple assumption future firms will have expected higher productivity and larger market shares on all markets that they enter. Accordingly, potential new entrants realize prior to starting production of their drawn variety, that they eventually will be ousted from, first the foreign market (if they should choose to export) and later the domestic market. They take this expected time of exit into account when deciding whether to enter the industry or not.

As is shown in Schröder and Sørensen (2012), the resulting dynamic model, where exit and death of firms is model endogenously determined and not depending on an exogenous death probability, has a number of testable properties concerning its cross-sectional and dynamic predictions for export market exit and firm closure. Most central for the purpose of the present chapter and our subsequent empirical investigation are:

Prediction 1. *Surviving firms are more productive than exiting firms (this applies both for export market exit and for firm death).*

Prediction 2. *Entry productivity and size of firms on a given market are positively linked to the duration of serving this market.*

Prediction 3. *For a given exit wave, younger (older) age cohorts account for a larger (smaller) share of the exiting firms.*

Prediction 4. *Only small firms leave a market.*

Prediction 5. *Firms observe a declining market share before market exit (this applies both for export market exit and for firm death).*

Prediction 6. *Exporters that cease to export continue to exist as pure domestic firms for a while.*

The next section introduces the central modeling elements and sketches of the proofs.

3 The Central Modeling Elements

In this section, we present a summary of the continuous-time-dynamic extension of the symmetric n-country Melitz (2003) model provided by Schröder and Sørensen (2012). Throughout the exposition the well-established Melitz (2003) notation and conventions such as the assumption of Pareto-distributed productivity draws are applied. For additional details the reader should refer to Schröder and Sørensen (2012).

Technological Progress

Technological progress is introduced as exogenous and continuous, thus following Dasgupta and Stiglitz's (1981) work on the dynamics of oligopolistic industries and innovation. In particular, the model introduces exogenous and continuous improvements in the distribution of productivities available to entering firms. At entry each firm pays sunk innovation costs of f_e labor units and draws a firm-specific marginal productivity φ that it maintains throughout its endogenous life cycle. Due to selection at the production cut-off, the average productivity of the incumbents of today will be higher than the average productivity draw of tomorrow, i.e. at any point in time some of the drawn blueprints are not worth bringing to the market. The central implication of continuously improving productivity draws among new entrants paired with constant firm-specific productivities is that incumbent firms experience declining relative productivity and thus falling market shares over time. Eventually individual market shares decline to levels, such that firms cannot cover fixed costs and endogenously shut down.

Turning to the specifics, a firm born at time t of type ω has productivity $\varphi_t(\omega)$ which is a realization from the Pareto

$$G_t(\varphi_t(\omega)) = 1 - \left(\frac{\varphi_t(\omega)}{\bar{\varphi}_t}\right)^{-k} \text{ for } \varphi_t(\omega) \geq \bar{\varphi}_t, \tag{1}$$

where $\bar{\varphi}_t$ determines the location and k determines the shape of the distribution. The location of the distribution improves exogenously and continuously at rate $\beta > 0$, i.e. $\bar{\varphi}_t = \bar{\varphi}_0 e^{\beta t}$.

We can decompose each productivity draw into a deterministic increasing state of the technology component $\bar{\varphi}_t = \bar{\varphi}_0 e^{\beta t}$ and a stochastic *lottery* component $\Psi(\omega, t) = \Psi(\omega) = \frac{\varphi_t(\omega)}{\bar{\varphi}_t}$ which is time-invariant and Pareto-distributed with shape parameter k and location parameter 1.[2] It follows that we can write productivity draws at any time t as

$$\varphi_t(\omega) = \varphi_0(\omega) e^{\beta t}, \tag{2}$$

where $\varphi_0(\omega)$ is a draw from the Pareto $G(\varphi_0(\omega)) = 1 - \left(\frac{\varphi_0(\omega)}{\bar{\varphi}_0}\right)^{-k}$ for $\varphi_0(\omega) \geq \bar{\varphi}_0$. To see this, note that

$$\begin{aligned}
\Pr\left(\varphi_0(\omega) e^{\beta t} < x\right) &= \Pr\left(\varphi_0(\omega) < x e^{-\beta t}\right) \\
&= 1 - \left(\frac{x e^{-\beta t}}{\bar{\varphi}_0}\right)^{-k} = 1 - \left(\frac{x}{\bar{\varphi}_0 e^{\beta t}}\right)^{-k} \\
&= 1 - \left(\frac{x}{\bar{\varphi}_t}\right)^{-k} = \Pr\left(\varphi_t(\omega) < x\right) \ .
\end{aligned}$$

Households

The representative household supplies exogenously L units of labor and chooses a consumption path $\{C_s\}_{s=t}^{\infty}$ to maximize utility[3] $U = \int_t^{\infty} \ln(C_s)\, ds$ subject to a budget constraint. The optimal expenditure path has $E_t =$

[2]To see this, consider the probability of drawing a *lottery* component below $\psi \geq 1$:

$$\begin{aligned}
&\Pr(\Psi(\omega, t) < \psi) = \Pr\left(\frac{\varphi(\omega, t)}{\bar{\varphi}_t} < \psi\right) \\
= \ &\Pr(\varphi(\omega, t) < \psi \bar{\varphi}_t) = G_t(\psi \bar{\varphi}_t) = 1 - \psi^{-k}
\end{aligned}$$

Hence Ψ is Pareto with shape parameter k and location parameter 1.

[3]For simplicity, we follow Melitz (2003) by imposing the assumption of no time discounting.

$E = L$ for all t which equals labor income (because wages are normalized to unity). Expenditures in any period are spread over the set of available varieties, Ω_t, to maximize $C_t = \left[\int_{\omega\in\Omega_t} [c_t(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$ implying a demand of

$$c_t(\omega) = \frac{E}{P_t}\left(\frac{p_t(\omega)}{P_t}\right)^{-\sigma} \text{ for all } \omega \in \Omega_t, \tag{3}$$

where $p_t(\omega)$ is the price of variety ω and $P_t = \left[\int_{\omega\in\Omega_t} [p_t(\omega)]^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$ is the price index.

Firms

After the payment of the sunk innovation costs f_e and the realization of the marginal cost drawn from the Pareto distribution (1), a firm's labor requirement conditional on production is $l_t(\omega) = f + \frac{q_t(\omega)}{\varphi(\omega)}$, where f is fixed production costs and $q_t(\omega)$ is output. A firm has to pay fixed costs of f_x for each export market it serves, and moreover exports are subject to iceberg trade costs, $\tau \geq 1$. Upon entry and subsequently at each point in time, firms decide conditional on productivity and industry structure which markets to serve.

Given the constant elasticity of demand, prices are set as a constant mark-up, $\frac{\sigma}{\sigma-1}$, on marginal costs. Flow profits at time t on the domestic market and on export markets for a firm with *lottery* component φ_0 and age m are given by

$$\pi_{t,m}(\varphi_0) = B_t e^{\beta(\sigma-1)(t-m)}\varphi_0^{\sigma-1} - f \tag{4}$$

$$\pi^x_{t,m}(\varphi_0) = B_t \tau^{1-\sigma} e^{\beta(\sigma-1)(t-m)}\varphi_0^{\sigma-1} - f_x, \tag{5}$$

where $B_t = \frac{1}{\sigma-1}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} EP_t^{\sigma-1}$ is the market-specific demand component at time t. As shown in Schröder and Sørensen (2012) a balanced growth path with a stable industry structure exists. A stable industry structure requires stable exit and export *lottery* thresholds (relative productivity), which in turn requires the above flow profits to be time-invariant. This can only be achieved if the market-specific demand component B decreases to balance the technological improvement, i.e. B must decrease at rate $\beta(\sigma-1)$.[4] Writing

[4]The stable industry structure implies that the distribution of marginal productivities increases at rate β which in turn implies that prices decrease at rate β. The time-invariant nominal expenditures and fixed/sunk costs imply, given the constant mark-ups, a time-invariant number of varieties, M_t. Thus it follows that $B_t = \frac{1}{\sigma-1}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} EP_t^{\sigma-1}$ decreases at rate $\beta(\sigma-1)$. See Schröder and Sørensen (2012) for further details.

$B_t = B_0 e^{-\beta(\sigma-1)t}$, the flow profit expressions read

$$\pi_m(\varphi_0) = B_0 \varphi_0^{\sigma-1} e^{-\beta(\sigma-1)m} - f \quad (6)$$
$$\pi_m^x(\varphi_0) = B_0 \tau^{1-\sigma} \varphi_0^{\sigma-1} e^{-\beta(\sigma-1)m} - f_x \ . \quad (7)$$

A new firm serves the domestic market provided $\pi_0(\varphi_0) \geq 0 \Leftrightarrow \varphi_0 \geq \varphi_0^{exit} = \left(\frac{f}{B_0}\right)^{\frac{1}{\sigma-1}}$ and export markets provided $\pi_0^x(\varphi_0) \geq 0 \Leftrightarrow \varphi_0 \geq \varphi_0^x = \left(\frac{f_x}{B_0}\right)^{\frac{1}{\sigma-1}} \tau$.[5] Due to the exogenously technological progress, a firm observes that its productivity falls over time relative to younger competitors. Eventually, the market share will fall to a level where the firm is unable to cover fixed costs in a given market, and the firm therefore endogenously exits the market at that point in time. The ages at which a firm shuts down (m^{exit}) and leaves a given export markets (m^x) are determined by (6) and (7), respectively. They are

$$m^{exit}(\varphi_0) = \frac{1}{\beta(\sigma-1)} \ln\left(\frac{B_0 \varphi_0^{\sigma-1}}{f}\right) \quad (8)$$
$$m^x(\varphi_0) = \frac{1}{\beta(\sigma-1)} \ln\left(\frac{B_0 \varphi_0^{\sigma-1} \tau^{1-\sigma}}{f_x}\right). \quad (9)$$

Industry Equilibrium

The industry equilibrium is pinned down by the free entry condition. Taking the endogenous market durations (8) and (9) into account, net present value of flow profits read[6]

$$\pi(\varphi_0) = \int_0^{m^{exit}(\varphi_0)} \left(B_0 \varphi_0^{\sigma-1} e^{-\beta(\sigma-1)m} - f\right) dm$$
$$= \frac{f}{\beta(\sigma-1)} \left[\frac{B_0 \varphi_0^{\sigma-1}}{f} - 1 - \ln\left(\frac{B_0 \varphi_0^{\sigma-1}}{f}\right)\right]$$
$$\pi^x(\varphi_0) = \frac{f_x}{\beta(\sigma-1)} \left[\frac{B_0 \tau^{1-\sigma} \varphi_0^{\sigma-1}}{f_x} - 1 - \ln\left(\frac{B_0 \tau^{1-\sigma} \varphi_0^{\sigma-1}}{f_x}\right)\right]$$

[5] We impose the conventional parameter restriction $f_x \tau^{\sigma-1} > f$ that ensures that firms, consistent with empirical evidence, are partitioned into exporters and non-exporters.

[6] On the balanced growth path, the interest rate equals the discount rate which by assumption equals zero.

The free entry condition balances the expected net present value of flow profits with the sunk cost of entry costs, i.e.

$$\int_{\varphi_0^{exit}}^{\infty} \pi(\varphi_0)\, dG(\varphi_0) + n \int_{\varphi_0^{x}}^{\infty} \pi^{\exp ort}(\varphi_0)\, dG(\varphi_0) = f_e,$$

which pins down the productivity thresholds as

$$\begin{aligned} \varphi_0^{exit} &= \left(\frac{(\sigma-1)}{k-(\sigma-1)} \frac{1}{\beta k} \frac{f}{f_e} \right)^{\frac{1}{k}} \left(1 + n \left(\frac{f_x}{f} \right)^{\frac{\sigma-1-k}{\sigma-1}} \tau^{-k} \right)^{\frac{1}{k}} \bar{\varphi}_0 \qquad (10) \\ \varphi_0^{x} &= \left(\frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \tau \varphi_0^{exit}. \end{aligned}$$

A comparison with the Melitz (2003) model conditional on productivities being Pareto-distributed reveals that the thresholds are only changed by a scalar of $\left(\frac{\delta}{\beta k}\right)^k$, where $\delta > 0$ is the conventional exogenous death probability. Hence, all the well-known predictions of the Melitz model – such as selection into export activity according to productivity or intra-industry reallocations – also apply in the extended version. Thus we do not elaborate these standard features that also apply to the dynamic model and which have been repeatedly shown to match the empirical facts. Instead we turn to the predictions of export market exit and firm survival from above.

Proof of the Theoretical Predictions

From the above model elements and (8) it follows that in the extended dynamic version of the model firm death is deterministic conditional on the firm-specific productivity draw. Thus the exogenous firm death is replaced by a model endogenous firm closure decision.

Predictions 1 and 2, i.e. that more productive and larger firms survive longer, follow directly from (8) when noting that entry size increases in marginal productivity.

Furthermore, from (8) and the declining density of the Pareto distribution it follows that for each cohort the absolute number of exits declines with maturity. Accordingly, in the age distribution of a given exit wave the most recent entries have the largest share (Prediction 3).[7]

[7] It can be shown that the age distribution for the group of active firms exiting the market at any point in time is exponential with parameter βk (see the Schröder and Sørensen (2012) for details on distributions).

The market shares of a firm with productivity φ on the domestic and export markets are

$$s_t(\varphi) = \frac{\frac{E}{P_t}\left(\frac{p(\varphi)}{P_t}\right)^{-\sigma} p(\varphi)}{E} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \varphi^{\sigma-1} P_t^{\sigma-1} \quad (11)$$

$$s_t^x(\varphi) = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \tau^{1-\sigma} \varphi^{\sigma-1} P_t^{\sigma-1} \quad (12)$$

Combining (4), (5), (11) and (12), we find that $\pi_t(\varphi) = \frac{s_t(\varphi)E}{\sigma} - f$ and $\pi_t^x(\varphi) = \frac{s_t^x(\varphi)E}{\sigma} - f_x$. Accordingly, flow profits increase in the market shares and exiting firms will thus be small (have a small market share), i.e. Prediction 4. Market shares decline over time due to a decreasing price level, P_t, and exiters thus observe periods of declining market shares prior to exit (Prediction 5). Finally, exporters that cease their exporting activity continue for a while to exist as pure domestic firms, since $\phi_x^* > \phi^*$, c.f. footnote 5. This proves Prediction 6.

4 Data and Empirical Strategy

We assess the central predictions of the model provided in Section 2 using a sample of Danish manufacturing firms spanning the years 1996 – 2007, which is provided by Statistics Denmark. The observational unit is the firm. We consider a sample of manufacturing firms defined by the latest NACE revision on the 2-digit level.

For the sake of comparability, our sample is defined as in the related literature. In particular, we follow Wagner (2009) and compare different exit cohorts to their surviving counterparts. A firm exit is defined as a pattern where a firm exists in time t but not in $t+1$ and does not reappear during the sample period. A survivor firm of time t is correspondingly defined as a firm which exists at least in time $t+1$, $t+2$, and $t+3$ (i.e. what happens after $t+3$ does not enter the classification). Firms with other existence patterns are not taken into account, such that the total number of firms N_t consists of survivors S_t and dying firms D_t. By construction, we observe for each cohort a firm's immediate pre-exit performance at time t. As we require surviving firms to survive at least three years longer than the exiting firms, the last observable and comparable exit cohort is from the year 2004. Moreover, Statistics Denmark has changed reporting rules in 1999. Before the change, all private firms subject to VAT had to report to the statistical office, irrespective whether they were truly active. After 1999 all truly active firms had to report to the general firm statistics and are thus included in our sample. Thus, the first exit cohort we consider is the one observed in 2000. We discard all firms which exit from the domestic market, but re-enter at a later point in time, as this pattern is likely to be due to misreporting rather than true firm closure. This initial cleaning decreases the sample of manufacturing firms by 1.17%. Finally, we require that an existing firm employs at least one full-time employee. Overall, for the sampling period from 1996 to 2007, we observe 3080 distinct manufacturing firms and focus on the exit cohorts of the years 2000, 2001, 2002, 2003 and 2004.

In order to classify the export status of firms, any firm with positive export sales is defined to be an exporter. In our analysis, we exclude the exporters who trade with oil products or who export to unknown or undisclosed countries of destinations. Moreover, we restrict our sample to countries included in the CEPII data set (215 countries of destination). An export survivor is a firm that exports to at least one country at each point in time t, $t+1$, $t+2$ and $t+3$. An export market exit is defined accordingly to firm death, but we do not generally rule out re-entry of the export market, such that an export exiting firm exports at time t, but does not export in time $t+1$, $t+2$, $t+3$ (but it may start again subsequently). In light of the related literature, it is likely that a firm's export knowledge fully decays in this time (Roberts and Tybout, 1997). With this definition, we compare continuous exporters with export stoppers rather than with temporary exporters, which matches most closely to the theoretical model.

As a matter of convention we subsequently use the term exit to refer to export market exit as well as to firm death. The respective tables presented below specify which type of exit is considered.

Productivity is measured as total factor productivity, which we estimate separately at the industry level using the method suggested by Levinsohn and Petrin (2003), thereby using the Stata function provided by Petrin et al. (2004).[8]

Some First Observations

Based on the above specified sample, Table 1 displays the exit rates by cohorts for all manufacturing firms, pure domestic firms and exporters. It reveals three main points. First, exit rates have increased between 2000 and 2004 for both domestic and exporting firms, leading to a total increase from 2.5% to 4.7%. Secondly, firms with less than median employment, i.e. small firms, account for the larger share of exiting firms throughout the entire period and

[8]Full results available from the authors upon request.

Table 1: Exit Rates by Cohort

	Overall	Small	Large
All Firms			
2000	2.5	1.4	1.0
2001	2.5	1.7	0.8
2002	3.2	2.0	1.3
2003	3.1	2.1	1.0
2004	4.7	2.8	1.9
Domestic Firms			
2000	2.8	2.1	0.7
2001	3.0	2.8	0.2
2002	3.0	3.0	0.0
2003	4.0	2.6	1.4
2004	6.0	5.3	0.6
Exporters			
2000	2.4	1.2	1.1
2001	2.3	1.4	0.9
2002	3.3	1.7	1.5
2003	2.9	2.0	0.9
2004	4.4	2.2	2.1

Table 1 presents firm exit rates by exit cohort for all firms, domestic firms and exporting firms. Firms are regarded as small (large), when they exhibit less (more) than median employment.

across both domestic and exporting firms. Overall, the exit rates in Denmark are slightly lower than the ones found for the German manufacturing sector for the period from 1975 to 2006 (Fackler et al., 2012). They hide considerable heterogeneity as the industry decomposition in Table 2 shows.

Among all manufacturing subsectors, the exit rate is highest for the furniture sector, amounting to 5.9% for the years 2000 – 2004. In sharp contrast, beverages and tobacco do not show any exit in the period of concern. The observation that the larger share of exit is driven by small firms carries over to the majority of sectors, apart from Paper and Paper Products, Basic Metals as well as Computer, Electronic and Optical Products.

Table 2: Exit Rates by Industry: All Firms, All Years

	Overall	Small	Large
Basic Metals	3.6	1.6	2.0
Beverages	0.0	0.0	0.0
Chemicals and Chemical Products	1.4	0.8	0.6
Coke and Refined Petroleum Products	3.8	3.8	0.0
Computer, Electronic and Optical Products	3.5	0.9	2.6
Electrical Equipment	3.4	2.4	1.0
Fabricated Metal Products	2.4	1.5	0.9
Food Products	1.9	1.1	0.8
Furniture	5.9	3.6	2.2
Leather and Related Products	1.6	1.6	0.0
Machinery	2.8	1.8	1.0
Motor Vehicles, Trailers and Semi-Trailers	0.9	0.9	0.0
Non-Metallic Mineral Products	2.5	2.2	0.4
Other Manufacturing	2.9	2.1	0.8
Other Transport Equipment	4.4	2.2	2.2
Paper and Paper Products	5.7	1.9	3.8
Printing and Reproduction of Recorded Media	5.2	4.0	1.2
Rubber and Plastic	2.6	1.0	1.5
Textiles	3.4	3.3	0.2
Tobacco Products	0.0	0.0	0.0
Wearing Apparel	2.7	2.4	0.3
Wooden Products	3.7	2.1	1.6

Table 2 presents an industry decomposition of firm exit rates by exit cohort for all firms in a 2-digit NACE industry. Firms are regarded as small (large), when they exhibit less (more) than median employment.

These different exit rates across industries can be related to considerable performance differences. Table 3 shows industry averages of total sales, employment and total factor productivity, as well as the respective growth rates. Whereas total sales naturally vary considerably across sectors, the overall picture in terms of sales growth seems to be more homogenous: Even though the extent of sales growth varies considerably, with the exception of Leather and Related Products, all industries exhibit positive sales growth. In sharp contrast, employment has declined for 14 out of 22 industries. The growth rates range from -6.3% in Wearing Apparel to 3.2% in Food Products, the latter one also being the one with the highest average employment level.

With respect to TFP, growth rates are moderate and positive but close to zero for all industries with the major exception of Leather and Related Products being characterized not only by negative sales, but also by a negative TFP growth.

The Danish manufacturer landscape displays similar patterns of exporting behavior as found for other countries (see for example Mayer and Ottaviano, 2007): Danish firms are active on international export markets - on average, the number of markets served by an exporting manufacturer in our sample amounts to 11, whereby 50% of firms in our sample do not serve more than 5 markets. Generally, most variation with respect to the number of markets served occurs across firms, but only to a lesser extent within firms. Around 26% of manufacturers export to only one country of destination, but contribute by less than 1% to the overall export revenue generated during the sample period.

Subsequently, we test the theoretical predictions of the model. The main tool of analysis is the Kolmogorov-Smirnov test, which allows us to compare size and productivity distributions of exiting and surviving firms. The Kolmogorov-Smirnov test is a non-parametric test, which tests the Null hypothesis of equality of distributions against first order dominance of one distribution.

Table 3: Industry Characteristics, All Years

	Obs.	Total Sales		Employees		TFP	
		Mean	Avg. Growth	Mean	Avg. Growth	Mean	Avg. Growth
Basic Metals	272	138.4	7.2	99.2	0.5	100.8	0.04
Beverages	89	445.0	9.6	247.2	2.8	134.9	0.04
Chemicals and Chemical Products	512	196.8	5.2	108.7	1.2	119.7	0.03
Coke and Refined Petroleum Products	28	1383.6	9.4	110.0	0.7	182.1	0.01
Computer, Electronic and Optical Products	123	64.5	4.7	60.3	-0.3	97.1	0.003
Electrical Equipment	313	103.5	2.2	84.9	-3.1	98.2	0.01
Fabricated Metal Products	1,825	40.9	4.6	42.6	0.2	91.6	0.03
Food Products	1,042	485.6	6.9	227.2	3.2	115.8	0.03
Furniture	1,281	59.3	2.4	53.8	-2.3	85.9	0.02
Leather and Related Products	65	222.0	-5.0	82.7	-5.7	91.1	-0.02
Machinery	1,867	91.2	4.4	84.4	-0.4	103.7	0.02
Motor Vehicles, Trailers and Semi-Trailers	113	104.0	3.7	108.5	-4.4	100.9	0.1
Non-Metallic Mineral Products	576	117.9	2.8	97.8	-1.6	111.5	0.004
Other Manufacturing	654	134.4	3.2	74.5	-1.2	110.9	0.02
Other Transport Equipment	49	80.3	3.1	60.8	2.2	120.3	0.03
Paper and Paper Products	469	108.6	3.9	79.1	-0.01	107.6	0.03
Printing and Reproduction of Recorded Media	941	35.5	1.3	31.7	-1.3	93.1	0.02
Rubber and Plastic	1,314	70.6	4.0	64.5	0.5	96.2	0.03
Textiles	600	46.1	1.6	36.8	-4.4	87.0	0.03
Tobacco Products	27	731.7	5.0	233.6	-1.1	290.6	0.1
Wearing Apparel	357	41.0	2.3	24.5	-6.3	97.7	0.01
Wooden Products	720	69.4	4.0	63.9	-0.1	88.4	0.03

5 Results

Prediction 1: The theoretical model suggests that higher productivity firms survive longer on both domestic and export markets. This is reflected in higher productivity found among all survivors within an exit cohort. Figure 1 shows kernel density estimates of firms TFP at time t split among those that exit in $t+1$ (dashed line) and those that remain active in the domestic market until $t+3$ at least (solid line). Departing from pure visual inspection, Table 4 displays results for a t-test of equal means against three different alternative hypotheses, namely a) survivors exhibit a higher average TFP, b) means differ and c) exiters exhibit a higher TFP. For all five cohorts, we reject the Null hypothesis in favor of mean inequality, and we reject mean equality between exits and survivors in favor of a higher average TFP of surviving firms. Our results, which are in line with Farinas and Ruano (2005), as well as Wagner (2009), thus confirm the theoretical prediction with respect to both firm death and export market exit as in both cases the productivity distribution of survivors first-order stochastically dominates the one of the exiting firms.

Prediction 2: Firms which enter a market with a higher level of productivity (and thus sales) survive longer. A high entry productivity should feed back into a persistently higher productivity level, leading to a persistent better chance of surviving. Along the lines of Farinas and Ruano (2005) and Wagner (2009), we consider the size distributions of exits and survivors at their time of entry. Since the model exhibits a clear link between productivity and size, we only examine the latter here. For firms which have been in the sample in the first year, the first observation on sales is used as a proxy for entry size. Table 5 shows that the role of entry size differs when considering export market exit and firm death. Concerning export market exit, only for two cohorts, we reject equality of the initial sales distributions of future exits and survivors. In case of firm death, equality of the initial sales distributions cannot be rejected. This result needs to be read with care, in particular since the proxy for entry size of those firms which are in the sample right from the beginning is likely to be imprecise.

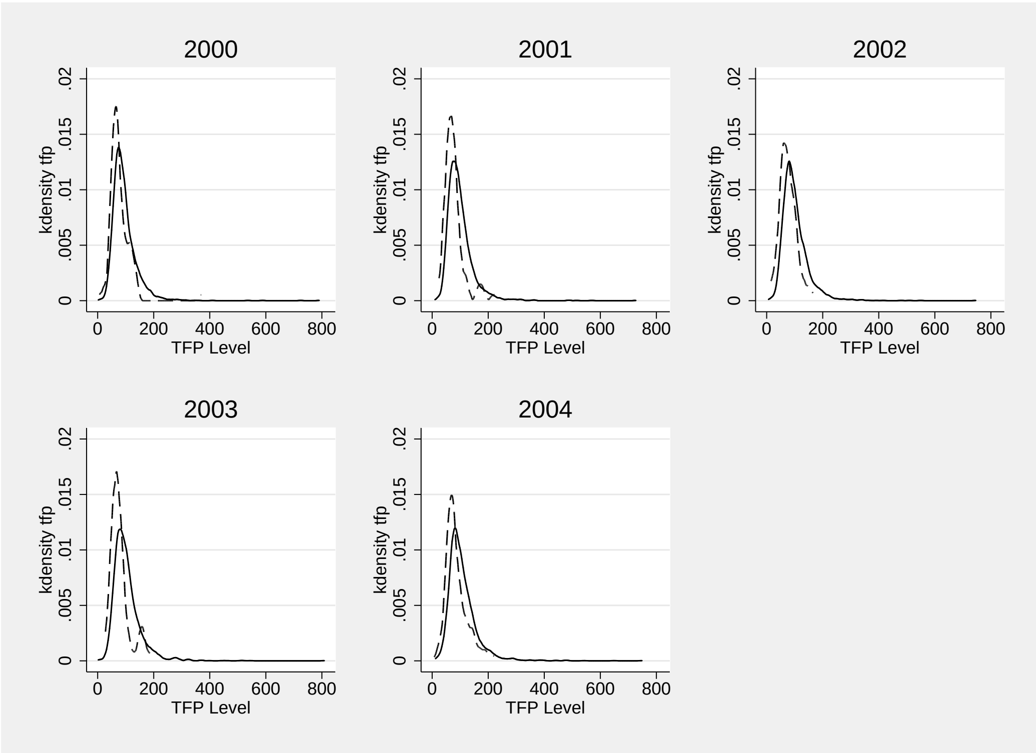

Figure 1: Kernel Density of TFP: Exits versus Survivors

Table 4: Productivity Differences between Exits and Survivors

		Mean		t-Test ($H_0 : \mu_S = \mu_E$)			Kolmogorov-Smirnov Test ($H_0 : F_S = F_E$)		
		Survivors	Exits	$p(\mu_S > \mu_E)$	$p(\mu_S \neq \mu_E)$	$p(\mu_S < \mu_E)$	$p(F_S \succ F_E)$	$p(F_E \succ F_S)$	$p(F_S \neq F_E)$
Firm Death	2000	95.4	79.8	0.005	0.010	0.995	0.000	0.976	0.000
	2001	99.2	77.0	0.000	0.000	1.000	0.000	0.999	0.000
	2002	101.6	75.3	0.000	0.000	1.000	0.000	1.000	0.000
	2003	103.8	79.0	0.000	0.000	1.000	0.000	0.996	0.000
	2004	107.9	85.8	0.000	0.000	1.000	0.000	1.000	0.000
Exp. Mkt. Exit	2000	95.0	74.8	0.000	0.000	1.000	0.000	1.000	0.000
	2001	97.8	82.4	0.000	0.000	1.000	0.004	1.000	0.003
	2002	100.8	81.8	0.000	0.000	1.000	0.000	0.999	0.000
	2003	103.3	79.4	0.000	0.000	1.000	0.000	0.994	0.000
	2004	107.3	91.2	0.000	0.000	1.000	0.000	0.999	0.000

Table 5: Entry Size Differences Among Survivors and Exits

		Mean		t-Test ($H_0 : \mu_S = \mu_E$)			Kolmogorov-Smirnov Test ($H_0 : F_S = F_E$)		
		Survivors	Exits	$p(\mu_S > \mu_E)$	$p(\mu_S \neq \mu_E)$	$p(\mu_S < \mu_E)$	$p(F_S \succ F_E)$	$p(F_E \succ F_S)$	$p(F_S \neq F_E)$
Firm Death	2000	102.1	89.2	0.238	0.477	0.762	0.687	0.394	0.720
	2001	103.0	69.4	0.015	0.030	0.985	0.215	0.929	0.132
	2002	103.4	62.3	0.000	0.000	1.000	0.867	0.566	0.516
	2003	102.8	66.5	0.011	0.023	0.989	0.224	0.475	0.135
	2004	101.9	74.2	0.027	0.053	0.973	0.306	0.331	0.175
Exp. Mkt. Exit	2000	101.0	75.7	0.036	0.073	0.964	0.097	0.926	0.060
	2001	101.2	65.9	0.002	0.004	0.998	0.511	0.922	0.289
	2002	102.4	54.4	0.000	0.000	1.000	0.421	0.964	0.236
	2003	102.6	48.3	0.000	0.000	1.000	0.000	0.569	0.000
	2004	101.8	69.5	0.005	0.010	0.995	0.120	0.755	0.071

Prediction 3: According to the theoretical results, younger firms constitute the majority share in a given exit cohort. This is strongly corroborated for both export market exit and firm death. As depicted in Table 6, young firms account for at least 75% of export market exits, and for at least 60% of dying firms. Thus, also for the Danish case, 'the liability of newness' is confirmed (compare Fackler et al., 2012, for a comprehensive literature review), even though results need to be taken with a pinch of salt given our measurement of firm age: Due to data limitation, we compare 'old' firms founded in 1997 to 'young' firms founded afterwards, and thus the perspective is restricted to a comparison of relatively young firms. Thus, we cannot consider the 'liability of oldness' to the full extent (see Fackler et al., 2012, for a discussion).

Table 6: Firm Age and Exit

	Share of Young Firms	
	Export Exit	Firm Death
2000	75.3	60.0
2001	80.5	90.0
2002	83.3	81.0
2003	85.5	83.3
2004	87.1	86.4

Prediction 4: We test whether only small firms leave a market by using a Kolmogorov-Smirnov test. If only small firms leave a market, the distribution of total sales observed by exiting firms should be stochastically dominated by the one of stayers. Table 7 provides clear evidence in favor of the model's prediction. For all cohorts, the Kolmogorov-Smirnov test rejects the Null hypothesis of equal sales' distributions in favor of first order stochastic dominance of the stayers. This result is found for firms leaving the export market as well as for firms that quit entirely.

Table 7: Export Market Exit, Firm Death and Pre-Exit Firm Size

	Mean		t-Test ($H_0 : \mu_S = \mu_E$)			Kolmogorov-Smirnov Test ($H_0 : F_S = F_E$)		
Firm Death								
2000	106.7	52.2	0.001	0.003	0.999	0.008	0.993	0.006
2001	121.2	37.0	0.000	0.000	1.000	0.000	1.000	0.000
2002	127.5	38.1	0.000	0.000	1.000	0.000	1.000	0.000
2003	130.7	27.3	0.000	0.000	1.000	0.000	0.999	0.000
2004	134.8	67.9	0.003	0.006	0.997	0.000	0.998	0.000
Export Market Exit	Survivors	Exits	$p(\mu_S > \mu_E)$	$p(\mu_S \neq \mu_E)$	$p(\mu_S < \mu_E)$	$p(F_S \succ F_E)$	$p(F_E \succ F_S)$	$p(F_S \neq F_E)$
2000	104.4	41.6	0.000	0.000	1.000	0.001	1.000	0.000
2001	116.4	42.8	0.000	0.000	1.000	0.002	1.000	0.002
2002	123.9	39.6	0.000	0.000	1.000	0.003	0.998	0.002
2003	128.8	25.3	0.000	0.000	1.000	0.000	0.994	0.000
2004	133.4	65.3	0.001	0.002	0.999	0.001	0.988	0.001

Prediction 5: Firms experience a decline in market share before exit (i.e. export market exit or firm death). Distinguishing between exits and survivors, Table 8 shows the share of firms which experience a decline in total sales, productivity and employment prior to domestic exit (death) or export market exit. In the case of export market exit, even in the cohort with the lowest share in sales declines (2000) more than 55.2% of all exiting firms experience a decline in total sales prior to export market exit. This compares to 49.3% of export stayers with declining sales in the same cohort. This pattern is in line with the theoretical prediction, and it is even more pronounced for firm death: The lowest share for exits with declining sales amounts to 62.9% in 2000, which compares to a decline share of only 48.8% among the surviving firms in the same cohort. This pattern is less pronounced for total factor productivity, but more pronounced for employment.

Table 8: Decline in Sales, Productivity and Employment before Firm Death and Export Market Exit

	Firm Exit				Export Market Exit		
	Share with decline in			Share with decline in			
	Sales	TFP	Employment		Sales	TFP	Employment
Survivors				Stayers			
2000	48.8	46.7	46.9		49.3	46.5	47.8
2001	53.3	46.5	53.4		55.9	47.6	55.5
2002	54.4	47.5	48.1		53.5	46.7	49.2
2003	53.6	48.0	48.2		54.0	48.9	48.9
2004	50.9	47.6	50.5		49.6	46.8	50.7
Exits				Exits			
2000	62.9	46.8	72.6		55.2	53.3	61.0
2001	72.6	56.5	71.0		65.2	52.8	62.9
2002	71.3	60.0	70.0		60.2	54.9	58.6
2003	65.8	60.5	75.0		65.6	60.9	60.2
2004	72.8	57.6	81.4		58.7	54.7	68.7

Table 8 depicts the share of firms that have experienced a decline in sales, TFP or employment prior to firm death or export market exit. Sales, TFP and employment are calculated relative to the industry average at time t.

Prediction 6: The model predicts that firms which stop to export continue to exist as domestic firms before they eventually die. Table 9 shows that this is true for between 33% and 50% of all firms that cease their exporting, i.e.

they continue as pure domestic firms. This relatively low percentage of firms continuing domestically is partially due to our definition of export exits. Moreover, it is likely that one would find a different pattern for countries where the domestic market makes up for a larger share of firms' sales in general, i.e. for Denmark we expect the home market to matter relatively little for the closure decision of of firms.

Table 9: Export Market Exit and Domestic Survival

Exit Year	Domestically active exits (%)
2000	49.5
2001	39.3
2002	39.2
2003	42.1
2004	33.3

Taking the Evidence Back to the Model – Future Research

Our empirical results confirm the testable predictions from theory to a large extent, but they also disclose some new patterns that require further investigation. Most prominently, although the model showed the pattern of shrinking sales for exiting and dying firms, it did not confirm the strict sequence whereby firm death is preceded by systematic exit from export markets. This hints at two potential model extensions. Firstly, the presence of sizable sunk export cost – opposed to per period fixed export costs – would generate an exit-all-markets-at-once pattern, i.e. given that sunk costs have been paid, all orders from abroad will be fulfilled until the firm closes. Secondly, the presence of strong cross subsidization within firms' activity portfolio could alter the exit pattern. In the case of equal size countries – the current set-up in the theory presented here – break-even patterns on the different markets (and hence market exit) have a clear hierarchy. If in contrast the home market is very small, say so small that it does not suffice to cover the production fixed costs of firms on its own, we expect that the model would generate simultaneous firms closure and exit from the last export markets. Another complementary perspective, which is not captured within the present model, is the number of destinations that a firm services. With more foreign destinations served the potential for cross-subsidization (and hence exit patterns that are more complex than what is examined in the present model) should be expected. Finally the present model as well as our empirical investigation ignore the role of multi-product firms and product exit as opposed to firm exit. Moreover, an additional perspective would be the link between firm closure and the preceding export market serving pattern, thereby exploring the role of temporary exports in the sense of Békés and Muraközy (2012), and by contrasting it to export market exit.

Future research will have to examine such extensions.

6 Conclusion

The present paper deploys the Melitz (2003) extension of Schröder and Sørensen (2012) to address firm survival and export market exit in an analytically solvable dynamic framework. The central driver of this approach is the inclusion of exogenous technological progress, such that newer firms draw from an improved productivity distribution and accordingly older firms eventually will be ousted from the market place. From this model several predictions for export market exit and firm survival are derived. In particular, high productivity firms (at any point in time) are likely also to produce in the future, i.e. they survive longer. Entry size and productivity of firms on a given market are positively linked to the duration of serving this market. Large exporters do not exit export markets, but smaller exporters do, i.e. firms exit markets after they have lost market shares, and exporters that cease to export will still serve their domestic market.

We contrast these theoretical results with the empirical stylized facts based on Danish firm-level data. In a nutshell, our results confirm the following predictions of the model. First, firms experience a decline in market share prior to death and export market exit. Secondly, firms that die or quit their exporting activity are small. Thirdly, our results show that small firms constitute the largest share of exits in a given cohort. Fourth, our empirical findings suggest that the productivity distribution of survivors first-order dominates the one of exits on both domestic and export markets. We find that between 33% to 50% of firms that stop exporting continue to exist domestically subsequently.

Overall, our combination of theory and data shows that the intense focus on export market entry and market serving modes that the recent decades of international economics research based on firm-level data has generated, can usefully and practically be complemented with a systematic investigation into export market exit patterns and firms survival. The present chapter has mapped out some initial guidance and results.

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Leuphana Universität Lüneburg
Institut für Volkswirtschaftslehre
Postfach 2440
D-21314 Lüneburg
Tel.: ++49 4131 677 2321
email: brodt@leuphana.de

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