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Corporate failure prediction in the European energy sector: A multicriteria approach and the effect of country characteristics

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ABSTRACT

This study examines the development of corporate failure prediction models for European firms in the energy sector, using a large dataset from 18 countries. The construction of the models is based on a multiple criteria decision aid (MCDA) approach taking into account both ordinal criteria and nominal country-sector effects. The analysis is based on different modeling specifications. First, traditional financial variables are examined, which are then extended with additional country-level data related to the economic and business environment, as well as data about the energy efficiency policies of the countries and the characteristics of their energy markets and networks. The results indicate that energy-related attributes have high discriminating power and add valuable information compared to the other attributes.

1. Introduction

The energy sector experiences a number of challenges due to geopolitical uncertainties and the introduction of actions and policies for strengthening energy sustainability, efficiency, security, and addressing climate change concerns. At the same time, huge investments are required to meet the increasing energy demand. The International Energy Agency estimates that, under its base scenario of a 30% increase in global energy demand by 2040, total investments of $44 trillion will be needed in energy supply (about 60% involving oil, gas and coal extraction and supply, whereas production and supply of renewables account for 20%), and an extra $23 trillion in energy efficiency (International Energy Agency, 2016).

The contributions of the private sector in this context, are of paramount importance, in areas such as the exploration of new energy reserves, the adoption and promotion of clean energy technologies, and the provision of affordable, secure, and reliable energy to end consumers. However, firms in the energy sector have recently been under severe financial pressure due to the plunge in oil prices, which led to the cancellation or postponement of planned infrastructure and exploration projects, while diminishing the prospects of investments already under implementation. Thus, the viability of energy firms is a timely issue, particularly in an international context, taking into account the developments in the economic/business environment as well as in the energy sector itself.

Past studies have examined issues related to the financial performance of firms in the energy sector in relation to financial indicators (Capece, Cricelli, Pillo, & Levialdi, 2010; Halkos & Tzeremes, 2012), corporate social responsibility and competitiveness (Pätäri, Arminen, Tuppura, & Jantunen, 2014), productivity and efficiency (Jamasb, Pollitt, & Triebs, 2008), and environmental aspects (Arslan-Ayaydin & Thewissen, 2017), among others. However, the viability of energy firms, from the point of view of corporate failure and financial distress, has not been examined. This is a bit surprising, given that energy markets have been shown to play an important role for achieving financial stability (Safarzyńska & van den Bergh, 2017).

The analysis and prediction of corporate failures and financial distress is an active area of research in both finance and operations research/management science (Altman & Hotchkiss, 2006; Balcaen & Ooghe, 2006; Bellovary, Giacomino, & Akers, 2007; Dimitras, Zanakis, & Zopounidis, 1996; Kumar & Ravi, 2007). The vast majority of existing studies on corporate failure prediction models focus on sectors such as banking, manufacturing, commerce, and services, usually in the context of one country. Recently, Altman, Iwanicz-Drozdowska, Laitinen, and Suvas (2017) and

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Laitinen and Suvas (2016) presented cross-country studies, focusing on the examination of the role of country-specific effects in explaining and predicting corporate failures for industrial companies.

Such a cross-country perspective suits well the characteristics of the energy sector, in the context described above. This is particularly true for Europe in the light of policies currently under implementation, towards a harmonized and liberalized European energy market, which will have a significant impact on the operation of firms in the energy sector and ultimately on consumers. In this framework, the main objective of this study is to investigate the potential of constructing cross-country corporate failure prediction models for European firms operating in the energy sector. Such an analysis extends previous studies on the financial performance of energy firms, adding the perspective of financial distress. Moreover, we adopt a broad approach covering all sub-sectors in the energy industry, instead of focusing only on a single sub-sector (e.g., oil and gas, utilities, etc.). The adopted cross-country setting enables the examination of the role of country-specific features, including not only information about the economic and business environment (which has been examined in previous cross-country financial distress prediction studies for industrial companies), but also data of particular interest to the energy sector, such as the energy performance of the countries and the status of their internal energy market. Incorporating such information into the analysis provides new insights on how policy actions and measures taken at the international or country level may affect the viability of firms in the energy sector. The empirical analysis is based on a large sample of more than 44,000 firms from 18 countries in the European Union (EU).

On the methodological side, the analysis is implemented using a MCDA approach for constructing failure risk assessment models in the form of an additive value function. MCDA techniques for constructing value function models from data have been successfully used in predicting corporate failures and financial distress using firm-specific financial data (for a recent bibliographic review, see Zopounidis, Galariotis, Doumpos, Sarri, & Andriosopoulos, 2015). However, such techniques are restricted to the handling of ordinal attributes, while ignoring nominal features that may add significant information in the analysis. This is particularly true for the setting in this study, because nominal effects related to country and sectoral factors are important for describing the external environment in which firms operate. Thus, we introduce and employ an extension of existing MCDA tools that allows the incorporation of both ordinal and nominal attributes in the models. Such an extension yields considerably better results than traditional MCDA models that incorporate only ordinal information and further confirms the importance of taking into account energy-related country-specific data.

The rest of the paper is organized as follows. The next section describes the modeling approach and the MCDA tools used to construct the financial distress prediction models. Section 3 is devoted to the presentation of the data, whereas Section 4 presents and discusses the results. Finally, Section 5 concludes the paper and discusses some future research directions.

2. Methodology

Assessing corporate failure risk in a cross-country context requires the consideration of not only firm-specific information, but also country-level data, which define the context within which firms operate. These involve the economic and business environment of the countries. Moreover, when focusing on sectors with specific features, such as the energy sector, it would be useful to examine further information about specific country aspects that relate to the energy sector, such as the energy performance of the countries and the conditions in their internal energy markets. The importance of incorporating industry-specific effects into corporate failure prediction models has been highlighted by Chava and Jarrow (2004).

Following this multifaceted framework, in this study we develop a distress risk score R_{ikj} for every firm i from country k and energy sub-sector j (e.g., electricity production, extraction of petroleum and natural gas, mining of coal, etc.), such that higher values correspond to lower failure risk. The risk score is a function of firm characteristics, country-specific attributes (economic and energy-related), as well as country and sector fixed effects that control for information not fully captured by the other available data:

$$R_{ikj} = f(\mathbf{x}_i, \mathbf{z}_k, \mathbf{e}_k, c_k, s_j) \tag{1}$$

where $\mathbf{x}_i = (x_{i1},\ x_{i2}, \ldots)$ is a vector of firm-specific attributes, $\mathbf{z}_k = (z_{k1},\ z_{k2}, \ldots)$ is a vector describing the macroeconomic and business environment in country k, $\mathbf{e}_k = (e_{k1},\ e_{k2}, \ldots)$ is a vector of energy-related data about country k, whereas c_k and s_j denote, respectively, the country and sector effects.

The specific form of the above general risk model can be expressed is various ways. Corporate failure prediction and credit risk assessment models are formulated in linear and non-linear forms, implemented through single model/method or ensemble schemes (Kumar & Ravi, 2007). Clearly, the choice of the most suitable approach is a critical issue. Naeem (2006) and Scheule, Baesens, and Rösch (2016) note a number of issues that should be considered when choosing the appropriate model and technique, including the nature of the data, implementation issues, the interpretability of the results, operational and cost issues, legal compliance, as well as predictive performance, among others. In a comparative analysis in the context of credit scoring, Baesens et al. (2003) found that linear models often provide similar results to non-linear ones, thus concluding that the data in this domain are characterized by weak non-linearities. An updated comparative study by Lessmann, Baesens, Seow, and Thomas (2015), however, showed that noticeable improvements can be achieved particularly through model/method combination approaches. Similar results were also reported by Finlay (2011). Despite the success of complex non-linear models in terms of statistical predictive performance, several studies have noted that the financial services industry still relies on simpler models (Finlay, 2010, p. 212). Finlay (2011) argues, that this can be attributed to issues such as the higher development and implementation costs for complex models, their lack of robustness over time and when applied to actual practice (Hand, 2006), as well as the understanding and the explicability of the models, which is often a regulatory requirement (rather than a mere cognitive issue or modeling choice by the analyst).

In the context of MCDA, decision models are expressed in forms that match the preferential system of decision-makers, while taking into account several characteristic properties and conditions (Bouyssou, Marchant, Pirlot, Tsoukiàs, & Vincke, 2006; Keeney & Raiffa, 1993). However, in this study we do not seek to provide insights from the perspective of a specific decision-maker (or a group of decision-makers) following an expert/judgmental setting (which is most appropriate when historical data are lacking; see, for instance, Angilella, Greco, Lamantia, & Matarazzo, 2004). Instead, we adopt a data-driven approach based on the existing literature and the current practices in corporate failure and credit risk modeling, aiming towards providing general insights. More specifically, we adopt an additive modeling form that extends pure linear models towards a more general form, allowing for non-linearities, while retaining the comprehensibility of the model. Of course, additive models are subject to preferential independence assumptions (Keeney & Raiffa, 1993), which may appear restrictive in the context of preference modeling. However, the acceptance of addi-