



A comparative analysis of the UK and Italian small businesses using Generalised Extreme Value models



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ARTICLE INFO

Article history:

Received 23 January 2014

Accepted 28 July 2015

Available online 10 August 2015

Keywords:

Decision support systems

Risk analysis

Credit scoring

Small and Medium Sized Enterprises

Default prediction

ABSTRACT

This paper presents a cross-country comparison of significant predictors of small business failure between Italy and the UK. Financial measures of profitability, leverage, coverage, liquidity, scale and non-financial information are explored, some commonalities and differences are highlighted. Several models are considered, starting with the logistic regression which is a standard approach in credit risk modelling. Some important improvements are investigated. Generalised Extreme Value (GEV) regression is applied in contrast to the logistic regression in order to produce more conservative estimates of default probability. The assumption of non-linearity is relaxed through application of BGEVA, non-parametric additive model based on the GEV link function. Two methods of handling missing values are compared: multiple imputation and Weights of Evidence (WoE) transformation. The results suggest that the best predictive performance is obtained by BGEVA, thus implying the necessity of taking into account the low volume of defaults and non-linear patterns when modelling SME performance. WoE for the majority of models considered show better prediction as compared to multiple imputation, suggesting that missing values could be informative.

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1. Introduction

Small and Medium Enterprises (SMEs) play a central role in the European Union (EU) economy, as recognised by the Small Business Act of the European Commission in 2008 (http://ec.europa.eu/enterprise/entrepreneurship/docs/sba/SBA_IA). In 2011 SMEs represented 99 per cent of enterprises in Europe, employing more than two thirds of the workforce and contributing 58 per cent of total EU added value. The importance of SMEs varies across the EU. In some countries, e.g. Italy, Spain and Portugal, SMEs have larger shares in employment and added value and higher presence than the EU average. On the contrary, these figures are lower than the EU average in other countries, e.g. the UK, Germany and France.

In this work we compare Italy and the UK since the economies of these countries are different, and it is of interest to explore the differences in predictors of SMEs failures, especially in the aftermath of the “credit crunch”. The literature on SME default prediction is limited, in particular in cross-country comparisons, and the main objective of this paper is to fill in this gap. This paper contributes to the existing

cross-country research by an initial exploratory investigation of risk predictors using accounting and some non-financial information that are available from public sources.

Several models are considered, starting with the logistic regression which is a standard modelling approach in credit risk research (Thomas, Edelman, & Crook, 2002). Yet in situations with low numbers of events (defaults), alternative approaches producing more conservative estimates of default probabilities might be of importance. In this paper we concentrate on asymmetric link function and non-linearity between the response and predictors. In real applications the number of defaults is small, therefore, suggesting the asymmetric link function might be beneficial. At the same time the assumption of linearity is not always supported by patterns in the real data. This paper extends the application of Generalised Extreme Value (GEV) regression that has been proposed for low default portfolios by Calabrese and Osmetti (2013) to two countries. Furthermore, the problem of non-linearity is explored through the application of non-parametric additive model (BGEVA).

The public sources often have incomplete data and this problem is particularly relevant for SMEs. Another objective and contribution of this paper consists in the exploration of two approaches to handle the missing values: multiple imputation and Weights of Evidence transformation, the latter being the credit industry’s preferred approach.

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The rest of the paper is structured as follows: [Section 2](#) provides some background information on the importance of SMEs to the economy and some differences across the two countries. It also summarises previous research on SMEs failure prediction. [Section 3](#) explains the methodology, and [Section 4](#) presents the empirical results, including data description, comparison of predictive accuracy and comparison of statistically significant risk predictors. The final section concludes.

2. Background and literature review

There are some notable differences in characteristics of SMEs in the UK and Italy. In Italy, SMEs form 99.9 per cent of the firms. In 2011 they employed around 81 per cent of the workforce and contributed 68.3 per cent of the Italian added value ([EC, 2012a](#)). In terms of the number of SMEs, Italy has the largest SME sector in the EU. With 3.813 million SMEs Italy has almost twice as many as UK (1.649 million). However, the vast majority of Italian SMEs are micro-firms with less than 10 employees. In fact, Italy's share of micro-firms, at 94.6 per cent, exceeds the EU-average (92.2 per cent). Hence, the micro-firms' contribution to employment (46.6 per cent against the EU-average of 29.6 per cent) and added value (29.4 per cent against the EU-average of 21.2 per cent) is high.

On the contrary, the UK economy is characterised by larger companies. In 2011 more than half of the UK added value was produced by large companies that employed less than half (45.7 per cent) of the workforce and constituted only 0.4 per cent of the UK companies. The percentage of micro-firms in the UK (89.5 per cent) is lower than the EU-average (92.2 per cent), and those employ only 20.3 per cent of the workforce and create only 18.5 per cent of the UK added value ([EC, 2012b](#)).

Financial crisis has substantially affected SMEs sectors in both countries and recovery has been weaker than in the EU on the whole. The Italian SME sector has reversed to the levels of 2005 (i.e. before the crisis) in terms of the number of firms, employment and value-added creation. In the UK, SMEs have been hit mostly in terms of employment and value-added creation, but the numbers of SMEs are higher than in 2005 and stable. In both countries larger firms suffered less as compared to the smaller ones.

Despite an important role that SMEs play in any economy, academic research into SMEs failure prediction is not very extensive. There are some (albeit not numerous) papers investigating success factors or default risk of SMEs in a specific country, e.g. [Altman and Sabato \(2007\)](#) for the US, [Fantazzini and Figini \(2009\)](#) for Germany, [Sohn and Kim \(2013\)](#) for South Korea, [Martens et al. \(2011\)](#) for Flanders – to give some examples, yet literature on international comparisons of failure prediction is exceptionally limited.

The survey by [Altman and Narayanan \(1997\)](#) summarised previous research on the performance of companies (not only SMEs) in 22 countries that included both developed and developing economies. Most studies surveyed found measures of profitability, leverage, liquidity, cash flow management, growth and efficiency to be important for bankruptcy prediction, although specific measures used would vary from country to country. A more recent study by [Lussier and Halabi \(2010\)](#) compared performance of SMEs in the USA, Croatia and Chile. Among the variables that were found important for business performance were characteristics of managers (education, experience) and the quality of business functions (record keeping, financial control, planning, staffing).

The most comprehensive study of European SMEs to date is by [Michala, Grammatikosa, and Filipea \(2013\)](#) where a simple hazard model ([Shumway, 2001](#)) has been applied to small businesses from eight European countries, namely Czech Republic, France, Germany, Italy, Poland, Portugal, Spain and the United Kingdom for the period of 2000–2009. The paper has confirmed the significance of indicators of profitability, coverage, leverage and cash flow for bankruptcy

prediction in cross-country setting. In addition, some non-financial company characteristics have been investigated and the effect of macroeconomic variables. [Pederzoli, Thoma, and Torricelli \(2013\)](#) modelled credit risk of EU innovative SMEs, but the authors did not make cross-country comparisons.

There were some comparisons between two countries. [Ihua \(2009\)](#) compared the key factors influencing SMEs failure between the UK and Nigeria, and found that economic conditions and infrastructure were more significant in Nigeria, whilst in the UK the key factors were due to internal company characteristics, including management efficiency.

[Dietsch and Petey \(2004\)](#) analysed default probabilities and asset correlations for French and German SMEs. Yet the focus of their analysis was more on comparison of correlations of SMEs as opposed to large corporations, and the paper did not look at financial ratios or other predictors of default.

As for SME research in the UK, [Lin, Ansell, and Andreeva \(2012\)](#) compared different definitions of financial distress on a sample from 2001 to 2004 and concluded that although each definition changed the model composition substantially, the most useful variables in distinguishing between distressed and healthy companies, were profit related measures, growth and efficiency ratios. [Altman, Sabato, and Wilson \(2010\)](#) developed a default prediction model using financial indicators of leverage, profitability, working capital and non-financial information (e.g. age, default events in the past) using the data from 2000 to 2007. They found that the non-financial variables provided a notable improvement in predictive performance. [Orton, Ansell, and Andreeva \(2011\)](#) explored the behaviour of the UK SMEs from 2007 to 2010 – through the "credit crunch". They demonstrated that there was a significant degree of stability and accuracy of credit risk models, despite increases in the numbers of SMEs defaults. Similar to [Altman et al. \(2010\)](#) they found company demographics, derogatory events and information about directors to be of significant value.

Regarding the modelling approaches, the overwhelming majority of studies reviewed above used logistic regression. Other models included proportional odds or simple hazard model ([Fantazzini, Figini, Giuli, & Giudici, 2009](#); [Michala et al., 2013](#)), Bayesian and classic panel models ([Fantazzini et al., 2009](#)), random survival forests ([Fantazzini & Figini, 2009](#)), Support Vector Machines ([Martens et al., 2011](#)).

In Italy [Vallini, Ciampi, Gordini, and Benvenuti \(2009\)](#) attempted to model SME defaults on a sample of small firms from 2001 to 2005 using profitability, liquidity and leverage ratios. Multiple discriminant analysis was compared to logistic regression, and the latter was found to produce better predictions. Later study by [Ciampi and Gordini \(2013\)](#) applied neural networks to the same dataset and reported their superior performance as compared to algorithms used in the earlier work. Both studies noted that credit scoring models could be built on accounting information, yet predicting default for SMEs was much more difficult as compared to large enterprises, with predictive accuracy decreasing in smaller firms segments.

[Calabrese and Osmetti \(2013\)](#) and [Calabrese, Marra, and Osmetti \(2013\)](#) applied GEV and BGEVA models to the sample of Italian SMEs from 2006 to 2011 and found superior performance of both models as compared to logistic regression. Variables found significant in predicting default were again measures of profitability, leverage and liquidity.

The current paper extends the existing literature by looking at two countries in comparison (Italy and the UK), by exploring SMEs failure in a more recent time period and by using more comprehensive list of financial measures.

3. Methodology

When constructing a credit scoring model, three common problems are often mentioned: first, low numbers of defaults, second,

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