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Southern Africa – Towards Inclusive Economic Development

Firm and product survival analysis

Evidence from South African tax administrative and product data

Syden Mishi, Weliswa Matekenya, Leward Jeke, Ronney M. Ncwadi, and Roseline T. Karambakuwa

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About the project

Southern Africa –Towards Inclusive Economic Development (SA-TIED)

SA-TIED is a unique collaboration between local and international research institutes and the government of South Africa. Its primary goal is to improve the interface between research and policy by producing cutting-edge research for inclusive growth and economic transformation in the southern African region. It is hoped that the SA-TIED programme will lead to greater institutional and individual capacities, improve database management and data analysis, and provide research outputs that assist in the formulation of evidence-based economic policy.

The collaboration is between the United Nations University World Institute for Development Economics Research (UNU-WIDER), the National Treasury of South Africa, the International Food Policy Research Institute (IFPRI), the Department of Monitoring, Planning, and Evaluation, the Department of Trade and Industry, South African Revenue Services, Trade and Industrial Policy Strategies, and other universities and institutes. It is funded by the National Treasury of South Africa, the Department of Trade and Industry of South Africa, the Delegation of the European Union to South Africa, IFPRI, and UNU-WIDER through the Institute's contributions from Finland, Sweden, and the United Kingdom to its research programme.

Corresponding author: Syden.Mishi@mandela.ac.za

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United Nations University World Institute for Development Economics Research
wider.unu.edu

Abstract: Enterprise development, especially expansion into export markets, is essential to create employment and unlock growth potential in many economies, including in sub-Saharan Africa. However, both firm and product survival (mainly in the export market) is not sufficiently documented to inform business development and export growth strategies. Using the South African National Treasury and UNU-WIDER CIT-IRP5 firm panel 2008–17 data set (version 3.4), we employ parametric and non-parametric methods to analyse the survivor function and hazard (exit) rate of firms and exported products, across the whole sample and by groups (such as sector, firm size, location (province), and membership of a special economic zone, among other categorizations). Our study enables an understanding of the survival rate of South African firms across different sectors, estimated with robust techniques (compared with the descriptive statistics that are usually relied on). The key issues investigated are South African products' survival in the export market and the overall determinants of survival, to inform support for firms and export promotion strategies. The results show that firm survival depends on the nature of the market, that is, the firm type and product characteristics. Similarly, products' survival is dependent mostly on the nature of the market.

Key words: enterprise development, firm survival, product survival, export market, employment, special economic zone

JEL classification: C14, D22, L25, L52

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* Nelson Mandela University, Port Elizabeth, South Africa; corresponding author: Syden.Mishi@mandela.ac.za

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Katajanokanlaituri 6 B, 00160 Helsinki, Finland

1 Introduction and background

Worldwide, there has been a shift from large multinational companies being the major contributors to economic growth, to small, medium, and micro enterprises (SMMEs) being regarded as the drivers of economic growth (Mishi 2018). The World Youth Conference held in Mexico in 2010 and the African Youth Conference held in Gambia 2011 both reached a consensus on the need to support SMMEs for the empowerment of youth and economic development in Africa. Economic prosperity is measured by the development of sustainable business enterprises, the creation of employment, improved efficiency, financial security, and many more. These factors generate income that supports and sustains healthy communities, peace, and general well-being. Despite the clear support for SMME development, overall business development is fundamental to economic development and prosperity: SMMEs are just the starting point.

Many developing and emerging economies are grappling with high levels of poverty, inequality, and unemployment, among many other socio-economic challenges, for which business development is considered a panacea. The growth and survival of firms and firm products, both within national borders and in export markets, is therefore critical, but this topic is not often studied. Most often, the development of business through thriving SMMEs is considered a key strategy for alleviating poverty through employment creation, rapid and sustainable economic growth, inclusive growth, and inequality reduction (Imbadu 2016). Firm growth in any country has a direct effect on economic growth due to increased output, value added, and profits (Dalberg 2011; UNCTAD 2001). However, empirical evidence shows that most businesses struggle to flourish during their early years due to a myriad of constraints that are widely documented (Chinje 2015); the same challenges that bedevil the economy are also barriers to access to business capital to ensure an increase in SMME start-ups and the probability of their survival to become well-established businesses (Mishi 2018). Factors affecting SMME growth, and the failure of SMMEs to pass the five-year life expectancy mark, are scattered in the literature (Cicea et al. 2019; Franquesa and Vera 2021; Ipinnaiye et al. 2017; Mohammed and Bunyaminu 2021). However, there has been a lack of effort to conduct a clinical analysis of the business life cycle from registration onwards, or to model firm survival and its determinants. The absence of profound research in this area is mainly due to the unavailability of data. However, the availability of firm-level data that is rich in the characteristics of both firms and products—especially exported products in customs data—provides a great opportunity to advance this enquiry. Such data is available from the South African National Treasury and UNU-WIDER's CIT-IRP5 firm panel 2008–17 data set (version 3.4) (National Treasury and UNU-WIDER 2019; Pieterse et al. 2018). In addition, the benefit of export-led growth depends on products that can survive in the export market (Brenton et al. 2009; Stirbat et al. 2013). Evidence about this is lacking for South Africa, and also for many other African countries, although limited evidence does exist for Ethiopia (Gebreyesus and Gebregergis 2018) and Kenya (Chacha and Edwards 2017), and there is also evidence for the least developed economies (Nicita et al. 2013), the Philippines (Pelkmans-Balaoing et al. 2016), and Peru (Freund and Pierola 2010). In general, the application of survival analysis to export data is not new (Brenton, Martha et al. 2010). Our study advances this existing literature by considering longitudinal outcomes, and by jointly estimating the survivor function from the treatment effect as well as the treatment effect on the longitudinal outcome in the case of South Africa.

In the wake of the fourth industrial revolution, firms need to be adaptive, and products need to be technologically inclined in their production, transportation, and use to survive on the market. This is in line with the South African government's goal to transform the economy into a globally competitive industrialized economy (van Rensburg et al. 2020). The South African National

Development Plan 2030 (National Planning Commission 2012) outlines a long-term development path towards a prosperous and successful economy characterized by high levels of economic growth, employment generation, and an equitable society. South Africa's New Growth Path and Industrial Policy Action Plan outline the government's industrial development agenda and the critical job drivers, prioritizing industrial sectors and a range of interventions to accelerate economic growth, create jobs, and fight poverty and underdevelopment (Nattrass 2011). An example would be 3D printing technology, which is supported by the South African Department of Science and Technology in preparation for the fourth industrial revolution, and support for entrepreneurs with laser engraving/cutting, desktop milling, and computer numerical control lathe technologies; this has enabled related products to survive commercialization and be sustainable. In this regard, the success or failure of exports needs to be understood (Cadot et al. 2013) for policy prescriptions, as the focus should not only be on diversifying the product range (Carballo and Volpe 2009).

This paper aims to estimate survival rates of firms operating in South Africa, focusing specifically on those involved in international trade. Survival is measured in two ways: firstly, by whether a firm continues to export or not (i.e. no longer exports but is still in local business, or no longer exists and is dormant); secondly, by significant changes in longitudinal/continuous indicators (number of products exported, size of business, and volume of sales, among other indicators of choice). The analysis uses the CIT-IRP5 firm panel 2008–17 data set (National Treasury and UNU-WIDER 2019).

The rest of the paper is organized as follows: section 2 provides a theoretical perspective and reviews the literature; section 3 outlines the methodology; section 4 presents and discusses the results. The last section focuses on the summary, policy implications, and recommendations.

2 Theoretical perspectives on firm and product survival analysis

Production theory provides firm properties, depicting scenarios where inaction is possible. In the context of this study, and in line with the literature (Esteve-Pérez et al. 2014), inaction is not possible when a firm faces sunk costs (inaction is possible only in the face of fixed costs). This implies that a firm that continues operation, particularly in the export market, during time $t < T$ may not truly have survived (i.e. may not have experienced the event of interest), but may instead be caught in the sunk costs fallacy (Arkes and Blumer 1985)—holding on, but as an unproductive venture (Dixit 1989a, 1989b; Krugman 1989). Thus, a firm's survival may not reflect its indefatigability, but merely its ability to avoid the very worst. This motivates our second view of survival from longitudinal indicators, rather than from a binary (yes or no): longitudinal survival analysis using continuous indicators helps us to ascertain the health of a business in the presence of the impossibility of inaction. In this way we are able to account for firms in a vegetative state, as we estimate the survivor function, which is a new phenomenon in the application of survival analysis in business and economic sciences. On the other hand, in the context of the Heckscher-Ohlin theory (Heckscher 1991; Subasat 2003), firms with a competitive advantage influence export duration through the products' factor intensity and the exporting country's factor endowments. In addition, considering the overall age of a firm and firm exposure to international markets, there is room to build capabilities, sales growth, and international relations, leading to an improvement in efficiency, product quality, and chances of survival. Therefore, a firm's years in existence and in the international market matter. However, we are not able to control explicitly for this, as the actual years of incorporation are not known: our data is available from 2010, and it does not contain firms' years of incorporation or their history prior to 2010.

A review of previous studies has been conducted in three thematic areas, and these are discussed in the next subsections.

2.1 Factors that are typically positively correlated with export survival

In the context of a neoclassical model, the probability of a firm's survival for a given interval of time is a function of a vector of market attributes and a vector of attributes that relate to the individual firm (Agarwal and Gort 1996). A firm's uniqueness, which can be brought about by management competencies, firm location, industry firm size, or technology advancement, is central to predicting its survival; firm heterogeneity is emphasized by Tovar and Martinez (2011). Market attributes include the proximity and number of markets.

The proximity of the market has been found to increase the survival of firms in export markets (Esteve-Pérez et al. 2007). This is supported in the context of Dutch exporters by van den Berg (2019), who shows that firms that are familiar with a particular market, and are in possession of a network of contacts and trading partners enabled by proximity and cultural overlaps, are able to boost export performance through that market. As per gravity model assumptions (Anderson and Van Wincoop 2003), firms trading in countries closer home stand a greater chance of survival. Regional trade blocs are therefore hypothesized to increase firm survival. The emergence of the African Continental Free Trade Area (AfCFTA) presents firms within the continent with great opportunities (Nwankwo and Ajibo 2020). It is imperative to note that the gravity model framework takes account of the size of the neighbouring market as well as the distance.

Compared with serving one market for its familiarity and the establishment of strong ties, van den Berg (2019) asserts that serving a wider variety of export markets can be associated with increased export performance. This is premised on the diversification principle (Gebreyesus and Gebregergis 2018; Tovar and Martinez 2011). Diversification is a long-acknowledged survival strategy that focuses on reducing risk and increasing expected value (Fuggazza and McLaren 2014).

Giovannetti et al. (2011) and Fu and Wu (2014) conclude that size and technological level positively affect the likelihood of a firm's survival. This was previously alluded to by Suárez and Utterback (1995), who assert that firms can survive if technology is considered a strategic variable. The importance of size is supported by Rahim and Mohammed (2018). Similarly, Gebreyesus and Gebregergis (2018) conclude that large and medium-sized firms easily survive in the export market. The size of a business in itself signifies growth, which comes as a result of survival. However, it is imperative to note that capital injection can also determine firm size before performance is taken into account—not all firms start small.

Fu and Wu (2014) and Gebreyesus and Gebregergis (2018) argue that if a firm has high productivity, it is more likely to survive. This suggests that efficiency in production is likely to give the firm a competitive advantage over its peers. Higher productivity may be possible in specialized firms (Crespi et al. 2008). Fu and Wu (2014) and Gebreyesus and Gebregergis (2018) add that export-oriented firms survive easily in the export market. In the same vein, Rahim and Mohammed (2018) refer to export intensity as a factor that increases survival.

Ownership may be key to survival: Fu and Wu (2014) argue that foreign ownership is an important determinant of export survival, while Gebreyesus and Gebregergis (2018) conclude that privately owned enterprises have better survival rates. Our data allows us to test whether foreign or domestic ownership matters for survival. Ownership brings different expertise and networks. Baggs (2005) concludes that the government's role should be to remove tariffs and lobby other countries to reciprocate; otherwise, survival is hampered.

Experience in a market is argued to be survival-enhancing. Stirbat et al. (2013) model firms' product destinations and find a positive impact of experience and networks on firms' survival. Rahim and Mohammed (2018) refer to a firm's age and longer period of exporting (history). Furthermore, Tovar and Martinez (2011) suggest that trade network effects are highly correlated with the survival of new exporting firms, implying that government aid in the exporting process should focus on expanding into new markets, not on promoting new export products. According to Stirbat et al. (2013), a firm's experience and network effect (referring to the firm's prior involvement in exporting with the same product, destination, and export market) are likely to increase the firm's chances to survive because it will have gained experience with the product or market. The trade network effect captures the influence of similar firms that are exporting in the same sector, which generally assists with matching international buyers and sellers (Cadot et al. 2011). As a result, Tovar and Martinez (2011) and Stirbat et al. (2011) have identified a positive correlation between trade networks and the survival of the firm in the market. The revealed comparative advantage depicts the relative advantage of a particular country in terms of trade flows. It has been found to result in higher odds of survival for firms in the advantaged country (Stirbat et al. 2011, 2013; Wagner 2011). South Africa dominates the continent, albeit not outright (Bahta and Willemse 2016). Geographical location, which may determine access to transport routes, overall transportation costs, and proximity to other export-supporting services, has been identified as one of the predictors of survival. Province-level aggregations of firms selling the same products in the same market during a particular month also positively determine the survival of firms. Strotmann (2007) supports the finding that a firm's geographical location has an impact on its survival. The effect of the home region (province) on survival is investigated in our study, which may inform spatial development economic strategies, especially in light of the special economic zones (SEZ) programme that South Africa has laid out. A detail discussion and framework for making the SEZ programme successful is detailed in Karambakuwa et al. (2020). Specifically, Gebreyesus and Gebregergis (2018) argue that firms located outside the capital (big) city survive better. This means that a particular location (e.g., rural versus urban) might give a firm higher or lower chances of survival.

2.2 Factors that are negatively correlated with export survival

Wagner (2013) concludes that exports do not play a role in overall firm survival. Firms are exposed to high failure risks when they are internationalized because of stronger competition in international markets.

On the other hand, state ownership is argued to increase the risk of export failure, as Fu and Wu (2014) and Gebreyesus and Gebregergis (2018) conclude. This may be due to inherent inefficiencies and bureaucratic red tape, which reduces the competitiveness of firms owned by the state. Audretsch et al. (2016) note that even though state ownership is important, productivity is key to survival.

The nature of the product (whether finished or raw goods) and the type of industry also have a bearing on survival rates (Gebreyesus and Gebregergis 2018). Often, the argument is to encourage the export of processed products in order to increase the value of exports; however, previous empirical work points to the contrary. It has been found that exporting a final product reduces the probability of survival compared with exporting raw goods (Rahim and Mohammed 2018). High costs of production reduce competitiveness, and hence firms that export raw products survive the export market better. Our study has access to data on industry type, which we use to test the nature of products; the data does not include information regarding whether it is raw materials or finished goods that are traded.

2.3 Methodological approaches

'Survival analysis' is just another name for time-to-event analysis, which is predominantly used in the biomedical and social sciences. Developments from these diverse fields have for the most part been consolidated into the field of survival analysis. In business, this analysis can be used to estimate the time to failure of SMMEs or products within a certain market (as in this case), among many other applications. Deriving the probability density gives an indication of the probability of failure given a set of predictor variables, computing densities across different categories of factor variables (such as firm type, home province, and firm size). There are certain aspects of survival analysis data, such as censoring and non-normality, that generate great difficulty when one is trying to analyse the data using traditional statistical models such as multiple linear regression. In the foreground, the analysis makes use of life tables; Cox regression (Cox 1972) and Kaplan-Meier analytical techniques, following literature such as Fugazza and Molina (2009) and Stirbat et al. (2013), then advance this analysis.

Esteve-Pérez et al. (2007) use a discrete-time proportional hazard model that accounts for unobserved individual heterogeneity, using data from Spanish manufacturing firms for 1990–2001. One the other hand, Stirbat et al. (2013) conducte a discrete-time logistic model survival analysis technique panel, as do Rahim and Mohammed (2018). Gebreyesus and Gebregergis (2018) use a non-parametric method to analyse the survivor function and hazard rate, while the semi-parametric method is used to analyse regression outputs based on the discrete-time proportional hazard model.

The use of multiple levels of analysis is important for understanding the trade-offs at both firm and product levels, and the effect of firm-level decisions on individual product performance. Performance measurement can be used to account for firm or product survival. Our observations for a product or firm begin when the product or firm first appears in the market. This is not necessarily the year of establishment or first production but may just be beginning point within the study. These observations continue to exist (coded zero for non-death) until the product or firm no longer appears in the market (coded one for death) (Stirbat et al. 2011). Intuitively, at the end of the study period (2017), a firm or product may still be zero (censored) if it does not die during the study period.

The literature shows the estimation of Kaplan-Meier survival rates for bilateral trade relationships at the product-line level. Non-parametric estimates for the probability of exit from export status is provided using the Kaplan-Meier survival functions estimator (Chacha and Edwards 2017). The non-parametric estimator gives us a guesstimate of the shape of the raw survival probability (or hazard rate) before the inclusion of any explanatory variables. The area under the survivor function provides the mean duration of export relations.

Recent literature has argued for the need to consider longitudinal outcome variables rather than the generally used binary outcomes (Crowther et al. 2013). Longitudinal or continuous outcome variables are more applicable to the field of business and economic sciences, and are therefore of interest in this study. This consideration enables an estimation of the treatment effect on the longitudinal outcome and on survival, which are modelled jointly; this is known as joint modelling of survival analysis.

3 Methodology

3.1 Data and method

Making use of the CIT-IRP5 firm panel 2008–17 data set (National Treasury and UNU-WIDER 2019), this paper applies survival analysis techniques in a broad context to determine firm survival in general, as well as product survival in export markets.

This data set suits our data needs, as it incorporates both product (customs) and firm-specific characteristic variables (see Appendix A). In addition, the data to estimate the panel survival analysis is needed in long format, which is the current format of the firm panel data set. Of key interest to the study are the number of products exported in the Harmonized System (HS) classifications HS4 and HS6, the actual products exported by industry codes HS4 and HS6 (recurrent/most exported products), and the volume of exports. Seventy-five percent of firms in the data set export one or two product types, with significant outliers: the number of products is evenly distributed up to 16 products exported per firm, then thinly spread beyond that point, depicting extreme outliers, which we handle by computing quartiles.

Regarding products, it was observed that a product may appear in some years and not in others, dropping off the export market with a possibility of re-entering at some point during the period of study. It is imperative to note that this does not reflect a complete stoppage in the export of the particular product (exit), but simply that the product is no longer the recurrent/most exported one; however, it has lost status, which is also of interest and can be interpreted as a temporary failure/exit. Within a firm, the recurrent/most exported products may vary over the years. This may reflect a change of strategy by the firm—for example, its withdrawal from international trade.

Given the above observations regarding the data, for the survival analysis in this study, the first step was to identify the event. The study is interested in survival within the export market: survival of the firm (having an export product equals one, zero otherwise), and survival of the product (being on the list of products equals one, zero otherwise). The event may be qualitatively discrete, as with the binary example given (survival versus drop), or quantitative (a continuous/longitudinal variable with an observable break). In addition, control or explanatory variables were considered. Variables of interest available in the data include: firm and market characteristics; economic sector of the firm/product; SEZ relationship; company structure; total assets (size); number of employees (size); volume of exports (export market size, relative to overall size); profitability; research and development expenditure; doubtful debts provision.

It is imperative to note that for the covariate values, any time point should represent their status just before the event. Thus, it would be wrong to use year-end covariate values on the same row as a bankruptcy (firm closure) event, which could have occurred earlier in the year. A couple of caveats in the data set need to be highlighted. First, observations are subject to censoring: for some firms (products), the event of interest (exiting the market) has occurred, and therefore we know the exact survival time (spell duration), whereas for others it has not occurred, and all we know is that the waiting time exceeds the observation time. Censoring is either left or right; left censoring in our context implies that firms that we observe in 2010 may have been incorporated and/or started engaging in international trade before 2010. We can only know this by inspecting the date of incorporation (firm age); we may not be able to identify the actual year of entering the export market, as some firms are incorporated without an international trade focus and change their strategy over time. In taking the above into account, an example is the assumptions by the available models: for example, the Cox model assumes a basic shared shape of the hazard as a function of time starting from time zero. In this study, the implication of the assumption of a shared hazard function shape is that time zero represents a calendar year (2010 in our data). Right censoring, on the other hand, implies that export behaviour is observed in 2017 but we are not sure when the exit year was (if the firm/product ever exited). Unlike left censoring, right censoring needs no control, as that can be easily handled by survival assumptions. According to Rabe-Hesketh and Skrondal (2012), the suitable model to employ when the event occurs within a certain time interval is the discrete-time hazard model. As an example, a company may have closed in January 2015, but the record will only be captured at the end of year 2015 (whether financial or tax year).

Second, there is the issue of multiple spells: there may be more than one survival episode (i.e. if a firm exits the market and re-enters during the study period), international trading status (as importer, exporter, or both) may change several times over the study period, and a product may also appear and disappear several times during the study period. Such interruptions can range anywhere between one year and many years (up to a maximum of eight, $T-1$). In this paper, we consider the duration of one spell while controlling for the existence of multiple spells. We do this while remaining mindful that data can suffer from measurement errors. For example, if the interval between spells is just one year, it is highly probable that this is due to misreporting, that is, activity took place but was not recorded. The incidence of recurrent events is inspected, and a dummy variable to control for this is considered (Besedes and Prusa 2006; Lejour 2015). This cannot be overlooked, as it may result in underestimation; therefore, we take a one-year gap as a measurement error.[1] In the real-world environment, there is recurrence and clustering of events, that is, firms may fail and be resuscitated, or there may be negative duration dependence (firms rebounding into the export market due to the sunk costs fallacy). This should form part of the crucial and standard selection of contemporary event history analysis (Box-Steffensmeier and De Boef 2006). This can be addressed by controlling for frailty (Mills 2011). Without this phenomenon, the assumption held is that all firms are homogenous, and that they are exposed to the same risk factors and set to default in the same way. Controlling for frailty brings the analysis closer to reality, as the likelihood of experiencing default is different among firms.

3.2 Model specification

The study follows three model specifications: the basic hazard model, the discrete-time hazard model, and longitudinal/panel joint estimation.

Basic hazard model

This estimates the probability of survival, that is, the probability that the outcome (death) does not occur before the end of the study period (T). At what point in time (t) does death (exit from the market, dormancy/liquidation of a firm or product) occur in relation to the overall time (T) under investigation?

$$S(t) = 1 - F(t) = Pr(T > t) \qquad [1]$$

T refers to a random variable that is non-negative and represents the time to exit, and t refers to any specific value of interest for random variable T. The probability density function of T is $f(t)$, and its cumulative distribution function is $F(t) = Pr\ (T \leq t)$; within the setting of the study T's survivor function, $S(t)$ is considered (Cleves et al. 2010). The survivor function is expressed as the

[1] E.g., if firm A appears in 2010, 2011, 2012, 2014, 2015, 2016, 2017, and 2018, this firm is considered not to have failed, as the one year missing (2013) could be a measurement error. But if firm B has observations in 2010, 2011, 2012, 2016, 2017, and 2018, this firm is considered to have failed, and the spell ranges from 2010 to 2012.

probability of survival beyond time t, which is the reverse of the cumulative distribution function of T in equation [1]. The conditional failure rate at time t is stated as

$$h(t) = -\frac{d\, lnS(t)}{dt} \qquad [2]$$

representing the relationship between survival and hazard functions.

At $t = 0$ (2010 in this study), the survivor function $S(t)$ is equal to one (100 per cent) and moves towards zero as t approaches infinity (in this study, we can observe only up to time T, the end of the study period). Conversely, the hazard ratio $h(t)$ is zero per cent at the start.

This can be extended to include covariates, as discussed below. Covariates help us to estimate survival probability more accurately, as possible influencing factors are taken into account.

Discrete-time hazard model

The discrete-time survival model may be most suitable, given that our data has coarse time scales as the time to event is expressed in years (Rabe-Hesketh and Skrondal 2012). With this data structure, the starting point is unique, and that starting point does not denote the year of establishment but only the start of the study period. A year is at least 365 days, taken as a single time period in this study. This complicates the analysis, in that a firm can exit within a single time unit (year) on any day, but this exit can only be recorded/observed at the end of the time unit (year). Thus, firms that exited on different days or months are treated as if they exited at the same time (year). In an effort to circumvent the bias, the hazard model is also estimated in the discrete-time framework with random effects controlling for shared frailty or unobserved heterogeneities. This is because the event is experienced in continuous time, but we only record the time interval within which the event takes place.

Taking the above discussion into account, we represent the estimation in complementary log-log (cloglog) format, as supported by Grilli (2005), Jenkins (2005), and Rabe-Hesketh and Skrondal (2012). This is depicted as

$$cloglog(h_i(t)\ (t)) \equiv ln\{-ln(1 - h_i(t))\} = \beta x(t)i' + \lambda t \qquad [3]$$

The last term, λt, is a time-dependant that is uniquely and independently estimated for each time t. This implies that no assumption is made about the baseline hazard function within the time interval; it is determined endogenously.

Longitudinal joint modelling

In this study, we have reason to envisage that the longitudinal and survival outcomes are related: for example, the trajectory of firm performance (the value of exports changes over time) will impact on the risk of death (exit from the export market) (Crowther et al. 2016). In the same vein, firms with a lower export value may be more likely to die, and this may affect estimates of the trajectory of the value of exports over time. As the value of exports may be related to the risk of exit (death), with lower values increasing the risk of exit, it can be taken that over time firms may drop out due to death, and only the well-performing (higher export value) firms will remain in the population. Joint modelling is ideal in such a scenario, as it helps to account for measurement errors, enables the utilization of all available repeated measures, reduces bias, and maximizes efficiency.

According to Crowther et al. (2013), a joint model of longitudinal and time-to-event data can effectively assess the impact that a longitudinal covariate, measured with error, has on the time to an event of interest. This approach has the advantage of reducing biases and improving precision. We adopt this approach as it resonates with firms' life cycle, taking into account confounding factors. This is an innovation in business and economic sciences, as such approaches have hitherto been the preserve of biological sciences. In this way we are able to analyse firm survival by reflecting on the realities of the business environment in a systems thinking context.

The longitudinal indicators of interest in firm survival are the firm's financial performance and its growth in size. These are assumed to change in value between observations, as the opposite is implausible; this would weaken any other form of survival analysis, such as the two-stage technique, as the uncertainty estimates from the first stage would not be carried through to the second stage (Sweeting and Thompson 2011). Joint modelling is best suited to such longitudinal data with an interest in estimating survival. Financial performance data and firm size information are collected repeatedly in parallel with the firm's participation (or not) in the export market as well as the firm's continued existence.

There are important features of the measurement to consider. The measurement may contain some errors; measurement on one firm is highly correlated, and the value of the indicators of interest may be related to the outcome (exiting a market or shutting down completely)—for example, low sales may point to a firm deciding to shut down. Such possibilities cannot be ignored. To robustly account for this, we can look at it from two perspectives that help us to find a solution:

1. There exist informative drop-outs: missing data can be informative and must not be ignored. For example, if the value of the indicators of interest is related to the risk of failure (insolvency), over time firms will drop out due to insolvency, and only-well managed firms (a healthier population) will remain.
2. Joint modelling enables us to account for measurement error when we look at how a time-varying indicator of interest is associated with an event (exit from the market/complete shutdown). This is a case of jointly modelling the longitudinal and survival processes together in one model.

Joint/simultaneous modelling allows us to assess the longitudinal process as well as the time to event. The results will be in two parts: longitudinal, to measure the effect of treatment on the longitudinal indicator (β); survival, to capture the association (α), which is the risk of death/event of interest, and also to show the effect of treatment on survival (ϕ). The overall treatment effect (log hazard ratio) is therefore $\alpha\beta+\phi$. By this process we are able to assess the indicator of interest's trajectory, taking informative drop-outs into account as indicated above, and we can jointly estimate the relationship between the trajectory of this indicator of interest, adjusted for measurement error (underlying profile of the indicator of interest), and the outcome (Henderson et al. 2000; Rizopoulos 2012; Wulfsohn and Tsiatis 1997). This type of analysis has been dominant in the health and biological sciences, for example in the field of AIDS research, where it has been used to relate CD4 trajectories to progression to AIDS in HIV-positive patients (Faucett and Thomas 1996).

Firms' decision-making is complex, and this requires systems thinking. As we outlined in section 2, there are instances where inaction is a viable option; however, there are many things to take into consideration, such as employees and their earnings during inaction. In the recent past, we have seen a number of firms across industry being regarded as 'too big to fail', explicitly or otherwise. Understanding the trajectory of longitudinal indicators is important to inform firms regarding what to monitor, how to respond, and at what point. This is why joint modelling is essential. At policy level, the interest is not limited to understanding which (types of) firms will not survive; it is about understanding what needs to be routinely monitored so that policies and necessary support can be adjusted to support firms' survival. Below we outline how the longitudinal joint model is integrated into the focus of our study.

Longitudinal submodel

Assume we observe a continuous variable (indicator of interest)

$$y_i(t) = m_i + e_i(t), e_i(t) \sim N(0, \sigma^2) \quad [4]$$

where

$$m_i(t) = X_i^T(t)\beta + Z_i^T(t)b_i, b_i \sim N(0, \Sigma) \quad [5]$$

$m_i(t)$ is the trajectory/profile function, which is the true unobserved value of the indicator of interest for the i[th] firm in year t.

Survival submodel

Define $M_i(t) = \{m_i(s), 0 \leq s \leq t\}$ to be the true unobserved longitudinal trajectory up to time t. Assuming a proportional hazard survival submodel,

$$h(t|M_i(t), v_i) = h_0(t)exp[\emptyset^T v_i + \boldsymbol{\alpha m_i(t)}] \quad [6]$$

where $h_0(t)$ is the baseline hazard function, and v_i is a set of baseline time-independent covariates with associated vector of log hazard ratios $\emptyset$.

In this study, we are interested in how changes in the trajectory of indicators of interest are associated with survival. This is a question of linking the component models, where for example

$$m_i(t) = (\beta_0 + b_{0i}) + (\beta_1 + b_{1i})t \quad [7]$$

From equation [6], $\boldsymbol{\alpha m_i(t)}$ is termed the current value of parameterization. As we are interested in linking the expected value of the outcome at the survival time, where the observed outcome is unlikely to be observed at the survival time, it is intuitively plausible to include the expected value of the longitudinal response in the linear predictor of the survival submodel.

Joint likelihood specification

The full joint likelihood takes the form

$$\prod_{i=1}^{N}\left[\int_{\infty}^{\infty}\left(\prod_{j=1}^{n_i}\boldsymbol{p(y_i(t_{ij})|b_i,\theta)}\right)p(b_i|\theta)p(T_i,d_i|b_i,\theta)db_i\right] \quad [8]$$

with the continuous longitudinal outcome represented by

$$\boldsymbol{p(y_i(t_{ij})|b_i,\theta)} = \boldsymbol{(2\pi\sigma_e^2)^{-1/2}exp\left\{\frac{[y_i(tij) - m_i(t_{ij})]^2}{2\sigma_e^2}\right\}} \quad [9]$$

For the multivariate normally distrusted random effects, we have

$$\prod_{i=1}^{N}\left[\int_{\infty}^{\infty}\left(\prod_{j=1}^{n_i}\boldsymbol{p(y_i(t_{ij})|b_i,\theta)}\right)\boldsymbol{p(b_i|\theta)}p(T_i,d_i|b_i,\theta)db_i\right] \quad [10]$$

where

$$\boldsymbol{p}(\boldsymbol{b}_i|\boldsymbol{\theta}) = (\boldsymbol{2\pi}|\boldsymbol{V})^{-q/2}\boldsymbol{exp}\left\{-\frac{\boldsymbol{b}`_i\boldsymbol{V}^{-1}\boldsymbol{b}_i}{\boldsymbol{2}}\right\} \quad [11]$$

The survival outcome, on the other hand, is

$$\prod_{i=1}^{N}\left[\int_{\infty}^{\infty}\cdot\left(\prod_{j=1}^{n_i}\boldsymbol{p}\big(\boldsymbol{y}_i(\boldsymbol{t}_{ij})\big|\boldsymbol{b}_i,\boldsymbol{\theta}\big)\right)\boldsymbol{p}(\boldsymbol{b}_i|\boldsymbol{\theta})p(T_i,d_i|b_i,\theta)db_i\right] \quad [12]$$

where

$$\boldsymbol{p}(\boldsymbol{b}_i|\boldsymbol{\theta})p(T_i,d_i|b_i,\theta)db_i = [h_0(T_i)\exp(\alpha m_i(t)+\emptyset v_i)]^{d_i}$$

$$*\ exp\left\{-\int_0^{T_i}h_0(u)\exp(\alpha m_i(u)+\emptyset v_i)\,du\right\} \quad [13]$$

Putting it into perspective, to estimate the effects assuming treatment u_i, this study uses the main export market ('Southern Africa Development Community (SADC) exporter') and market diversification ('qmarket') as natural treatments. We do not test the effect of this treatment on the longitudinal outcome (we use value of exports, total foreign sales, number of HS4/HS6 products exported, number of employees, and log of total assets for size) or the survival outcome (exit from the export market/inaction).

Assume

$$y_i(t) = m_i(t) + e_i(t) = (\beta_0 + b_{0i}) + (\beta_1 + b_{1i})t + \boldsymbol{\beta}u_i + e_i(t) \quad [14]$$

and

$$h(t) = h_o(t)\exp\,[\emptyset u_i + \boldsymbol{\alpha}m_i(t)] \quad [15]$$

Due to the link of the models, direct and indirect effects of treatment on survival are determined as follows:

- β is the direct effect of treatment on the longitudinal outcome.
- $\emptyset$ is the direct effect of treatment on survival.
- $\alpha\beta + \emptyset$ is the overall treatment effect on survival.

As argued by Ibrahim et al. (2010), joint modelling overcomes the weakness of underestimating the true treatment effect on survival, both direct and overall, which is inherent in earlier techniques. This argument still holds even in cases where β equals zero, that is, where treatment is not associated with the longitudinal outcome.

We apply the outlined techniques to our data, and the results are presented and discussed in the next section.

4 Results: presentation and discussion

4.1 Descriptive analysis

The data set contains 6,290,877 observations.[2] Of these, nearly 65 per cent are actively engaged in business, while 35.18 per cent are dormant across the study period (2010–17). A dormant company is one that has been registered but is not carrying on any kind of business activity or receiving any form of income.

It is imperative to note that South Africa's development strategy is anchored in export-led growth; hence the importance of understanding international trade. This is despite sharp criticism of the pursuit of export-led growth, especially in the wake of the shift in global economic activity and globalization, which erodes abnormal profits (surpluses) by any country in the international market (Palley 2012).

South Africa belongs to many country groupings—such as the SADC, the Southern African Customs Union (SACU), the African Union, the Group of 20 (G20), and the emerging markets of Brazil, Russia, India, China, and South Africa (BRICS), among others—which play a pivotal role in sustaining international trade. Among these groupings, the SADC is the most geographically connected (more significantly so than SACU: all SACU members are SADC members, but not vice versa), and there is the recently ratified AfCFTA, which is intended to promote intra-Africa trade. Exports to these countries matter, given evidence in the literature that the trading partner country matters for firm survival, especially evidence from gravity models that proximity is beneficial (Fu and Wu 2014). Questions such as 'do companies that focus on exporting to SADC countries survive longer?' are worth investigating in this framework. Considering international trading firms only, Table 1 depicts the trend in firms' participation status in the international market over the years (2010–17): the number of firms, those that become inactive, and those involved solely in either export or import.

Table 1: Firms' participation in the international market

Year	Total firms (fin. yr)	Total firms (tax yr)	Dormant firms	Δ dormancy ratio	Δ number of firms	Exporter (fin. yr)	Exporter (tax yr)	Importer (fin. yr)	Importer (tax yr)
2010	742242	754750	177346	23%		6816	6996	13133	13304
2011	754256	757522	211722	28%	0.4%	7787	7828	13231	13236
2012	805020	813419	267864	33%	7.4%	8092	8126	13471	13575
2013	827957	833077	300845	36%	2.4%	8165	8196	13733	13743
2014	853053	855929	330194	39%	2.7%	8386	8394	13525	13624
2015	867087	873371	341785	39%	2.0%	8356	8399	13737	13811
2016	911134	918050	378605	41%	5.1%	8401	8451	13692	13768
2017	907134	849138	379881	45%	-7.5%	8069	7279	13525	12226

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

[2] This takes into account repeated observations per firm.

The number of firms in the data set by financial year (operational) or tax year (regulatory) is almost the same. We use the tax year in further analysis, as the data is mainly tax system-based; the noting of failure is either by dormancy or non-reporting (no tax submission), and the unique identifier is the tax number. It is concerning that the proportion of dormant firms increases over the years, growing from 23 per cent of total firms in 2010 to 45 per cent by 2017. Changes in the total number of firms have been positive but erratic over the years, with a 7.5 per cent decline by 2017. Overall, there are more solely importing firms than solely exporting; the balance for the total number of firms accounts for those both exporting and importing.

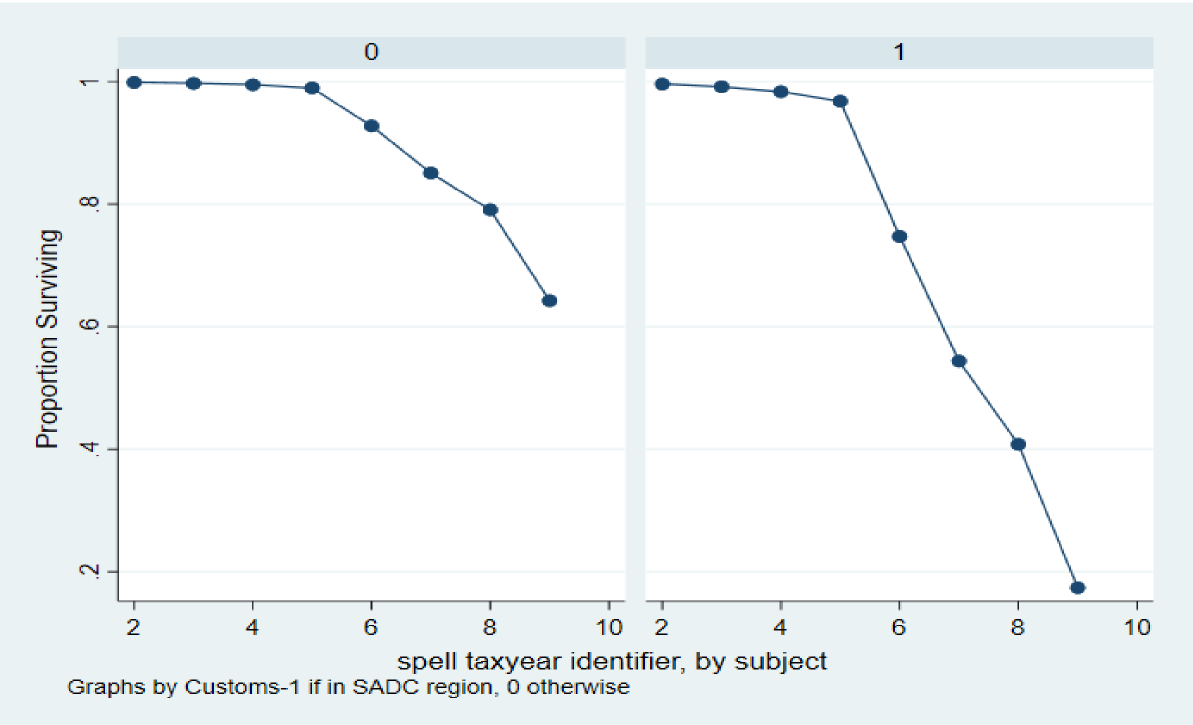
Our first task is to define the event so that survival analysis (a test of time to event) will be implementable. We have *export* as an event, taking the value one if a firm is an exporter in that year, and zero otherwise (i.e. if the firm no longer exports, either because it becomes dormant or because it focuses on the domestic market, changes to being an importer, or shuts down completely). In addition, we also have *int_trade*, which takes the value one if the firm is in international trade as an exporter, importer, or both, and zero if the firm exits from the export market (i.e. is no longer in international trade, is dormant or completely closed, or is focusing only on the domestic market). The occurrence of events is summarized in subsequent tables for each event as defined.

4.2 Firm survival in the export market

Descriptive statistics show an overall survival rate of 97.42 per cent over the eight-year period, a high overall rate compared with the SMME survival rate of nearly 30 per cent in five to seven years (Bushe 2019).

Figure 1 shows the trend in survival over time.

Figure 1: Survival curve for firms by export region: SADC or otherwise



Note: 0: non-SADC region. 1: SADC region.

Source: authors' illustration based on data from National Treasury and UNU-WIDER (2019).

In Nigeria, Jegede (2018) identified a 95 per cent failure rate in the first year, which is significantly worse than our findings. Besedes and Prusa (2006) found that survival specifically in the export market was only two years for US-bound exports, although we acknowledge that times—and trade partners—have changed since that analysis was done. Using a Kenyan firm-level data set, Chacha and Edwards (2017) observed that survival beyond five years in the export market was very rare. The general limitation of these studies is that they are based on small samples and survey data, unlike our study. Even though we cannot depict the year of entry into the market for each firm, the snapshot we provide offers great insights. We use administrative data, which is more accurate and representative of the whole country, as is the case with Stirbat et al. (2013).

Our study further dissects this analysis with different grouping variables to assess whether survival is dependent on the identified factors. Table 2 shows estimates of the survival function for firms exporting to the SADC region compared with those exporting to the non-SADC region. The table shows that there is a rapid decline in survival rates in the second section (to below 20 per cent by year nine) compared with the first section (to above 60 per cent by year nine), implying that the survival rate is relatively higher in firms that do not have the SADC as their main export market.

Table 2: Firm survival by export destination: SADC versus other

Interval	Beg. total	Death	Lost	Survival	Std error	95% conf. int.	
sadc_exporter = 0							
1-2	111899	100	24814	0.9990	0.0001	0.9988	0.9992
2-3	86985	116	22814	0.9975	0.0002	0.9971	0.9978
3-4	64055	119	20777	0.9952	0.0003	0.9887	0.9957
4-5	43159	188	18713	0.9897	0.0005	0.9990	0.9906
5-6	24258	1039	15343	0.9277	0.0019	0.9239	0.9314
6-7	7876	428	5421	0.8508	0.0040	0.8429	0.8584
7-8	2027	94	1391	0.7908	0.0070	0.7766	0.8042
8-9	542	56	486	0.6427	0.0187	0.6047	0.6781
sadc_exporter = 1							
1-2	89696	291	18663	0.9964	0.0002	0.9959	0.9968
2-3	70742	282	18116	0.9918	0.0003	0.9911	0.9925
3-4	52344	360	16930	0.9837	0.0005	0.9826	0.9847
4-5	35054	434	15375	0.9681	0.0009	0.9662	0.9698
5-6	19245	3157	10803	0.7473	0.0035	0.7403	0.7541
6-7	5285	1002	3200	0.5441	0.0060	0.5322	0.5559
7-8	1083	192	630	0.4081	0.0096	0.3892	0.4269
8-9	261	105	156	0.1739	0.0155	0.1448	0.2053

Note: 1: main market is SADC. 0: main market is other than SADC.

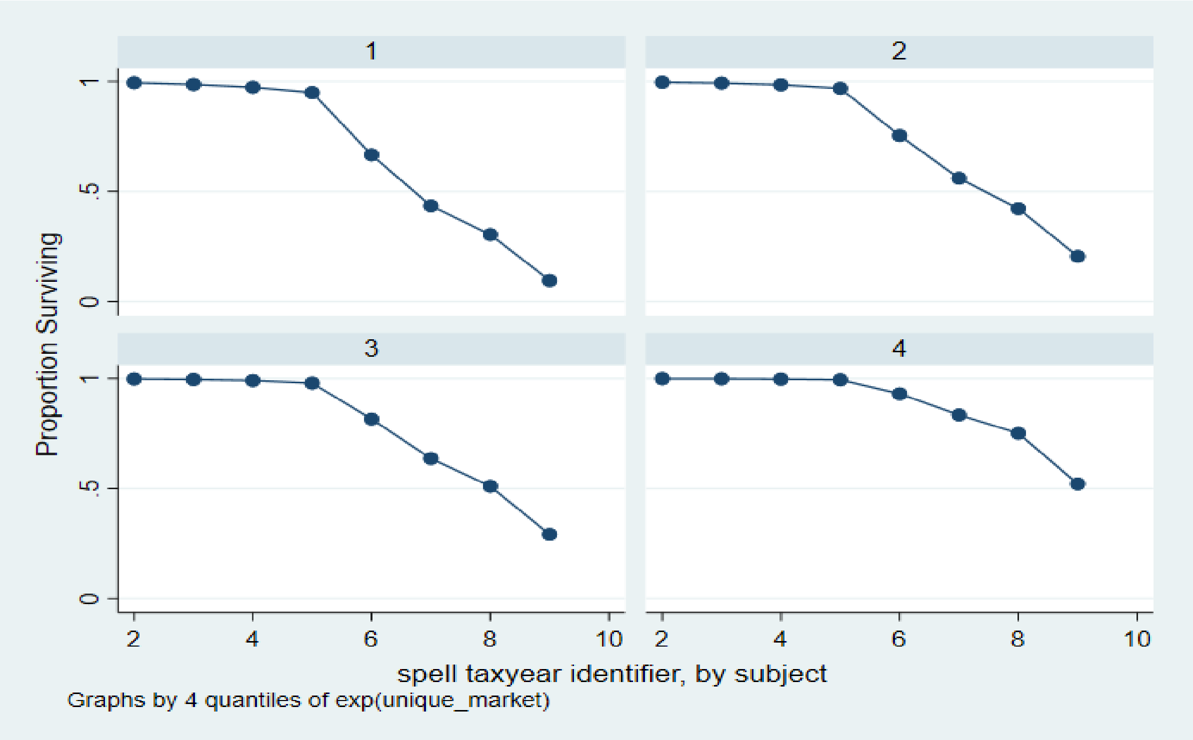
Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

The actual survival rates are depicted in Table 2. At study year two, the survival rate is almost 100 per cent, regardless of whether the firms export to the SADC or non-SADC region. This probability of survival continues until the fifth year for firms exporting to non-SADC regions, and until the fourth year for those exporting to the SADC region. Even though firms in both groups show a rapid decline in survival rates between years four and five, the death rate of firms exporting to the SADC is much higher, with the survival rate dropping to 17.39 per cent by the end of the study period, while those exporting to non-SADC countries have a survival rate of 64.27 per cent at the end of the study period. The gravity model assumptions and findings in the literature are thus refuted. This may be due to factors such as the size (depth and breadth) of the non-SADC market rather than just the distance. This means that over those eight years, firms exporting outside the SADC region have better survival chances compared with firms exporting within the SADC.

Trade bloc advantages seem not to bring benefits in this regard, contrary to the findings of Martuscelli and Varela (2015). In this case, the nature of the export market appears to be a determining factor, in line with Agarwal and Gort (1996).

In line with Agarwal and Gort (1996), our study considered the market extensive margin (Brenton and Newfarmer 2007) from the angle of market diversification. The data contains the number of markets in which a firm trades. Figure 2 presents an analysis of the effect of the number of markets in which a firm trades on the firm's survival.

Figure 2: Survival function for firms operating in different markets



Source: authors' illustration based on data from National Treasury and UNU-WIDER (2019).

The number of markets showed several outliers; therefore, quartiles were created, and the analysis is across these groupings. Figure 2 shows estimates of the survival curve of firms operating in different numbers of markets: quartiles one, two, three, and four. From the second to the fifth tax year, there are high and constant survival curves, which show that firms have approximately 100 per cent survival rates in all four markets. Approximately towards the sixth tax year, the survival curve starts to drop sharply, especially in quartiles one to three, which implies poor survival chances among firms selling to few markets. The hypothesis of market diversification for survival is therefore supported. Brenton, Saborowski et al. (2010) suggest that firm entry rates into markets may be the same across different types of economies, but exit rates differ significantly. The results here are in line with export diversification from the extensive margin point of view (Matthee et al. 2016), which is an increase in the number of trading partners (it can also be accompanied by an increase in the number of products exported) (Brenton and Newfarmer 2007; IMF 2014). South Africa needs to tap into the extensive sustainability margin to help with the structural transformation of the economy and the realization of export-led growth (Besedes and Prusa 2006), which is inclusive (Purfield et al. 2014). Table 3 presents the survival rates in numbers.

Table 3: Life table of survival by quartiles of number of export markets

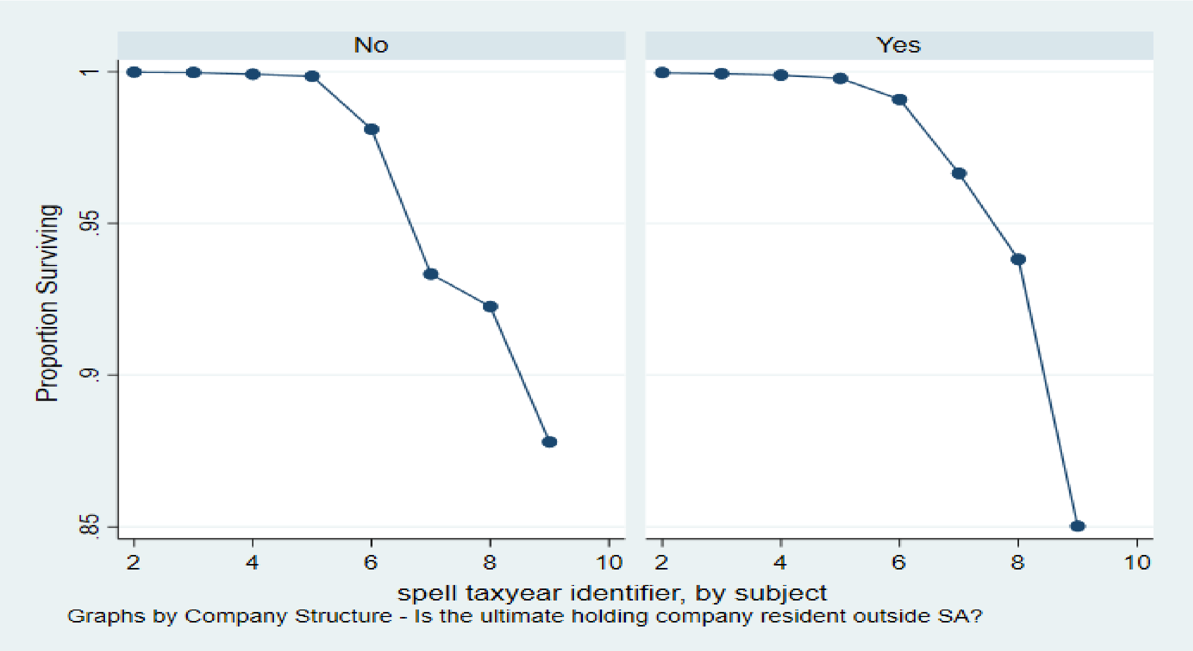
Interval	Beg. total	Death	Lost	Survival	Std error	95% conf. int.	
qmarket = 1							
1-2	50661	258	11173	0.9943	0.0004	0.9935	0.9949
2-3	39230	269	10317	0.9864	0.0006	0.9852	0.9879
3-4	28644	304	9236	0.9739	0.0009	0.9721	0.9757
4-5	19104	369	8266	0.9499	0.0015	0.9469	0.9528
5-6	10469	2354	5158	0.6665	0.0050	0.6566	0.6762
6-7	2957	775	1456	0.4348	0.0075	0.4201	0.4494
7-8	726	161	377	0.3045	0.0101	0.2849	0.3244
8-9	188	68	90	0.0958	0.0122	0.0736	0.1215
qmarket = 2							
1-2	24374	70	5230	0.9968	0.0004	0.9959	0.9975
2-3	19074	67	5001	0.9928	0.0006	0.9914	0.9939
3-4	14006	91	4473	0.9851	0.0010	0.9830	0.9869
4-5	9442	121	4035	0.9690	0.0018	0.9654	0.9723
5-6	5286	843	2973	0.7540	0.0067	0.7407	0.7668
6-7	1470	265	876	0.5604	0.0114	0.5378	0.5824
7-8	329	58	187	0.4224	0.0179	0.3871	0.4572
8-9	84	29	55	0.2056	0.0294	0.1513	0.2658
qmarket = 3							
1-2	31618	55	6544	0.9981	0.0003	0.9975	0.9985
2-3	25019	51	6294	0.9957	0.0004	0.9948	0.9965
3-4	18674	74	6073	0.9910	0.0007	0.9896	0.9923
4-5	12527	115	5527	0.9793	0.0013	0.9767	0.9817
5-6	6885	794	4228	0.8164	0.0054	0.8055	0.8267
6-7	1863	274	1231	0.6371	0.0105	0.6162	0.6571
7-8	358	49	221	0.5109	0.0182	0.4747	0.5459
8-9	88	24	64	0.2920	0.0353	0.2247	0.3623
qmarket = 4							
1-2	29388	14	5811	0.9995	0.0001	0.9991	0.9997
2-3	23563	16	5774	0.9987	0.0002	0.9981	0.9991
3-4	17773	20	5530	0.9974	0.0004	0.9965	0.9980
4-5	12223	29	5279	0.9943	0.0007	0.9929	0.9955
5-6	6915	300	4427	0.9309	0.0036	0.9235	0.9347
6-7	2188	138	1703	0.8348	0.0084	0.8176	0.8505
7-8	347	22	253	0.7515	0.0185	0.7131	0.7855
8-9	72	13	59	0.5216	0.0546	0.4098	0.6221

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

Survival rates differ across the quartiles: firms in quartile one (few export markets) show a survival rate of only 9.58 per cent by the end of the eight-year study period; quartile two shows a 20.56 per cent survival rate; quartile three shows a 29.20 per cent survival rate; and there is a significantly higher survival rate in quartile four at 52.16 per cent. This suggests that having more markets gives a firm a higher chance of survival (Chacha and Edwards 2017). Many markets have been shaken since the global financial crisis of 2007, with a great swing in fortunes over the years; therefore, diversifying markets can be a significant survival strategy for firms, as the results here suggest. However, these results contradict finings by Martuscelli and Varela (2015), who argue that product diversification is more beneficial that market diversification.

Ownership type, such as conglomeration or foreign ownership, is a possible predictor of survival. Figure 3 presents the results.

Figure 3: Estimates of survival curves for firms operating locally versus in foreign countries



Note: no = ultimate holding company is inside South Africa. Yes = ultimate holding company is outside South Africa.

Source: authors' illustration based on data from National Treasury and UNU-WIDER (2019).

From Figure 3 it can be deduced that the survival rate is higher for firms with a holding company that is resident outside South Africa: the survival rate is over 95 per cent by year seven of the study in this group, compared with below 90 per cent for locally owned firms. This is in line with Martuscelli and Varela (2015), who found that foreign-owned firms' survival rate was on average 2.8 per cent higher. However, the trend is reversed by the end of the study period, as local firms' survival rate is about 87 per cent, but for foreign-owned firms it is around 85 per cent. The latter finding corroborates that of Wagner et al. (2012), who observed that foreign-owned firms' survival rate was lower than that of locally owned forms (in their case, German). Foreign ownership is theoretically considered to be beneficial for survival in that it broadens networks, provides external market knowledge, and may give access to relatively cheaper resources, therefore making foreign-owned firms more competitive than domestic firms. The results here show that the foreign ownership effect is indeterminate. It will be of interest to consider the nature of the products exported, as it is generally argued that African countries export more raw products than finished goods (Ndong-Obiang 2015).

Table 4 shows the life table for local firms compared with foreign-owned firms in terms of survival rates. The table shows that if the ultimate holding company is outside South Africa, the survival rate is slightly higher in the early years (years one to seven of the study) compared with firms whose ultimate holding company is resident in South Africa. However, the final survival rate at the end of the study (years eight to nine) is higher for firms whose ultimate holding company is based in South Africa (survival rate 87.80%) compared with firms whose holding companies are outside South Africa (survival rate 85.02%). Domestically controlled firms may struggle to survive in the early years (their short-term survival rates are lower), but in the longer term they show greater persistency. This is one reason for protecting local firms, as ultimately they contribute to sustainable employment. The literature suggests that domestic/locally owned and foreign-owned firms face different incentives and impediments, and this can influence the probability of entry, exit, and survival, given the opportunity to cushion shocks in one market. If the ultimate holding firm is based outside South Africa, that holding company may have exposure to a relatively better operational environment, enabling it to subsidize subsidiaries operating within South Africa (Vartia 2004). This in turn will give those South Africa-based subsidiaries better chances of survival than would otherwise be possible. In effect, such a firm (for example, a foreign-controlled firm in South Africa) can afford inaction even under conditions where the theory predicts otherwise (see Esteve-Pérez et al. 2014).

Table 4: Firm survival analysis of local versus foreign-owned

Interval	Beg. total	Death	Lost	Survival	Std error	95% conf. int.	
Yes							
1-2	46475	4	8507	0.9999	0.0000	0.9997	1.0000
2-3	37964	4	9432	0.9998	0.0001	0.9996	0.9999
3-4	28528	14	8956	0.9992	0.0002	0.9988	0.9995
4-5	19558	10	8348	0.9986	0.0003	0.9979	0.9990
5-6	11200	133	7225	0.9810	0.0015	0.9778	0.9838
6-7	3842	110	3160	0.9333	0.0047	09236	0.9419
7-8	572	4	447	0.9226	0.0070	0.9076	0.9353
8-9	121	3	118	0.8780	0.0260	0.8160	0.9201
No							
1-2	19747	5	3422	0.9997	0.0001	0.9993	0.9999
2-3	16320	5	4189	0.9994	0.0002	0.9988	0.9997
3-4	12126	5	3817	0.9989	0.0003	0.9981	0.9993
4-5	8304	7	3372	0.9978	0.0005	0.9966	0.9986
5-6	4925	24	2928	0.9909	0.0015	0.9875	0.9934
6-7	1973	28	1670	0.9665	0.0048	0.9558	0.9747
7-8	275	5	209	0.9382	0.0133	0.9060	0.9596
8-9	61	3	58	0.8502	0.0498	0.7194	0.9232

Note: no = ultimate holding company is inside South Africa. Yes = ultimate holding company is outside South Africa.

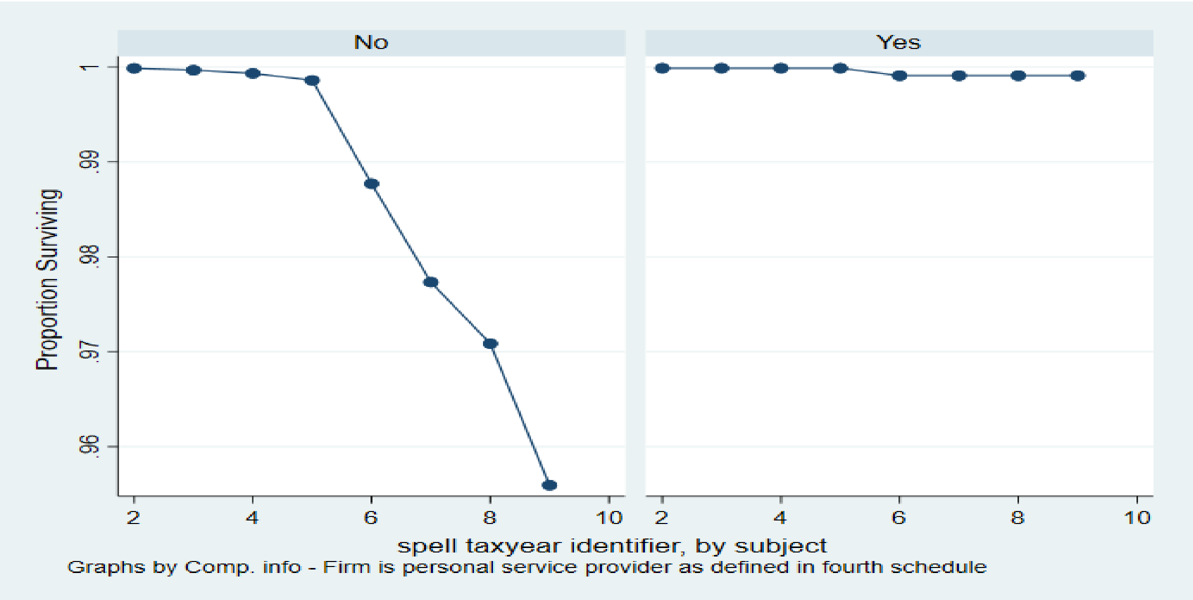
Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

Figure 4 show estimates of the survival functions of firms that are personal service providers compared with non-personal service providers.

Figure 4 shows that the survival rate is much higher (close to 100 per cent) for personal service provider firms over the study period. This contrasts with firms that said they were not in personal service provision, where the survival rate drops to around 95 per cent. Such firms are considered to employ unskilled to low-skilled workers and to be more likely to fail (Ács et al. 2006).

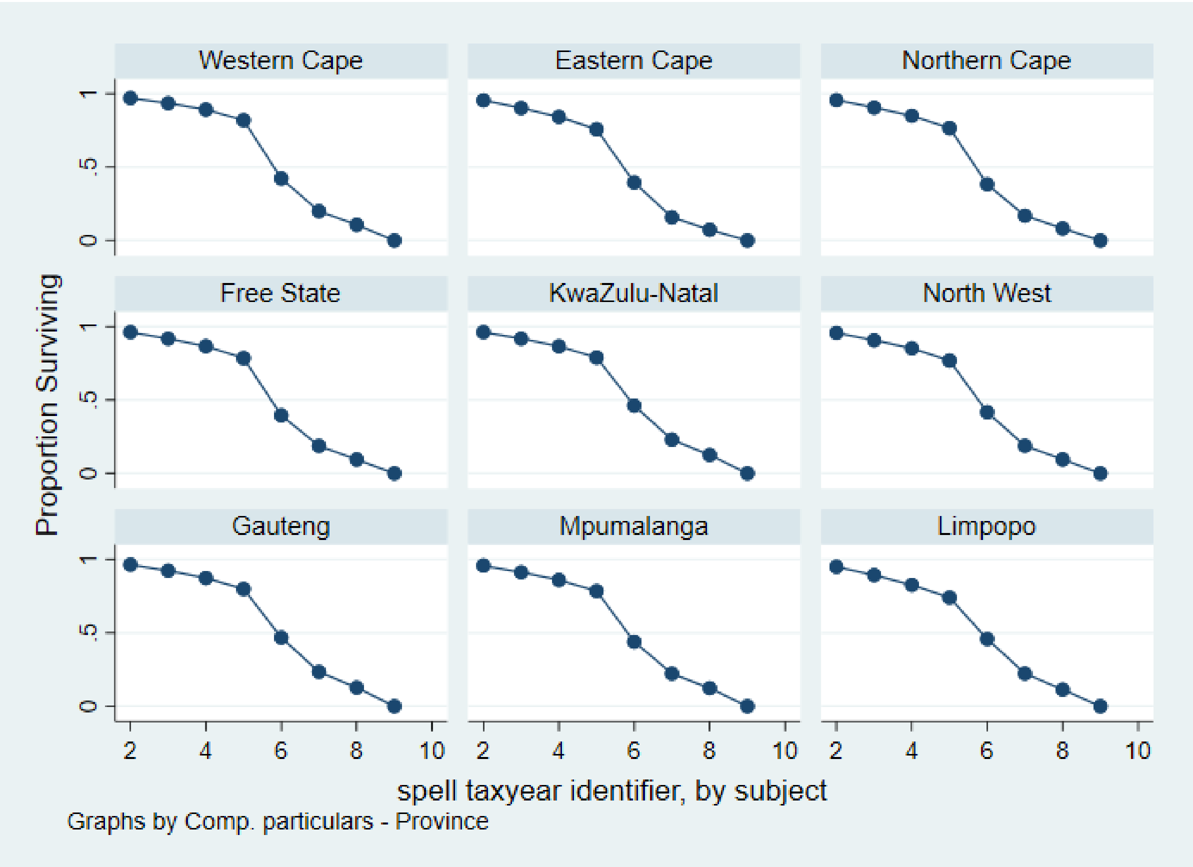
Our study further investigated the region where a firm is based, comparing survival rates across the nine South African provinces. The results are shown in Figure 5.

Figure 4: Survival analysis by firm type, based on whether the firm is a personal service provider



Source: authors' illustration based on data from National Treasury and UNU-WIDER (2019).

Figure 5: Survival in the export market by firms' home province



Source: authors' illustration based on data from National Treasury and UNU-WIDER (2019).

Based on results in Figure 5, the geographical region where the firm is located in South Africa matters, given access to infrastructure and possible cost differences in accessing international markets. Given the devolution of governmental powers in South Africa, support structures for businesses vary from one province to another. Survival rates vary across different provinces, with regions such as Gauteng, Western Cape, and Mpumalanga showing relatively better survival rates up to year seven; unfortunately, all firms that are recorded from the start of the study period die (exit the export market) within the study period, given the zero per cent survival rate recorded in the final year. It is imperative to note that those that join during the study period may still exist at the end of the study period; the survival rate tracks only those that existed from the start of the study.

4.3 Discrete hazard model

Logistic regression analysis was done to ascertain the effect of various continuous variables on the survival of firms in the export market. Table 5 shows the results.

Table 5: Logistic regression on the prediction of survival in the export market

Export	Odds ratio	Std error	z	p > (z)	95% conf. int.	
log_value_exports	.822359	.0857355	-1.88	0.061	.6703768	1.008797
log_number_hs6	2.044088	1.640051	0.89	0.373	.4241774	9.850349
log_number_hs4	.5748337	.4818536	-0.66	0.509	.1111792	2.972082
log_employees	2.217957	.600167	2.94	0.003	1.305037	3.769499
log_total assets	.9225467	.0979235	-0.76	0.448	.749269	1.135897
_cons	4.781086	8.485834	0.88	0.378	.1474855	154.99

Note: number of observations: 1,777 observations. LR $chi^2(5)$: 13.23. Prob. > chi^2: 0.0213. Pseudo R^2: 0.0752.

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

The results in Table 5 show that firms with more export value are less likely to exit the market (0.822 < 1; p-value 0.061). This can be interpreted through the intensive export diversification argument. More productive exports are considered to reflect manufactured goods rather than raw natural resources (Matthee et al. 2016). Market experience and expansion increase the chances of a firm's survival, and this is also supported by the literature (Inui et al. 2017).

On the other hand, firms with more employees (large firms) are more likely to exit the export market (OR 2.22 > 1; p-value 0.003). The literature reports that larger firms can absorb shocks and therefore have better survival chances (Heikki et al. 2019). However, Govindarajan and Srivastava (2016) support our finding, arguing that large firms are vulnerable to disruptions, and therefore their survival rate is lower.

Our study carried out a cloglog regression analysis, and the results are presented in Table 6. Being a tax resident in South Africa, the value of domestic sales, the value of foreign sales, and provision for doubtful debt have a statistically significant effect on survival, reducing the hazard rate. The intensive diversification hypothesis is supported by statistically significant foreign gross sales, which reduce the hazard ratio (thus increasing survival). In general, more sales mean a higher survival rate. On the other hand, providing for doubtful debt also reduces the hazard ratio; this can be interpreted as realistic in assessing the risk faced by the firm, which is thereby able to plan accordingly.

Table 6: Cloglog regression on the predictors of surviving in the export market

Export	Coeff.	Std error	z	p > (z)	95% conf. int.	
Own foreign	-.5890261	.4192287	-1.41	0.160	-1.410699	.232647
Tax resident	-4.597345	.1673068	-27.48	0.000	-4.92526	-4.269429
Foreign gsles	-8.62e-09	3.70e-09	-2.33	0.020	-1.59e-08	-1.37e-09
Domestic gsales	-1.86e-09	4.83e-10	-3.84	0.000	-2.80e-09	-9.08e-10
Doubtful prov	-1.44e-07	3.77e-08	-3.82	0.000	-2.18e-07	-7.03e-08

Note: number of observations: 9,939. Zero outcomes: 9,896. Non-zero outcomes: 43. Wald $chi^2(5)$: 1131.22. Log likelihood: -452.35794. Prob. > chi^2: 0.0000.

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

4.4 Joint modelling

The results from the joint modelling estimation are presented in this section, with each longitudinal outcome discussed (see Appendix B for the Stata implementation). The results are in two parts for robustness, and generally they corroborate the 2010–17 and 2013–17 data sets, with the latter taking outliers into account. Few instances with statistical significance are observed in the 2013–17 data set, which is not the case with the full data set (2010–17).

Exporting to the SADC has a direct negative statistically significant effect on the value of exports (log value of exports) (β -0.250, 95 per cent confidence interval (CI) -0.285–0.214) (Table 7). This implies that if a South African firm has the SADC as its main export region, the value of those exports will be lower compared with exports to other regions. Having the SADC as the main export market has a direct positive effect on survival (ø -0.260, 95 per cent CI 0.210–0.310); this is also reflected in the association coefficient (α -0.117, 95 per cent CI -0.127–0.107), showing that the SADC export market helps to reduce firm deaths. The market may not be sufficiently lucrative to bring significant value (value of exports) compared with other regions, but its geographical proximity and shared cultural values in the region help firms to survive. This finding is similar to the conclusion by Esteve-Pérez et al. (2007) that firms exporting to closer markets survive longer than those exporting to distant markets. This is a hopeful sign for the recently agreed and implemented AfCFTA. Firms need to know the trade in the market. For the South African economy, this brings hope regarding employment creation and job security if firms can trade more within the region. South Africa is apparently the economic powerhouse of the region, with other countries such as Zimbabwe experiencing socio-economic crises and unable to be lucrative due to their constrained incomes.

Firms with the SADC as the main exporting destination have higher numbers of products in the market. A firm may possibly be able to diversity and export different types of products due to low shipment costs, the geographical proximity advantage as pointed by Esteve-Pérez et al. (2007), and cultural similarities that give rise to demand for many diverse products. Whether the number of products is measured by HS4 or HS6, the outcome is the same. In the same vein, there is a positive and statistically significant direct effect on survival, which is in line with results obtained for the value of exports. In both cases, having the SADC as the main export market reduces the risk of death (i.e. not exporting any product, or exiting the market). Firms exporting to other regions are highly likely to end up drastically reducing the number of frequently exported products, or having no product exports, compared with those that have the SADC as the main export market. Thus, firms that are familiar with a particular market are able to boost their export performance in that market (van den Berg et al. 2019).

The majority of firms generate revenue from both local and foreign markets. Survival in the foreign market can be deduced from the value of foreign sales. The SADC treatment has no significant effect on foreign sales, but it has a positive and statistically significant effect on the survival of firms, with no significant effect on risk of death.

Another longitudinal variable of interest is firm size (Table 8), which can be measured by the number of employees (which is important for employment creation) or a log of total assets. The SADC treatment has a negative but statistically insignificant direct effect on firm size; however, the effect on survival is positive and statistically significant. Rahim and Mohammed (2018) and Fu and Wu (2014) also point to the importance of size for firm survival. Exporting mainly to the SADC may not help to create more jobs (above we saw that the value of exports is lower), but it helps to maintain existing jobs (survival). The association coefficient shows that the SADC treatment reduces the risk of death. On the other hand, firm size as measured by log of total assets is positively influenced by the SADC treatment, with the treatment having a positive effect on survival and reducing the risk of death.

Our study further checks the impact of the number of markets in which a firm trades (Table 9). The numbers have been reduced to four quantiles (qmarket treatment) for the purposes of this analysis, ranging from a few markets (one to two) to a higher number in quantile four (16 markets in some cases). We hypothesize that a firm chooses to enter x number of markets as a survival strategy rather than by default. We understand the counterargument that the nature of the product may automatically assign a firm to trade in specific markets; generally, this is too rare a co-occurrence to cause any bias. The results are presented in Table 9, with longitudinal variables on performance as well as growth of firm (size).

The results show that the qmarket treatment has a positive effect on export value, with a negative effect on survival as the treatment increases the risk of death. Entering many markets may be considered a diversification strategy, as it has potential to general more revenue; however, it may require unique management skills to ensure the costs are kept in check. If resources are thinly spread, the additional revenue from one more market becomes smaller; hence survival is threatened, as the risk of death increases.

On the other hand, the qmarket treatment has a positive effect on the number of exported products, whether these are defined based on HS4 or HS6. Survival is reduced; however, the overall risk of death is reduced.

The qmarket treatment increases foreign sales, as expected. However, it reduces survival and increases the risk of death. Foreign sales are good; however, when spread across different markets they expose the firm to possible management competency challenges, and market diversification does not hold in this case. Specialization is supported, as per traditional trade theory, rather than just vying for export markets regardless.

The qmarket treatment reduces firm size as measured by the number of employees (Table 10), reducing survival, but the risk of death is smaller. On the other hand, when size is measured by the log of total assets, the results show that the treatment has a positive effect on total assets, but the survival and risk of death effect is the same as when size is measured by the number of employees.

Table 7: Effect of SADC market on South African firm performance and survival

	2010-17 (average n = 186682)					2013-17 (average n = 131208)					
	Coeff.	Std error	z	p > z	95% conf. int.	Coeff.	Std error	z	p > z	95% conf. int.	Effect type
Longitudinal variable: log_value_exports											
Time (years)	-.0893235	.0046623	-19.16	0.000	-.0984614 -.0801855	.087577	.0048562	18.03	0.000	.0780591.097095	
_Time#SADC treatment	.0336542	.0057346	5.87	0.000	.0224145.0448938	-.0355203	.0059453	-5.97	0.000	-.0471728 -.0238678	
SADC treatment	-.2494381	.0182225	-13.69	0.000	-.2851536 -.2137226	-.1051926	.0186325	-5.65	0.000	-.1417116 -.0686735	β
_cons	12.54936	.0183333	684.51	0.000	12.51343 12.58529	12.21522	.0186855	653.73	0.000	12.1786 12.25185	
Survival											
assoc: value (risk of death)											
_cons	-.117286	.0051048	-22.98	0.000	-.1272912 -.1072808	-.0933216	.0047385	-19.69	0.000	-.1026089 -.0840344	α
ln_lambda											
SADC treatment	.2598944	.0253951	10.23	0.000	.210121.3096679	.1596268	.0226104	7.06	0.000	.1153112.2039424	$\emptyset$
_cons	-6.696124	.093463	-71.64	0.000	-6.879308 -6.51294	-7.515248	.0931076	-80.72	0.000	-7.697736 -7.332761	
ln_gamma											
_cons	1.404789	.0090827	154.67	0.000	1.386987 1.422591	1.521082	.0089677	169.62	0.000	1.503505 1.538658	
Longitudinal: log number of products (HS6)											
Time(years)	-.0008428	.0023872	-0.35	0.724	-.0055217.0038361	-5.07e-06	.0024859	-0.00	0.998	-.0048774.0048672	
_Time#SADC treatment	-.0005262	.0029359	-0.18	0.858	-.0062804.005228	-.0087226	.0030429	-2.87	0.004	-.0146866 -.0027585	
SADC treatment	.1635167	.0093951	17.40	0.000	.1451027.1819307	.1823578	.0095931	19.01	0.000	.1635557.2011599	β
_cons	1.508709	.0095671	157.70	0.000	1.489958 1.52746	1.510678	.0097565	154.84	0.000	1.491556 1.5298	
Survival											
assoc: value (risk of death)											
_cons	-.3430378	.0107195	-32.00	0.000	-.3640477 -.322028	-.3351052	.0098085	-34.16	0.000	-.3543295 -.3158809	α
ln_lambda											
SADC treatment	.4645745	.0258435	17.98	0.000	.4139221.5152269						$\emptyset$
_cons	-7.770276	.0693587	-112.03	0.000	-7.906217 -7.634336	.3664161	.0229565	15.96	0.000	.3214222.4114099	
ln_gamma						-8.247253	.0732613	-112.57	0.000	-8.390843 -8.103664	
_cons	1.414734	.0090181	156.88	0.000	1.397059 1.432409	1.516261	.0090142	168.21	0.000	1.498593 1.533928	
Longitudinal (number of products - HS4)											
Time (years)	.0017359	.0022386	0.78	0.438	-.0026515.0061234	-.0021982	.0023331	-0.94	0.346	-.0067709.0023745	
_Time#SADC treatment	-.0012733	.002753	-0.46	0.644	-.006669.0041224	-.007295	.0028558	-2.55	0.011	-.0128923 -.0016978	
SADC treatment	.1528895	.0087912	17.39	0.000	.1356591.1701199	.1667432	.0089865	18.55	0.000	.1491301.1843564	β
_cons	1.323506	.0088734	149.15	0.000	1.306114 1.340897	1.334529	.0090589	147.32	0.000	1.316774 1.352284	
Survival											
assoc: value (risk of death)											
_cons	-.3715853	.01169	-31.79	0.000	-.3944973 -.3486733	-.3601801	.0106801	-33.72	0.000	-.3811127 -.3392475	α

ln_lambda											
SADC treatment	.462405	.025848	17.89	0.000	.4117439.5130662	.364238	.0229633	15.86	0.000	.3192307.4092453	$\emptyset$
_cons	-7.804167	.0692501	-112.70	0.000	-7.939895 -7.668439	-8.27833	.0731782	-113.13	0.000	-8.421756 -8.134903	
ln_gamma											
_cons	1.415959	.0090166	157.04	0.000	1.398287 1.433631	1.516273	.0090177	168.14	0.000	1.498599 1.533947	
Longitudinal (log foreign sales)											
Time (years)	-.0167816	.0090765	-1.85	0.064	-.0345712.001008	.0253508	.0096249	2.63	0.008	.0064863.0442153	
_Time#SADC treatment	.0080789	.0131912	0.61	0.540	-.0177754.0339332	-.0217019	.0138168	-1.57	0.116	-.0487825.0053786	
SADC treatment	.0576826	.0407603	1.42	0.157	-.0222061.1375714	.106541	.0398599	2.67	0.008	.0284171.184665	β
_cons	17.00734	.0317202	536.17	0.000	16.94517 17.06951	16.9476	.031073	545.41	0.000	16.8867 17.0085	
Survival											
assoc: value (risk of death)											
_cons	-.0086492	.0269125	-0.32	0.748	-.0613968.0440984	-.0032832	.0306431	-0.11	0.915	-.0633426.0567761	α
ln_lambda											
SADC treatment	.9690828	.0923028	10.50	0.000	.7881727 1.149993	.7249188	.1022393	7.09	0.000	.5245334.9253041	$\emptyset$
_cons	-10.29782	.5529977	-18.62	0.000	-11.38168 -9.213965	-11.34645	.657125	-17.27	0.000	-12.63439 -10.05851	
ln_gamma											
_cons	1.566122	.0341582	45.85	0.000	1.499173 1.633071	1.690543	.0413188	40.91	0.000	1.609559 1.771526	

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

Table 8: Effect of SADC market on South African firm size and survival

	2010-17 (average n = 15749)					2013-17 (average n = 131210)					
	Coeff.	Std error	z	p > z	95% conf. int.	Coeff.	Std error	z	p > z	95% conf. int.	Effect type
Longitudinal (log#employees)											
Time (years)	.0066632	.0096497	0.69	0.490	-.0122498.0255762	-.0105501	.0093526	-1.13	0.259	-.028881.0077807	
_Time#SADC treatment	-.0053431	.0177497	-0.30	0.763	-.0401318.0294457	.0110286	.0151579	0.73	0.467	-.0186804.0407375	
SADC treatment	-.0246594	.0546437	-0.45	0.652	-.1317592.0824404	-.0470514	.0493972	-0.95	0.341	-.1438682.0497655	β
_cons	.2414265	.0488477	4.94	0.000	.1456867.3371663	.2509218	.0480509	5.22	0.000	.1567437.3451	
Survival											
assoc: value (risk of death)											
_cons	-.2293287	.360021	-0.64	0.524	-.9349568.4762995	-.9373205	1.506497	-0.62	0.534	-3.89 2.015359	α
ln_lambda											
SADC treatment	1.707791	.5896307	2.90	0.004	.5521357 2.863446	1.666871	.6630016	2.51	0.012	.3674122 2.966331	∅
_cons	-13.57599	2.82744	-4.80	0.000	-19.11767 -8.034308	-14.35314	2.702109	-5.31	0.000	-19.64918 -9.057107	
ln_gamma											
_cons	1.940898	.2265728	8.57	0.000	1.496823 2.384973	1.953875	.2240068	8.72	0.000	1.51483 2.392921	
Longitudinal (log total assets)											
Time (years)	-.0865306	.001687	-51.29	0.000	-.089837 -.0832242	.0970218	.0017588	55.16	0.000	.0935746.100469	
_Time#SADC treatment	.0159529	.0025066	6.36	0.000	.0110401.0208657	-.0257937	.0026011	-9.92	0.000	-.0308918 -.0206956	
SADC treatment	.0736346	.0083981	8.77	0.000	.0571747.0900945	.1640311	.0085452	19.20	0.000	.1472828.1807793	β
_cons	15.1966	.0109072	1393.27	0.000	15.17522 15.21797	14.83436	.0108891	1362.32	0.000	14.81302 14.8557	
Survival											
assoc: value (risk of death)											
_cons	-.1588474	.0050008	-31.76	0.000	-.1686487 -.1490461	-.16243	.0047389	-34.28	0.000	-.171718 -.1531419	α
ln_lambda											
SADC treatment	1.332642	.026847	49.64	0.000	1.280023 1.385261	1.188533	.0239442	49.64	0.000	1.141603 1.235463	∅
_cons	-7.218947	.1060222	-68.09	0.000	-7.426746 -7.011147	-8.060777	.1075	-74.98	0.000	-8.271473 -7.850081	
ln_gamma											
_cons	1.461834	.0093297	156.69	0.000	1.443548 1.48012	1.619171	.0093272	173.60	0.000	1.60089 1.637452	

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

Table 9: Effect of number of export markets (qmarket) on South African firm performance and survival

	2010-17 (average n = 1750)					2013-17 (average n = 1645)					
	Coeff.	Std error	z	p > z	95% conf. int.	Coeff.	Std error	z	p > z	95% conf. int.	Effect type
Longitudinal (value of exports)											
Time (years)	-.0428684	.0053616	-8.00	0.000	-.0533769 -.0323599	-.2680225	.0010461	-256.21	0.000	-.2700728 -.2659721	
_Time#qmarket treatment	-.0095967	.0019941	-4.81	0.000	-.0135051 -.0056884	.0968695	.0004573	211.85	0.000	.0959733.0977657	
qmarket treatment	1.107674	.0068877	160.82	0.000	1.094174 1.121174	1.28396	.002096	612.56	0.000	1.279852 1.288068	β
_cons	10.18657	.0184939	550.81	0.000	10.15033 10.22282	10.84213	.0047183	2297.87	0.000	10.83288 10.85138	
Survival											
assoc: value (risk of death)											
_cons	.0237698	.0064458	3.69	0.000	.0111361.0364034	.016285	.0226555	0.72	0.472	-.028119.0606891	α
ln_lambda											
qmarket treatment	-.5000362	.0140072	-35.70	0.000	-.5274899 -.4725826	-.6471549	.0684965	-9.45	0.000	-.7814056 -.5129041	∅
_cons	-7.298641	.0934938	-78.07	0.000	-7.481886 -7.115396	-1.433798	.4454414	-3.22	0.001	-2.306847 -.5607486	
ln_gamma											
_cons	1.410785	.0088807	158.86	0.000	1.393379 1.428191	.3485524	.1139183	3.06	0.002	.1252768.5718281	
Longitudinal (#HS6 products)											
Time(years)	.0049611	.0026954	1.84	0.066	-.0003219.010244	-.2507807	.0006386	-392.68	0.000	-.2520324 -.249529	
_Time#qmarket treatment	-.002064	.0010005	-2.06	0.039	-.0040249 -.0001031	.0949958	.0002792	340.30	0.000	.0944487.095543	
qmarket treatment	.596056	.0034898	170.80	0.000	.5892161.6028958	.3906205	.0012796	305.27	0.000	.3881125.3931285	β
_cons	.4369392	.0095733	45.64	0.000	.4181759.4557025	1.251121	.0028805	434.35	0.000	1.245476 1.256767	
Survival											
assoc: value (risk of death)											
_cons	-.0773507	.0116717	-6.63	0.000	-.1002268 -.0544745	-.3645368	.0531477	-6.86	0.000	-.4687045 -.2603691	α

ln_lambda											
qmarket treatment	-.4120058	.0137461	-29.97	0.000	-.4389476 -.3850639	-.3109454	.0701639	-4.43	0.000	-.4484641 -.1734267	∅
_cons	-7.035139	.0668743	-105.20	0.000	-7.16621 -6.904068	-1.326693	.3842726	-3.45	0.001	-2.079853 -.5735325	
ln_gamma											
_cons	1.40855	.0088749	158.71	0.000	1.391155 1.425944	.3421811	.1156398	2.96	0.003	.1155313.5688309	
Longitudinal (#HS4 products)											
Time (years)	.0042933	.0025577	1.68	0.093	-.0007196.0093062	-.2563136	.0005325	-481.35	0.000	-.2573572 -.2552699	
_Time#qmarket treatment	-.0009454	.0009496	-1.00	0.319	-.0028066.0009158	.0952318	.0002328	409.16	0.000	.0947756.095688	
qmarket treatment	.5298229	.0032995	160.58	0.000	.5233561.5362897	.2797858	.0010669	262.24	0.000	.2776947.2818769	β
_cons	.3757919	.0090315	41.61	0.000	.3580904.3934933	1.271455	.0024017	529.40	0.000	1.266748 1.276162	
Survival											
assoc: value (risk of death)											
_cons	-.096366	.0125467	-7.68	0.000	-.120957 -.0717749	-.439048	.0579361	-7.58	0.000	-.5526006 -.3254954	α
ln_lambda											
qmarket treatment	-.4063351	.0134975	-30.10	0.000	-.4327897 -.3798806	-.3027124	.0674928	-4.49	0.000	-.4349959 -.1704289	∅
_cons	-7.035632	.0668629	-105.22	0.000	-7.16668 -6.904583	-1.342468	.3859167	-3.48	0.001	-2.098851 -.5860857	
ln_gamma											
_cons	1.408817	.0088741	158.76	0.000	1.391425 1.42621	.344005	.1159076	2.97	0.003	.1168304.5711797	
Longitudinal (foreign sales)											
Time (years)	.0061322	.020782	0.30	0.768	-.0345997.0468641	-.0395717	.0034503	-11.47	0.000	-.0463341 -.0328093	
_Time#qmarket treatment	-.0076057	.0062756	-1.21	0.226	-.0199057.0046943	.0248756	.0013361	18.62	0.000	.0222568.0274944	
qmarket treatment	.1033705	.0206449	5.01	0.000	.0629072.1438338	.1063113	.0061454	17.30	0.000	.0942666.118356	β
_cons	16.81094	.0654071	257.02	0.000	16.68274 16.93913	16.32513	.0155179	1052.02	0.000	16.29472 16.35555	
Survival											
assoc: value (risk of death)											
_cons	.0027233	.0266197	0.10	0.919	-.0494505.054897	.126815	.0892705	1.42	0.155	-.0481519.3017819	α

ln_lambda											
qmarket treatment	-.622055	.0354627	-17.54	0.000	-.6915606 -.5525495	-.6403254	.1889825	-3.39	0.001	-1.010724 -.2699264	∅
_cons	-8.201582	.5513935	-14.87	0.000	-9.282293 -7.12087	-2.524707	1.811759	-1.39	0.163	-6.075691 1.026276	
ln_gamma											
_cons	1.561802	.0337161	46.32	0.000	1.49572 1.627884	-.106656	.3931144	-0.27	0.786	-.8771461.6638341	

Source: authors' calculations based on data from National Treasury and UNU-WIDER (2019).

Table 10: Effect of number of export markets (qmarket) on South African firm size and survival

	2010-17 (average n = 1750)					(Average n = 1645)					
	Coeff.	Std error	z	p > z	95% conf. int.	Coeff.	Std error	z	p > z	95% conf. int.	Effect type
Longitudinal (#employess)											
Time (years)	-.0399319	.0361064	-1.11	0.269	- .1106992.0308354	Insufficient observations					
_Time#qmarket treatment	.0239478	.0157917	1.52	0.129	-.0070034.054899						
qmarket treatment	-.0309763	.0382358	-0.81	0.418	- .1059172.0439645						β
_cons	.3569381	.1063916	3.35	0.001	.1484145.5654618						
Survival											
assoc: value (risk of death)											
_cons	-.4265074	.4287384	-0.99	0.320	- 1.266819.4138044						α
ln_lambda											
qmarket treatment	-.051006	.2602169	-0.20	0.845	- .5610219.4590098						∅
_cons	-11.1631	2.269794	-4.92	0.000	-15.61181 - 6.714382						
ln_gamma											
_cons	1.862199	.2006553	9.28	0.000	1.468922 2.255476						
Longitudinal (total assets)											
Time (years)	-.0640528	.0033238	-19.27	0.000	-.0705673 - .0575382	.0641608	.0150446	4.26	0.000	.0346738.0936477	

_Time#qmarket treatment	-.0025578	.0012156	-2.10	0.035	-.0049403 -.0001753	.0744766	.0065408	11.39	0.000	.0616569.0872963	
qmarket treatment	.1765931	.0045152	39.11	0.000	.1677434.1854428	.4499656	.0297592	15.12	0.000	.3916386.5082927	β
_cons	15.30181	.0152659	1002.36	0.000	15.27189 15.33173	14.97888	.0670732	223.32	0.000	14.84742 15.11034	
Survival											
assoc: value (risk of death)											
_cons	-.1490924	.0053265	-27.99	0.000	-.159532 -.1386527	-.1063923	.0199933	-5.32	0.000	-.1455784 -.0672062	α
ln_lambda											
qmarket treatment	-.3529555	.0121203	-29.12	0.000	-.3767108 -.3292001	-.4975293	.0616074	-8.08	0.000	-.6182775 -.3767811	$\emptyset$
_cons	-5.417637	.1060851	-51.07	0.000	-5.62556 -5.209714	-.8656989	.5935005	-1.46	0.145	-2.028938.2975407	
ln_gamma											
_cons	1.462249	.0092177	158.63	0.000	1.444183 1.480316	.6456863	.127834	5.05	0.000	.3951363.8962363	

Source: authors’ calculations based on data from National Treasury and UNU-WIDER (2019).

5 Summary, conclusions, and recommendations

5.1 Summary and conclusions

This paper has aimed to estimate the survival rates of firms operating in South Africa, focusing specifically on those involved in international trade. An estimation of the firm and product survival analysis is carried out using a tax administration panel data set. The results show that firms' survival depends on the nature of the market, which includes product and market characteristics (external), and firm characteristics, which include firm size, ownership, and location (internal). This therefore closes a gap identified by Manjón-Antolín and Arauzo-Carod (2008).

The descriptive analysis results show that the overall firm survival rate over the eight-year period is higher than the survival rate in five to seven years. Therefore, we conclude that firms tend to survive more after having operated for many years, which can be attributed to the establishment of networks and the experienced gained. Results also indicate that the survival rate is relatively higher for firms that export to distant markets (outside the SADC) than for firms that export to the SADC. Thus, the gravity model of trade, which specifies that distance confers an advantage, is refuted by this administrative data, and SADC trade bloc advantages appear not to be present. AfCFTA needs to take this into account, especially regarding transport infrastructure and the establishment of transnational zones, as argued by Karambakuwa et al. (2020). We also conclude that there may be other factors increasing the survival of non-SADC exporting firms, such as trade regulations that are friendlier to South African firms (bilateral and multilateral agreements with Europe, BRICS, and G20 countries), the size of the non-SADC market in general and its purchasing power, and the particular location of the firm within South Africa (as part of an SEZ, or in a province with trading or other relations with specific countries, e.g., through city twinning).

Using four quartiles and estimates of the survival curves of firms operating in the different markets, results indicate poor survival chances among firms that sell to few markets. We conclude that the diversification of markets is important for the survival of exporting businesses, as they can depend on other markets if they face challenges with a particular market. Firms with a small number of export markets show very low survival rates, while those with more exports show a higher survival rate. This leads to the conclusion that having more markets gives a firm a higher chance of survival.

The foreign ownership effect is indeterminate, as results showed that during the first six years survival was higher for firms with a holding company that was resident outside South Africa than within South Africa, but later the survival rate for local firms increased to higher rates than foreign-owned firms. This may be due to the products exported and different incentives, although foreign-owned firms have advantages such as greater exposure in the international market. Further, the survival rate is much higher for personal service-providing firms, which are considered to employ unskilled to low-skilled workers. This may explain the low absorption rate for skilled labour in the South African market compared with unskilled labour.

We conclude that that geographical region where the firm is located in South Africa is important for survival. The results show that regions such as Gauteng, Western Cape, and Mpumalanga have relatively better survival rates up to year seven. This may be due to access to infrastructure, possible cost differences in accessing international markets, and varying business support structures between one province and another.

Results from the logistic regression analysis of the discrete hazard model show that firms with more export value are less likely to exit the market, implying that diversification is important for survival. On the other hand, firms with more employees (large firms) are more likely to exit the export market, and this may be because they are vulnerable to shocks. The results from a cloglog regression indicate that being a tax resident in South Africa, having a higher value of domestic and foreign sales, and providing for doubtful debts increases survival and reduces the hazard rate.

The results from the joint modelling estimation indicate that for South African firms, when the SADC is the main export region, the value of exports is lower compared with exports to other regions. However, there is a higher number of products exported, meaning that a firm is able to diversify and export different types of products, possibly due to the SADC's geographical proximity advantage (it is easier to transport various type of products, using different modes of transport such as by road, which is not possible with other markets) and cultural similarities. On the other hand, having the SADC as the main export market helps to reduce firm deaths. Thus, exporting mostly to the SADC may not help to create more jobs, but it helps to maintain existing jobs (retention through survival).

The qmarket treatment (quantiles of number of markets) shows that entering many markets is a diversification strategy with potential to generate more revenue; however, it may require unique management skills to ensure the costs are kept in check. Further, there is the danger of spreading resources thinly, leading to smaller additional revenue from one more market, and ultimately reducing survival. When foreign sales are spread across different markets, this exposes the firm to possible management competency challenges; market diversification does not hold in this case. Also, the qmarket treatment reduces the firm size as measured by the number of employees, reducing survival, but the risk of death is even smaller. The qmarket treatment has a positive effect on the number of exported products, meaning that the overall risk of death is reduced. When size is measured by the log of total assets, the treatment has a positive effect on firm size.

5.2 Recommendations

The South African economy stands to benefit from an export strategy: the potential exists, and more benefits can be tapped through the following recommendations.

Investment in transport infrastructure to facilitate regional trade

South Africa needs to invest in—and mobilize other countries to invest in—upgrading port and telecommunications networks in Africa under the auspices AfCFTA. South Africa stands to benefit more as a major producer within the region, and it has a sound existing infrastructure. Ease of doing business needs to be improved by cutting unnecessary red tape and aligning regulatory requirements across countries.

Encouragement of city twinning among African cities to leverage the understanding of cultures and tastes

Metropolises and cities that are home to firms in the export market, or those that want export-oriented firms to locate in their region, should identify sibling cities within the region and beyond. Such twinning must be done with an understanding of the size and nature of the sibling's market. A good candidate is one with a large and growing population, a populace that is open to new products, and cultural diversity so that South African products may be well received and survive in that market.

Interventions to develop small businesses and support services to focus on market scouting and building managerial competencies in general

As firms grow, the operational environment changes, and new technologies come on board, managers need to be adequately skilled. Bigger firms have been revealed to be vulnerable to death, which may be attributable to sophistication that is beyond management's comprehension, making the firm vulnerable to the weakest of negative shocks.

Reconfiguration of the SEZ model and its expansion to transnational zones to support AfCFTA objectives as well as ensuring exploration of regional markets with reduced transaction costs

In addition, processing zones have potential to increase the value of exports, which has been found to increase the chances of firm survival. South Africa needs to put structures in place to add value on all exported products; export processing zones, and mineral refining or cutting, among other strategies, will help to enhance value.

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Appendix A

Table A1: Indicators observed and study variables

Observation	Variable in this study
International - company owns foreign assets or investments	Foreign ownership
Comp. particulars - province	Regional location
Comp. info - is the company registered/licensed for customs purposes?	Business activity status for inclusion and exclusion selection
Comp. info - main industry source code	Industry type
Comp. info - firm is SA resident for tax purposes (foreign)	Foreign ownership
Comp. info - did the company cease to be a resident during the year?	Foreign ownership changes
Number of IRP5 tax certificates	Number of employees
Comp. info - gross income in year of assessment	Firm performance
Comp. info - total assets in year of assessment	Size of business
Turnover	Size of business
Gross profit/loss - add rebates	Firm performance
SEZ - is business or services provided from within SEZ(s)?	Government initiatives
Characteristic - belongs to foreign holding company	Foreign ownership
Company is a small business corporation as defined in S12E	Firm size
Gross income of small business corporation (SBC)	Firm performance
Customs - main transport used for trade	Competitiveness (infrastructure access)
Customs - total unique countries exports are destined for	Trading partners
Customs - total unique HS6 products exported	Type of products (count)
Customs - total unique HS4 products exported	Type of products (count)
Customs - total value of exports	Performance in international market
Customs - largest regional export partner	Trading partner
Customs - largest export partner by income group	Status of major trading partner
Customs - largest export partner by region and income group	Trade partner characteristics
Customs - value of exports by country	Performance in export market
Customs - value of exports from SADC trading partner	Regional integration
Customs - value of exports from high-income OECD trading partner	Market quality
Customs - value of exports from high- income non-OECD trading partner	Market quality
Customs - HS6 code of most recurrent/most exported good	Type of products
Customs - HS4 code of most recurrent/most exported good	Type of products

Source: authors' compilation based on data from National Treasury and UNU-WIDER (2019).

Appendix B

For the longitudinal joint estimation, we fit the joint model using Stata (stjm), with the basic structure of $longitudinal\ indicator\ [varlist], panel(varname)[gh(\#)\ \ldots]$ (Crowther et al. 2013).

For the longitudinal submodel:

- Ffp (numlist) is fixed FPs of time.
- Rfp (numlist) is random FPs of time.
- Varlist is baseline covariates.
- Time interaction (varlist) is interaction covariates with fixed time functions.

For the survival submodel:

- Survmodel (exp|weib|gomp|fpm|rcs) is the survival model.
- Survicov (varlist) is the baseline covariates.

For this study, the following structure has been followed:

```
stjm long_response trt, panel(id) survmodel(weibull) ffp(1) survcov(trt)
timeinterac(trt)
```

translating to (using one example for our data):

```
stjm log_value_exports sadc_exporter, panel(FID) survmodel(weibull) ffp(1)
survcov(sadc_exporter) timeinterac(sadc_exporter)
```

- Log value of exports is the longitudinal indicator of interest.
- Sadc_exporter is the treatment (SADC is the main export market).
- FID (firm identification, which is the tax reference number) is the panel identifier.