

Analysis of Financial Distress cross Countries: Using Macroeconomic, Industrial indicators and Accounting Data

Abstract

This paper applies three-way multidimensional scaling and cluster analysis to examine the nature of insolvency in the Gulf Corporation Council, the United Kingdom and the United States of America between from 2004 to 2012. The findings of this paper reveal that analyzing the financial statements data with indicators of industrial and macroeconomic, provide a better understanding of the performance of the solvent and insolvent firms cross-counties. The results proved that the financial health of firms should be examined in situ within the local macro environment. There is also a clear implication for managers of firms as paying most of ones attention to one aspect of financial performance appears to increase the risk of insolvency.

Keywords: Corporate insolvency, Financial ratios, Macroeconomic indicators and Multidimensional scaling

1. Introduction

Financial distress is one of the most important threats facing firms regardless of their size and operation (Charitou et al., 2004). In the last four decades, predicting financial distress research has been a hot topic in corporate finance for academics and practitioners as it serves as an effective early warning signal for creditors, investors, corporate regulators and other stakeholders. The collapse of many global firms during the financial crisis of 2007, proved the limitation of corporate distress models based only on observables at the firm level as there is an urgent need to examine the dynamic macro environment (Tinocoa and

10 N., 2018, 2013). Furthermore, changing of government regulation targeting a specific product, such as has happened with tobacco, is another factor that can potentially increase the bankruptcy rate for the firms in specific industry.

It seems reasonable to suggest that, to better understand corporate failure, we should study the effects of all information accounting, macroeconomic
15 and industry information simultaneously; i.e. adopt a multilevel perspective (Kozlowski and Klein, 2000). However, most corporate failure studies are not multi-level (Goudie and Meeks, 1991), as researchers tend to study each level discretely. The majority of studies are at the firm-level where, typically, researchers study the effects of within-firm factors within a single country while
20 controlling for industrial-level effects by, for example, matching firms by industry sector (see (Altman and Narayanan, 1997)). Likewise, at the macro-level, studies tend to focus on the variance of macro-level variables within a single country over time.

Therefore, the aim of the current study is to discover whether new indicators
25 macroeconomic and industrial information can give a better understanding of characterising insolvency in different macro dynamic environments by using three-way multidimensional scaling (MDS) and cluster analysis. This study contributes to the literature in three ways. First, while the majority of studies focus on analysis of the financial ratios to predict the corporate insolvency,
30 our study adds a new dimension by taking into account macroeconomic and industrial information which has been accorded limited attention in previous corporate insolvency researches. This information allows us to examine how specific aspects of the macro environment may impact firm failure. We believe that the impact of analysis related to the combination of such external pressure
35 data as well as accounting data on firms is of direct interest, especially since it is recognized that not all companies respond to external pressures equally. Second, one of the crucial contributions of this study is that many researchers have studied corporate insolvency in the course of individual studies of each country. In light of the added value of investigating the determinants of corporate failure
40 across different contexts, this study adds to the existing literature a new pattern

of studying the similarities and dissimilarities of the structures of insolvent and solvent firms contextual with other firms in different economies like the Gulf Corporation Council (GCC), the United Kingdom (UK) and the United States of America (USA). Third, our study is among few studies that adopt the MDS
45 model in the field of corporate insolvency. To the best of our knowledge, there is no study that applies the MDS model in different regions.

The remainder of this paper is organized as follows: Section 2 discusses the literature on the different levels of study related to corporate insolvency research, states the research questions, describes the sample and summary statistics and
50 provides the analysis and discussion of the empirical test and finding in Section 3. This is followed by the final conclusions and discussing the implications of the results in Section 4.

2. Literature and research questions

2.1. Financial ratios

55 The majority of financial distress research focuses on the impact of within-firm factors. Typically, researchers use financial ratios as proxies for the financial management of the firm. Altman (1968), Deakin (1972), Ohlson (1980), Zmijewski (1984), Gilbert et al. (1990) reported profitability and leverage ratios as significant. Similarly, researchers such as Beaver (1966) , Altman (1968),
60 Deakin (1972), Peel et al. (1986), Back et al. (1996) and Jones and Hensher (2004) reported liquidity ratios as significant. Although early research tended to ignore them, cash flow-based ratios have also demonstrated predictive capacity in a number of studies, such as those of Gilbert et al. (1990), Sung et al. (1999) and Ravisankar et al. (2010). In contrast, although both types appeared
65 in Altman (1968)'s seminal study, neither activity nor market ratios have been widely reported as significant, bar a few exceptions, such as Peel et al. (1986) who reported activity ratios to be significant.

There is no doubt, then, that financial ratios are an important aspect of insolvency research, but what we learn about insolvency from each study de-

70 pends on how the researchers approached the problem and the techniques they
used. Some methods offer more insight than others. As computing power and
speed have grown, machine-learning techniques, such as neural networks (Coats
and Fant, 1993; Salchenberger et al., 1992) and genetic algorithms (Shin and
Lee, 2002; Varetto, 1998), have become more popular because they can classify
75 insolvent and solvent firms very accurately. However, they are not interpretable
and, as such, offer no insight. In this regard, the more traditional statistical
techniques, such as Logit regression (Ohlson, 1980; Peel et al., 1986; Zavgren,
1985), Probit regression (Zmijewski, 1984), univariate analysis (Beaver, 1966;
Deakin, 1972) and, to a lesser extent, Multiple Discriminant Analysis (MDA)
80 (Altman, 1968; Sung et al., 1999), are more useful because one can interpret
the results. Unfortunately, statistical techniques are not without some limita-
tions themselves. MDA, often the default baseline technique for evaluating other
techniques (Altman and Narayanan, 1997), assumes that financial ratios are nor-
mally distributed and that the variance-covariance structures of insolvent and
85 solvent firms are equivalent, but, as Ezzamel et al. (1987) show, both of these
assumptions rarely hold up in practice. Logit and Probit regression models do
not have the distributional assumptions of MDA, but both are prone to produc-
ing biased estimates, particularly in small-sample studies (Firth, 1993), which
are quite common in insolvency studies. Given these problems, (Molinero and
90 Ezzamel, 1991) suggest MDS as an alternative. A non-parametric technique,
MDS has no distributional assumptions unlike MDA. MDS is also not reliant
on maximum likelihood estimates and, as a result, does not suffer from biases
found in Logit and Probit regression. Furthermore, the visualisation philoso-
phy of MDS allows for a richer, more intuitive insight into corporate insolvency.
95 Perhaps because of the precedent set by pioneers Beaver (1966) and Altman
(1968), most micro-level research of insolvency is empirical rather than theo-
retical. Even so, a number of theories have been used or proposed to explain
insolvency at the firm level. One stream of research applies Entropy theory,
based on changes in the structure of the balance sheets of firms, to predict fail-
100 ure (Booth, 1983). A second stream applies the Gamblers ruin theory in which

researchers posit that a failing firm will sell its assets to meet its losses until its net worth is zero: i.e. it is bankrupt (Morris, 1997; Scott, 1981). A third, much more popular stream applies the cash management theory, which suggests persistent cash flow problems will eventually cause firm distress (Gombola and Ketz, 1983b; A. Aziz and Lawson, 1988; Aziz and Lawson, 1989; Gilbert et al., 1990).

2.2. *Macroeconomic indicators*

Macroeconomic indicators, Liu (2004) claimed, have been neglected in the (largely) microeconomic analysis of corporate insolvency. Nevertheless, a number of macroeconomic factors have been found to affect insolvency. One such factor is the rate of inflation. Wadhvani (1986) suggested that inflation can create cash flow problems and cause bankruptcy; this is because imperfect credit markets fail to regulate debt levels with inflation. Similarly, interest rates have been shown to impact failure rates in a number of countries, such as the US Rose et al. (1982) and the UK Desai and Montes (1982), and Young (1995). Oil prices may also be a relevant macroeconomic indicator, particularly in the GCC, where the oil and gas industries are prevalent. Platt et al. (1994) found that adding oil prices as an independent predictor increased the classification accuracy of their prediction model.

2.3. *Industrial factors*

Often, conditions across industry sectors can be, or appear to be, so disparate that it is common for investors to diversify their investments across a number of industry sectors in an attempt to minimise industry-specific risk of insolvency (see Fabozzi et al. (2002)). Using standard econometric analysis, Caves (1998) reports global patterns that suggest business failure rates differ across industry sectors. Based on this premise, typically, to control for industry-specific effects, insolvency studies match each insolvent firm sampled with its nearest neighbour among the population of continuing firms in the same industry (Altman and Narayanan, 1997; Kumar and Ravi, 2007). A second, more refined way to

130 account for industry-level effects is by standardising ratios using the industry
median (Platt and Platt, 1991).

Since the majority of studies do not explicitly model the effect of industry
sector, the evidence for how insolvency varies across different industries or how
specific industry characteristics may impact insolvency is relatively sparse, al-
135 though there are some exceptions to this general pattern. An early example is
the study of (Gupta and Huefner, 1972), which examined cluster patterns in
financial ratios across different industry sectors. However, the effect of indus-
try sector differences on corporate insolvency may be insignificant, as reported
recently by Hossari (2009).

140 Another factor that can impact corporate insolvency is legislation, partic-
ularly bankruptcy codes. Differences in insolvency rates have been observed
before and after legislation within and across countries. Bhattacharjee et al.
(2004) reported that the impact of macroeconomic instability on bankruptcy
is less marked in the United States than in the United Kingdom because USA
145 firms facing bankruptcy are shielded from economic instability by Chapter 11.
Beyond bankruptcy codes, other regulations had been shown to significantly
impact insolvency. For example, Campbell et al. (2012) claimed that the size
of the state government affected differences in failure rates across states in the
United States.

150 *2.4. A multilevel perspective on financial distress*

The foregoing literature review suggests that insolvency is likely to be a mul-
tilevel phenomenon, as, conceptually, there are clear cross-level links among the
factors, which are believed to be significant. For example, micro-level research
suggests that insolvency can be predicted by profitability, leverage, liquidity and
155 cash flow-based financial ratios. Hence, we can infer that any factor outside the
firm, for example, a macroeconomic condition that can affect earnings, debt,
equity or cash generation, will probably affect the risk of insolvency. Despite all
this, only a few insolvency studies have taken a multilevel perspective.

In this regard, Goudie and Meeks (1991) and Bhattacharjee et al. (2004)

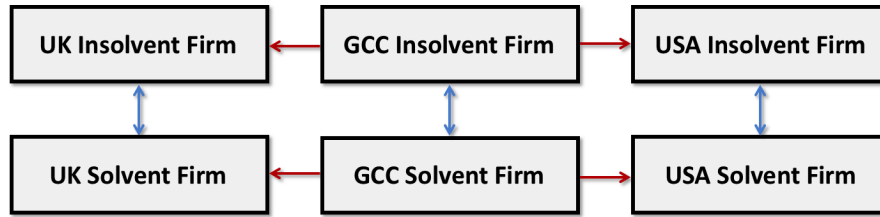


Figure 1 GCC insolvency vis-a-vis other regions: framework of comparisons.

160 are exceptional; they are among the few to have modelled insolvency taking a multilevel perspective. Goudie and Meeks (1991) predicted firm failure, taking into account macroeconomic-, industry- and firm-level effects. They used a two-stage approach: firstly, they predicted each company's financial accounts using a Keynesian economic model—the macro-industry model (MDM); they then predicted the company's insolvency using multivariate discriminant analysis
 165 based on the predicted accounts. Hossari (2009) applied multilevel modelling (MLM) to examine the effect of the industry sector on the risk of insolvency among Australian firms using financial ratios. Bhattacharjee et al. (2004) used macroeconomic variables, industry-effects and firm-level factors as inputs into
 170 a Cox Proportional Hazards model to examine the effect of macroeconomic instability and the insolvency legislation in the United States and the United Kingdom.

2.5. The research problem: contextualizing the nature of insolvency in the GCC

The majority of insolvency studies to date have used samples from the USA,
 175 followed by the UK and other European countries (Kumar and Ravi, 2007). Despite a number of recent studies using samples from elsewhere, such as Australia (Booth, 1983), and France (Mselmi et al., 2017), insolvency research in the GCC remains underdeveloped in comparison.

Notably, Khoja et al. (2014) found that, in the GCC, insolvent firms appear
 180 to focus much more on non- strategic sales activities than solvent firms, but having only sampled firms in the GCC, they were not able to state whether the

differences were due to the intrinsic differences between failing and healthy firms, as opposed to the prevailing environment in the GCC, which is quite different from other regions. As (Khoja et al., 2014, p. 4) admit, there are important
185 differences between the GCC and other major trading blocs. These include the GCC economies dependency on oil and the GCC stock markets being less mature and liberal and inefficient in the weak form (AlAjmi and Kim, 2012; Arouri et al., 2011).

In this study, we examine a number of research questions based on the
190 framework of comparisons shown in figure 1. The first and second of the research questions arise from horizontal comparisons:

RQ1: In what way are the financial structures of healthy firms in the GCC similar to those in the UK and the USA?

RQ2: In what way are the financial structures of insolvent firms in the GCC
195 *similar to those in the UK and the USA?*

RQ1 and RQ2 both address the notion of universal firm characteristics. Whereas RQ1 considers whether a solvent firm in the GCC has distinctive characteristics that would be readily recognised as those of a solvent firm elsewhere (such as in the UK and the USA), RQ2 considers the idea that insolvent firms in
200 the GCC share identifiable characteristics with insolvent firms in other regions. In contrast, the third research question, RQ3, arises from the vertical following of from horizontal comparisons in Figure 1.

It addresses the idea of universal solvent versus insolvent differences and considers whether differences observed between solvent and insolvent firms in
205 the GCC would be readily observed between solvent and insolvent firms elsewhere, say in the UK or the USA. In other words, do the characteristics that differentiate a failing firm from a healthy one in the GCC remain unchanged elsewhere?

RQ3: In what way are the differences observed between solvent and insol-
210 *vent firms in the GCC similar to the differences observed between solvent and insolvent firms in the USA and the UK?*

The multilevel perspective should enable us to understand how macroeco-

215 nomic factors may be related to the factors that may define or influence the character of insolvency in the GCC and whether comparable patterns can be expected elsewhere. Hence the fourth research question, RQ4, is the following:

RQ4: How are macroeconomic factors related to characteristics that typify insolvency in the GCC, and are the relationships comparable in the USA and UK?

220 The USA and UK are ideal comparators for contextualising insolvency in the GCC for two reasons, Firstly, while little is known about insolvency in the GCC, arguably, given the larger body of research using samples from the USA and the UK (Kumar and Ravi, 2007), nowhere else is insolvency better understood than in those countries. The UKs and USAs environments contrast sharply with the GCC. Relative to the GCC, the UK and USA stock markets are more mature, 225 more efficient in the weak form and more liberal (AlAjmi and Kim, 2012; Arouri et al., 2011). Both countries economies are also less dependent on oil and, hence, less sensitive to oil prices. Furthermore, while similar to each other, the UK and the USA also differ from each other in important ways, as they are geographically distant and belong to different economic blocs, The UK is in the European 230 Union, while the USA is in the North American Free Trade Agreement. They also have different legislations (see, for example, Bhattacharjee et al. (2004)). Hence, comparing the GCC to each country should give unique insights.

Secondly, on the trade side, the USA and the UK have formed important investment and trade partnerships with the GCC, creating a high-level invest- 235 ment which has reached 7.2% investment growth, compared to 2% growth in the rest of the world. Large European and USA banks have set up in the GCC region, and many other projects have long been attractive to Western firms in other industries, especially in the petroleum and real estate sectors. Thus, this region is considered to be a promising business environment for Western 240 firms, especially with the GCC governments efforts to develop the liberalization of foreign investment laws and to increase foreign ownership in the GCC stock market. Thus, the Western and USA companies investment in the GCC market may experience different business environments as well as variance of the

commercial risks, which can be reduced by understanding and determining the
245 main corporate failure factors. These could be different from the predictors of
bankruptcy in the Western countries.

3. Data, analysis and results

3.1. Data

3.1.1. Sample of firms

250 We collected data on matched pairs of insolvent and solvent firms in the
GCC, the UK and the USA during the period of 2004 to 2012. To operationalise
our main goal, which was to contextualise insolvency in the GCC using the UK
and USA as comparators, we had to make like-for-like comparisons by hold-
ing important properties of firms constant across the different environments.
255 Therefore, we categorised insolvency in the same way across the three countries
by applying the Kuwaiti legal definition of insolvency, which defines a firm as
insolvent when its accumulated losses reach 25% of its capital.

We matched each insolvent firm with an equivalent solvent firm in the same
country by industry sector and by comparable asset size. These matching
260 criteria are those which are most widely used in the literature (Altman and
Narayanan, 1997). For each pair of firms, we collected the financial data for the
year prior to failure. For the GCC and the UK, we managed to find 58 matching
pairs of firms, but we found only 49 pairs for the USA due to the small number
of insolvent firms in the Agriculture and Hotel and Tourism sectors. The sample
265 of firms is displayed by sector and country in Table 1.

3.1.2. Measures of within-firm conditions: financial ratios

To measure conditions at the firm level, we collected the financial statements
of the firms from the database DataStreamTM as well as from the firms' own
websites, and we used the financial statements to calculate the financial ratios.
270 To be consistent with Khoja et al. (2014), we calculated the 28 financial ratios
that have been most widely and successfully used in the literature (Altman,

Table 1

Sample of insolvent/solvent firms by sector and country

Sample of Insolvent Firms: Sector by Country				
Sectors	Country			Total
	GCC	UK	USA	
Agriculture	15	15	7	37
Construction	7	7	7	21
Hotel and Tourism	5	5	4	14
Industrial Investment	9	9	9	27
Petrochemical Industries	3	3	3	9
Retail and Services	12	12	12	36
Telecommunications	1	1	1	3
Transportation	6	6	6	18
Total	58	58	49	165

Sample of Solvent Firms: Sector by Country				
Sectors	Country			Total
	GCC	UK	USA	
Agriculture	15	15	7	37
Construction	7	7	7	21
Hotel and Tourism	5	5	4	14
Industrial Investment	9	9	9	27
Petrochemical Industries	3	3	3	9
Retail and Services	12	12	12	36
Telecommunications	1	1	1	3
Transportation	6	6	6	18
Total	58	58	49	165

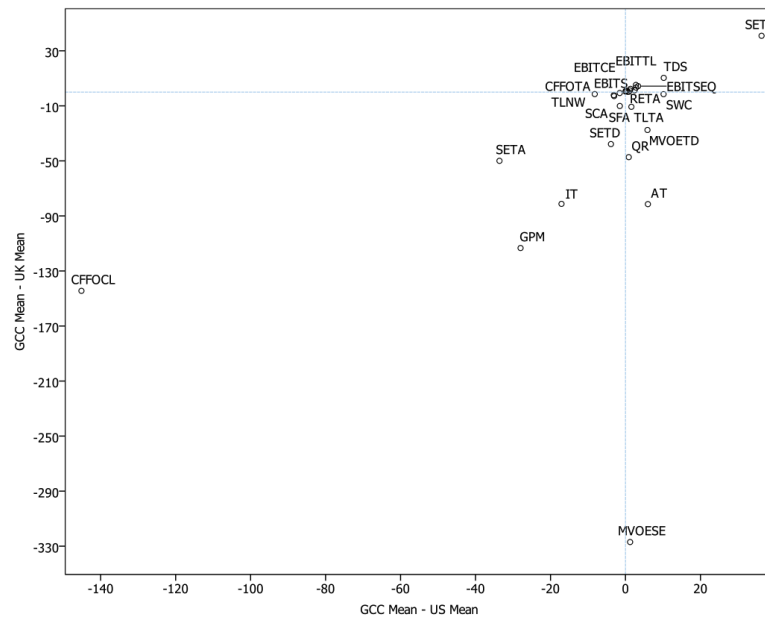


Figure 2 Differences in ratio means: GCC v UK, USA.

1968; Beaver, 1966; Dambolena and Khoury, 2012; Deakin, 1972; Elam, 1975; Gombola and Ketz, 1983a; Mensah, 1983). The 28 include activity, cash flow, leverage, liquidity, market and profitability ratios, and they cover all 6 major categories of ratio. The descriptive statistics of the ratios in each country are presented in Table 2.

Normality tests showed that none of the 28 ratios are normally distributed in any of the three countries; the *Shapiro-Wilks* statistic was significant at the 0.001 p-value level for all ratios.

Figure 2 is a graph that shows the differences in the mean values of the ratios between the GCC and the UK and USA. For each ratio, we have calculated the differences of GCC mean less the UK mean and the GCC mean less the USA mean. Thus, positive values indicate that the GCC mean is greater than those of the UK or the USA; negative values indicate a lesser mean. In the graph, points close to the vertical axis represent small differences between the GCC and the UK, and points close to the horizontal axis represent small differences

between the GCC and the USA.

In Figure 2, most of the ratios are located in a cluster around the origin, but a number of ratios show noteworthy mean differences. The largest difference
290 observed is for the mean level of *MVOESE*, which is much smaller in the GCC than in the UK, unlike the USA where it is of similar magnitude to that of the GCC. The second biggest difference is for the mean value of the ratio *CFFOCL* it is much smaller in the GCC than in the cases of both the UK and the USA. The leverage ratios *SETL* and *SETA* present an interesting contrast, which may
295 suggest important differences in levels of shareholders' equity over liabilities compared to shareholders' equity over assets. *SETL* has a much larger mean value in the GCC than is the case in both the UK and the USA, whereas the mean for *SETA* is much smaller than both the UK and the USA. The mean values of *GPM* (Gross Profit/Sales) and *IT* (Cost of Sales/Inventory) are
300 also notably smaller in the GCC than they are in both the UK and the USA. Similarly, the mean value of *AT* (Sales/Total Assets) is much smaller in the GCC than it is in the UK; it is also smaller than in the USA, although not to the same extent.

Table 2
Summary statistics of financial ratios by country

Ratios	Description	Mean			Std. Dev.		
		GCC	UK	USA	GCC	UK	USA
EBITSEQ	Return on Equity	3.8	-0.5	0.4	41.0	3.2	3.3
EBITCE	Return on Capital Employed	2.9	-0.4	0.1	31.0	2.7	0.4
EBITS	EBIT Margin	-1.5	-0.8	0.0	29.0	5.7	0.2
EBITTL	Earning to Total Liabilities	2.8	-2.4	0.0	30.5	14.9	0.7
GPM	Gross Profit Margin	2.4	115.7	30.3	16.7	956.5	16.9
RETA	Retained Earnings to Total Assets	1.5	-0.9	0.2	159.3	5.5	0.3
SETA	Equity to Total Assets	2.0	52.0	35.6	10.7	158.6	26.7
SETL	Equity to Total Liabilities	44.2	3.2	7.9	33.8	9.9	70.6
TLTA	Total Liabilities to Total Assets	2.2	12.9	0.6	3.6	132.6	0.3
TLNW	Total Liabilities to Net Worth	0.6	2.0	8.8	0.4	5.3	64.7
SETD	Equity to Debt	2.2	40.0	6.1	6.6	232.8	36.2
CR	Current Ratio	4.2	2.8	1.7	9.7	5.5	1.0
QR	Quick Ratio	1.9	49.2	1.1	2.3	503.5	0.8
WCCTA	Working Capital to Total Assets	1.3	0.1	0.1	1.7	0.3	0.2
IT	Inventory Turnover	0.0	81.2	17.0	3.6	322.9	27.6
TDS	Debt Ratio	10.9	0.6	0.7	33.8	2.1	1.6
AT	Total Asset Turnover	7.0	88.4	1.0	57.9	935.2	0.7
SCA	Sales to Current Assets	0.6	2.9	3.7	0.6	2.1	3.5
SFA	Fixed Asset Turnover	1.8	11.9	3.4	3.9	42.6	7.9
SWC	Working Capital Turnover	2.7	4.2	-7.5	6.6	31.2	109.7
CFFOTA	Cash Flow on Assets	-2.9	0.0	0.1	52.7	0.4	0.3
CFFOS	Cash flow on Sales	0.2	-0.6	0.1	1.3	4.7	0.2
CFFOCL	Cash Flow on Current Liabilities	-144.52	-0.1	0.6	1144.6	1.6	0.7
CFFOTL	Cash Flow on Total Liabilities	0.6	-0.2	0.6	4.0	1.3	0.4
CFFONW	Cash Flow on Net Worth	0.4	0.3	-0.4	2.1	2.8	6.7
TDCFFO	Total Debt to Cash Flow Ratio	3.0	2.6	2.9	27.7	10.0	
MVOETD	Market Value to Debt	40.8	68.4	35.0	356.9	398.1	277.5
MVOESE	Market Value to Equity	6.9	333.9	5.6	15.2	3481.5	33.0

Table 3
Descriptive statistics of macroeconomic variables

Factor	Mean			Std. Dev.			Coefficient		
	GCC	UK	USA	GCC	UK	USA	GCC	UK	USA
Stock Index	26.7	784.2	319.7	137.6	417.0	1137.4	26.1	15.0	15.5
Inflation Rate	0.3	0.9	0.5	3.1	0.9	1.4	71.4	32.7	58.3
Interest Rate	0.4	0.5	0.4	0.9	2.1	1.5	16.9	82.3	33.0
Oil prices	6.1	1.5	9.1	26.9	30.5	30.0	31.3	37.5	33.7

3.1.3. Measures of macroeconomic conditions

305 To examine the influence of macroeconomic conditions, we collected data on the inflation rate, interest rate and oil price corresponding to the financial statement year for each pair of firms and the country of the firms. The literature suggests these macro variables may impact insolvency (Desai and Montes, 1982; Goudie and Meeks, 1991; Jayasekera, 2018). We also collected data on the stock
310 index to account for the size of index operating in each country at the time of failure. Table 3 shows the descriptive statistics of the macroeconomic variables. The stock index is clearly much smaller in the GCC than in the USA and, to a lesser extent, the UK. Both inflation and interest rates are, on average, higher in the GCC than in the UK, although interest rates are more variable in both the
315 UK and the USA than in the GCC. The oil price applies worldwide; there should be no differences across countries at a particular point in time. The observed differences in the summary statistics of oil price are due to the slight variations across the countries for the distributions of the years between 2004 and 2012 for which we collected data. Similar to the ratios, all the macro variables are
320 non-normal, with the *Shapiro-Wilks* statistic significant at the 0.001 p-value level.

3.2. Data analysis and results: three-way multidimensional scaling

3.2.1. Rationale of three-Way MDS

We used three-way Multidimensional Scaling to address the research ques-
325 tions. MDS is a data reduction technique, and the objective is to explain the

greatest amount of the structure within a large amount of data using only a few key dimensions. MDS can be conducted with metric or non-metric variables (Kruskal, 1964; Kruskal and Wish, 1978) and, for this reason, it is often preferred over other data reduction techniques, such as factor analysis when all variables of interest are not at least interval scaled or do not satisfy distributional assumptions, such as normality. Typically, MDS involves the construction of a map based on similarities or proximities among data entities (cases or variables) from the given data such that entities with similar characteristics are located near to each other on the map. Hence, the structure within the data can be inferred by studying the loci of known entities on the map. Three-way MDS extends the analysis into a *third* way by examining data from different sources. Here the idea is that data from different sources can have a common structure (among the cases or variables) but also individual differences due to each source. For this reason, three-way MDS is ideal for our purposes because we can study the similarities among the firms but also the differences due to the source, i.e. type of firm (solvent, insolvent) from a specific country.

There are several advantages that three-way MDS offers, which are relevant to the current research. First, it allows data reduction from many financial ratios to a smaller number of more broad dimensions of financial ratios. This allows us to summarise the structure of the data. Second, the three-way structure allows us to better capture the hierarchical, multilevel structure of the data, allowing study at various levels of analysis. Most importantly in this study, this advantage allows us to examine patterns at sector level. Third, MDS output lends itself very well to visualisation via MDS maps. Visualisation often offers the ability to understand patterns not readily available in other types of output such as tables of statistical output. In our study, the value of the visualisation is enhanced as we have overlaid the maps MDS with the results of the additional, Cluster analysis. We argue that the visualisation is key in explaining the patterns in the financial ratios revealed by the MDS. Finally, MDS is non-parametric. As such, it is suitable for analysing the data even if the data do not obey distributional assumptions such as normality. On the other hand, the

latter may also be considered a disadvantage of MDS. The lack a parametric basis implies there are no statistical tests associated with MDS that can be used to test hypotheses and then apply conventional p-value based decisions to reject or accept hypotheses. Another limitation, as we discuss below, is that it is necessary to apply discretionary rules to decide the number of dimensions to retain in the final solution. As such the final solution involves a trade-off between parsimony and comprehensive data coverage.

3.2.2. Number of MDS dimensions to retain

The first step in the MDS model was to determine dimensionality. Since the main objective of MDS is to represent the data structure using a small number of key dimensions, the number of dimensions retained should be much smaller than the number of entities in the data. Typically, it is no more than a handful of MDS dimensions that, like components in Principal Components Analysis (PCA), are extracted hierarchically. The first few dimensions capture the majority of the variance in the data; they are the most meaningful and most interpretable. Higher dimensions, which capture less variance, are less important and less meaningful, and, as such, harder to interpret, but the amount of variance explained increases in the number of dimensions retained. Therefore, deciding how many dimensions to retain is an important decision. In this study we adopted a method applied by Neophytou and Mar-Molinero (2004) and Chipulu et al. (2013), where the dimensionality of the data is decided by an independent model *a priori* to the actual MDS model.

Although PCA differs from CATPCA and MDS in that it is parametric and they are not, the three techniques share a commonality in that their overarching purpose is data reduction. In all three, one starts off with a dataset with many variables, which one then reduces to a smaller number of dimensions (or components). In all three, the number of dimensions to retain can range from the minimum of one to the maximum of j , where j is the number of variables in the original dataset. As such, all three technique share the conundrum of how many dimensions (or components) to retain between one and j . There

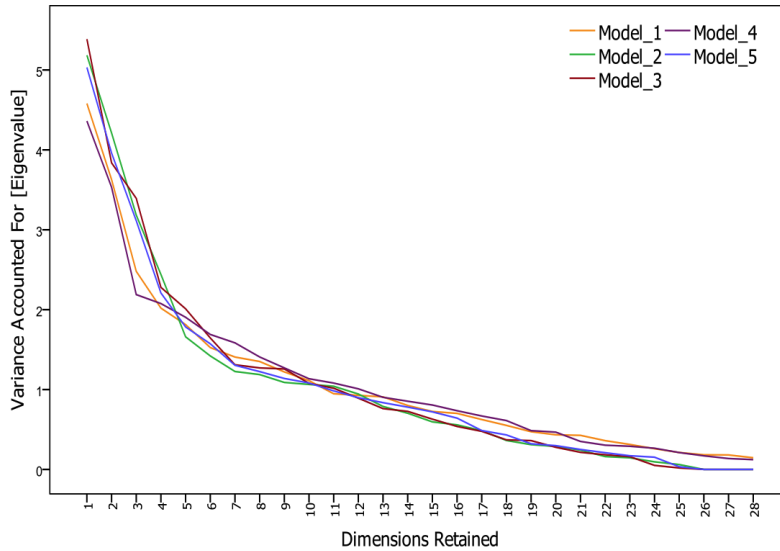


Figure 3
 Variance accounted for per dimensions retained

happens to be a lot more research and experience with the application of PCA. From this, researchers have developed discretionary rules for determining the number of dimensions to retain. Since these rules work well and they are applied post-analysis and are, therefore, independent of the parametric basis of PCA,
 390 a number of previous research has demonstrated that they also work well for MDS. Hence, it is important to emphasize that it is these discretionary rules developed by PCA researchers that we have borrowed rather than any core part of the PCA technique itself.

395 We sampled the dataset to obtain five bootstrap replicates of it. Each replicate was equal in size to the original dataset. We then conducted categorical principal components analysis (CATPCA) of the 28 ratios for each replicate.

Figure 3 is a scree plot or "elbow diagram" which shows the amount of variance explained by each dimension for each of the five CATPCA models. The
 400 overall shape in Figure 3 suggests a turn or "elbow" at Dimension 4: four dimensions may be sufficient to capture the majority of the structure in the data.

However, the lines in Figure 3 are somewhat divergent, indicating that the exact dimensionality of the data is uncertain. Therefore, adopting a conservative approach commonly used in PCA (Neophytou and Mar-Molinero, 2004), we extracted an MDS configuration with six dimensions, but only interpreted the first
405 four; as we treated the last two dimensions as representing residual variation.

3.2.3. Three-way MDS procedure

The first step in the MDS was to split the data into the six data "sources" representing each type of firm in each country, which are "GCC-insolvent", "GCC-Solvent", "UK-Insolvent", "UK-Solvent", "USA-Insolvent" and "USA-Solvent". For each source, we calculated proximities among the 28 financial ratios using the Euclidean distance metric. As a result, there were six proximity matrices one for each source. We then entered the six matrices as the inputs into the three-way MDS model using the *Prefscal* algorithm (Busing et al.,
415 2005). The *Prefscal* algorithm first estimated a six-dimensional space common to all sources. Secondly, it rescaled the common space along each of the six dimensions, based on the weight each source places on that dimension. In other words, scale transformations were applied to the common space until the resultant space was a good fit for each individual source.

The final three-way MDS model fitted the data well. It accounted for 82%
420 of the variance in the ratios, and the normalised stress value was 0.05. The sum-of-squares of DeSarbo's Inter-mixedness Indices was 0.19, and the Shepard's Rough Non-degeneracy Index was 0.76, which indicates that the extracted configuration is unlikely to be degenerate (Busing et al., 2005). Table 4 is a list
425 of the coordinates of each ratio on the four MDS dimensions of interest.

3.2.4. Hierarchical cluster analysis (HCA) of ratios

Once again, we followed the precedents set by (Neophytou and Mar-Molinero, 2004) in that we used hierarchical cluster analysis (HCA) to help us interpret the MDS dimensions. We used Ward's method to cluster the 28 ratios based
430 on the Euclidean distances among them. We selected Ward as the clustering

method because it produces compact clusters by minimising cluster variance (Punj and Stewart, 1983).

Table 4
Coordinates of ratios on retained MDS dimensions

Variable	Variable Description	Dim_1	Dim_2	Dim_3	Dim_4
MVOETD	Market Value of Equity/Total Debt	-6.642	0.6	0.704	-0.379
GPM	Gross Profit/Sales	-0.325	0.641	-1.181	0.28
SETA	Shareholders' Equity/Total Assets	-0.521	0.492	-0.929	-0.409
EBITS	EBIT/Sales	1.196	-1.319	0.087	-0.006
RETA	Retained Earnings/Total Assets	1.224	-1.313	0.593	-0.036
TDS	Total Debt/Sales	1.3	-1.268	0.335	-0.307
CFFOTA	CFFO/Total Assets	1.304	-1.319	0.465	-0.266
CFFOCL	CFFO/Current Liabilities	1.382	-1.201	0.75	0.107
MVOESE	Market Value of Equity/Shareholders' Equity	0.86	0.633	-0.697	-0.444
CR	Current Assets/Current Liabilities	1.175	-0.946	-0.862	-0.792
IT	Cost of Sales/Inventory	-0.576	0.483	-1.085	-1.446
CFFOS	CFFO/Sales	1.156	-1.302	-1.343	-1.15
WCTA	Working Capital/Total Assets	1.165	-1.292	-1.299	-1.317
CFFOTL	CFFO/Total Liabilities	1.15	-1.307	-1.332	-1.345
CFFONW	CFFO/Net Worth	0.782	-0.937	-1.412	-1.384
SETL	Shareholders' Equity/Total Liabilities	1.328	-1.142	0.192	0.636
EBITCE	EBIT/Capital Employed	0.897	-1.305	-1.29	0.906
EBITTL	EBIT/Total Liabilities	1.046	-1.323	-1.297	0.894
SCA	Sales/Current Assets	0.582	-0.986	-1.359	-1.425
AT	Sales/Total Assets	1.559	0.599	0.472	-1.143
TLTA	Total Liabilities/Total Assets	1.538	0.387	-1.111	-1.149
QR	(Current Assets - Stocks)/Current Liabilities	1.464	0.542	-1.299	-1.279
EBITSEQ	EBIT/Shareholders' Equity	0.679	-1.249	-1.078	0.818
TDCFFO	Total Debt/CFFO	-0.191	-0.952	0.246	-1.54
SFA	Sales/Fixed Assets	0.346	-0.844	-0.996	-1.42
TLNW	Total Liabilities/Net Worth	-0.401	-1.091	-1.411	-1.489
SWC	Sales/Working Capital	-0.386	0.179	-1.003	-1.212
SETD	Shareholders' Equity/Total Debt	-0.185	0.567	-0.866	-0.82

There were several stages in the HCA agglomeration schedule. We selected a five-cluster solution which appeared at the fifth stage. This was because we judged it to be the clearest solution. Table 5 5 is a summary of the contents of the clusters. Cluster 1 contains only the ratio *MVOESE*; Cluster 2 contains only *CFFOCL* and Cluster 3 contains the activity ratio *AT* and the profitability ratio *GPM*. The presence of *AT* implies efficiency in generating sales from assets; *GPM* suggests efficiency in generating net revenues after accounting for cost of goods (Megginson and Smart, 2006). This combination, we believe, suggests that Cluster 3 is an indicator of **efficiency of sales activities**. Cluster 4 contains the three leverage ratios *SETD*, *TLTA* and *SETA*, the liquidity ratio *QR*, the activity ratio *IT* and the market ratio *MVOETD*. It is dominated by ratios which indicate a firm's ability to manage debt in such a way that it can maintain liquidity to finance its activities and accumulate market value, i.e. sustain day-to-day activities while growing in the long term. Therefore, we interpreted Cluster 4 as **operational and strategic debt management**. Cluster 5 is the largest. It contains 18 ratios, which cover all 6 ratio categories except market. Cluster 5 appears to represent nearly all measures of a firm's financial performance. Therefore, we labelled it as having **generic financial performance**.

3.2.5. Meaning of MDS dimensions

To enable visualisation and, hence, greater ability to see the structure in the data, we drew two-dimensional (2-D) maps of the MDS dimensions of the ratios using the coordinates in Table 4. This mapping approach is typical in MDS; see, for example, Neophytou and Mar-Molinero (2004). Figure 4 is a map of Dimension 1 versus 2, and Figure 5 is a map of Dimension 3 versus 4. Since the dimensionality of the actual MDS configuration is higher than two, the relative locations of the ratios on the 2-D maps can be misleading.

To help show the true overall distances among the ratios as well as aid interpretation, we added the five HCA clusters as an overlay on the MDS maps. In the same way that one would associate PCA components with high-loading variables, when interpreting each dimension, we paid the most attention to those ratios which have large (in absolute value terms) coordinate values on them; this is because those are the ratios that are most strongly associated with the dimension (see also Chipulu et al. (2013)).

In Table 4, we have highlighted the ratios we have used in this way. We interpreted

Table 5

The contents of HCA ratio clusters

Cluster 1	
MVOESE	Market: Market Value to Equity
Cluster 2	
CFFOCL	Cash Flow: Cash Flow on Current Liabilities
Cluster 3	
AT	Activity: Total Asset Turnover
GPM	Profitability: Gross Profit Margin
Cluster 4	
MVOETD	Market: Market Value to Debt
QR	Liquidity: Quick Ratio
IT	Activity: Inventory Turnover
SETD	Leverage: Equity to Debt
TLTA	Leverage: Total Liabilities to Total Assets
SETA	Leverage: Equity to Total Assets
Cluster 5	
EBITS	Profitability: EBIT Margin
EBITTL	Profitability: Earning to Total Liabilities
EBITCE	Profitability: Return on Capital Employed
EBITSEQ	Profitability: Return on Equity
SETL	Leverage: Equity to Total Liabilities
TLNW	Leverage: Total Liabilities to Net Worth
RETA	Leverage: Retained Earnings to Total Assets
CR	Liquidity: Current Ratio
WCTA	Liquidity: Working Capital to Total Assets
SFA	Activity: Fixed Asset Turnover
TDS	Activity: Debt Ratio
SCA	Activity: Sales to Current Assets
SWC	Activity: Working Capital Turnover
CFFOTA	Cash Flow: Cash Flow on Assets
TDCFFO	Cash Flow: Total Debt to Cash Flow Ratio
CFFOS	Cash Flow: Cash flow on Sales
CFFOTL	Cash Flow: Cash Flow on Total Liabilities
CFFONW	Cash Flow: Cash Flow on Net Worth

the four MDS dimensions as follows:

Dimension 1: Effectiveness of sales and cash-generating activities

In Figure 4, Clusters 3, 4 and 5 are all located on both the negative and positive sides of Dimension 1. Therefore, none of the three clusters is, in itself, a clear pointer
470 towards the meaning of Dimension 1. However, one can see that *AT* (Sales/Total Assets), *TLTA* (Total Liabilities/Total Assets) and *QR* (Current Assets-Stocks)/Current Liabilities) have large, positive coordinates on Dimension 1. *QR* reflects a firm's ability to use its liquid assets to meet short-term obligations; *AT* indicates how efficiently the firm can generate sales from its assets, and *TLTA* indicates how well the firm uses its
475 creditors' funds to finance activities (Bragg, 2002; Megginson and Smart, 2006). *CF-FOTA* (Cash Flow from Operations/Total Assets), *SETL* (Shareholders' Equity/Total Liabilities) and *CFFOCL* (Cash Flow from Operations/Current Liabilities) also have large, positive coordinate values on Dimension 1. We believe this pattern of ratios represents a measure of how well a firm uses its assets and creditors' funds to generate
480 sales and cash, and to maintain liquidity. A high level of cash or liquidity increases capacity to meet debt obligations: this may explain the large, positive coordinate of *TDS* (Total Debt/Sales). Thus, we interpreted dimension 1 to be an indicator of **effectiveness of sales and cash-generating activities**.

Dimension 2: Trade-off between debt management and cash generation/profitability

The proximity of Clusters 3 and 4 on the positive side of Dimension 2 in Figure 4 suggests this side of Dimension 2 may represent a firm's effectiveness at managing debt, which may go hand in hand with efficient sales activities. Cluster 5 occupies most of the negative side of Dimension 2. Given the generic nature of Cluster 5, this
490 provides no helpful guide per se. However, by inspecting Table 3, one can see that the ratios with the highest negative coordinates on Dimension 2 are either indicators of profitability, namely *EBITS*, *EBITTL* and *EBITCE*, or cash flow measures, namely *CFFOTA*, *CFFOS* and *CFFOTL*. Hence, we interpreted Dimension 2 to be a **trade-off between debt management and cash generation/profitability**.

Dimension 3: Usage of debt versus usage of own assets

495 Dimension 3 is similar to Dimension 1 in that the location of the clusters is not very helpful in terms of interpreting the dimensions. Hence, as with Dimension 1, we relied on the ratios with high coordinate values to interpret dimension 3. *CFFOCL* (Cash

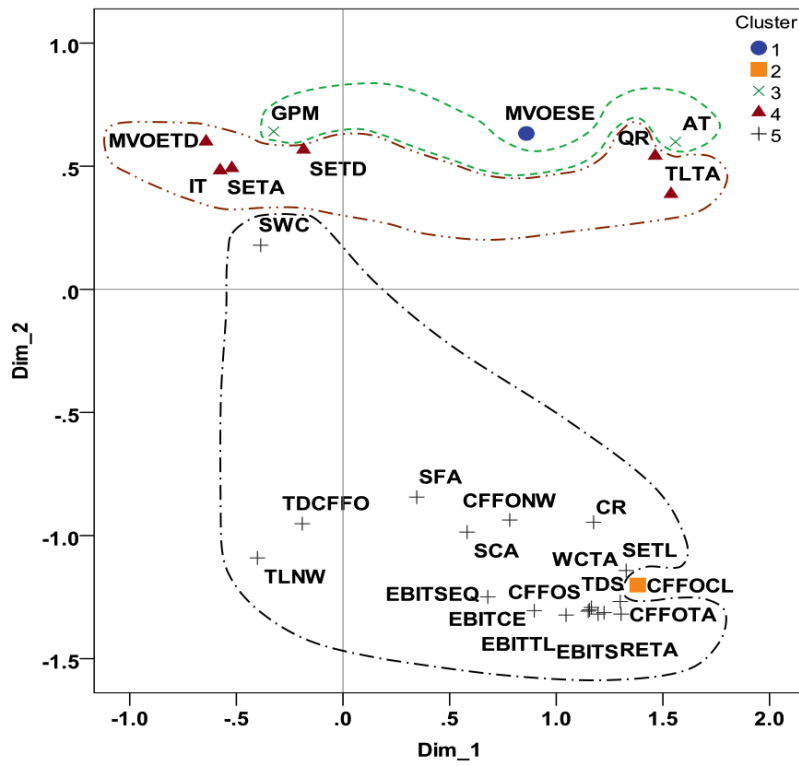


Figure 4 Map of Dimension 1 versus Dimension 2

Flow from Operations/Current Liabilities) has the largest positive coordinate, followed
500 by *MVOETD* (Market Value of Equity/Total Debt). Together, these two ratios suggest
ability to generate cash and accrue market value from debt. In contrast, the two ratios
with the largest negative coordinates *CFFONW* (Cash Flow from Operations/Net
Worth) and *TLNW* (Total Liabilities/Net Worth) measure how well a firm uses its
net worth. Dimension 3 appears to be a contrast between using debt, for example, to
505 earn cash, as opposed to using a firm's own assets, i.e. its net worth. Therefore, we
labelled Dimension 3 **usage of debt versus usage of own assets**.

Dimension 4: Trade-off between profitability and cash-generating activities

As with Dimensions 3 and 1, we interpreted Dimension 4 by looking at the ratios
510 with large coordinates. On the one hand, Dimension 4 appears to be about profit-
ability. The largest positive coordinates are for the profitability ratios *EBITCE*
(Earnings before Interest and Taxes/Capital Employed), *EBITTL* (Earnings before
Interest and Taxes/Total Liabilities) and *EBITSEQ* (Earnings before Interest and
Taxes/Shareholders' Equity). On the other hand, the ratios with the large, negative co-
515 ordinates are either indicators of cash generation, namely *TDCFFO* (Total Debt/Cash
Flow from Operations), *CFFONW* (Cash Flow from Operations/Net Worth) and
CFFOTL (Cash Flow from Operations/Total Liabilities), or indicators of activity;
that is to say, *IT* (Cost of Sales/Inventory), *SCA* (Sales/Current Assets) and *SFA*
(Sales/Fixed Assets). We concluded, hence, that dimension 4 is a **trade-off between**
520 **profitability and cash-generating activities**. We believe that this interpretation
is consistent with the large, negative coordinate value of *TLNW* (Total Liabilities/Net
Worth) on Dimension 4. As a result, highly leveraged firms may be forced to generate
large amounts of cash to meet their obligations, even at the expense of profitability.

3.2.6. Relative importance attached to MDS dimensions

525 We can infer the importance that each source attaches to the dimensions by study-
ing the weights or re-scaling factors that are required to transform the common space
into an individual space relevant only to each source. Table 6 is a summary of the
importance weighting that each source attaches to each dimension and the overall re-
lative importance of each dimension, which is determined by the amount of variance
530 that each dimension accounts for. Table 6 also shows the specificity of each source.
As explained by (Khoja et al., 2014, p. 19), an intuitive interpretation of specificity is

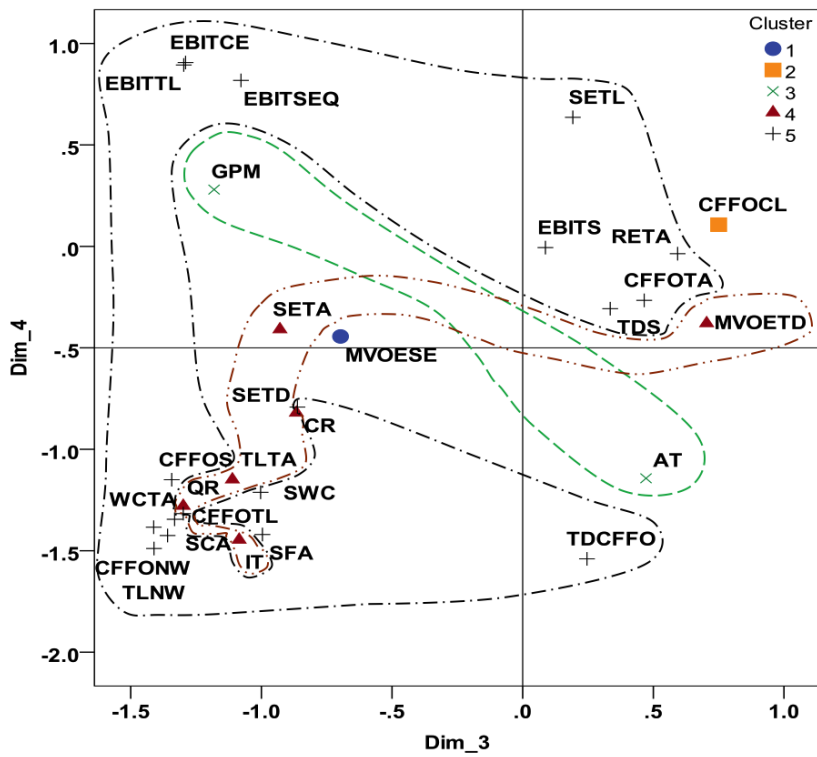


Figure 5 Map of Dimension 3 versus Dimension 4

Table 6

Importance attached to dimensions by sources

Source	Dimensions				Specificity
	Dim_1	Dim_2	Dim_3	Dim_4	
GCC Insolvent Firm	3.0	18.4	1284.4	18.3	0.9
GCC Solvent Firm	1291.3	809.2	524.9	2.8	0.4
UK Insolvent Firm	1359.7	586.2	1.4	21.4	0.6
UK Solvent Firm	435.9	79.9	322.9	1288.8	0.7
USA Insolvent Firm	0.0	1400.4	0.0	0.4	1.0
USA Solvent Firm	1269.9	1010.6	331.3	313.4	0.4
Importance	0.34	0.26	0.14	0.11	

that it “captures the trade-off a source makes between focus on one, some or all of the dimensions: as emphasis on one or a few dimensions increases, lack of emphasis on the others may ensue”.

535 We can observe some broad patterns from the data in Table 6. One is that insolvent firms are more specific than solvent firms, which is particularly pronounced in the USA and the GCC, where insolvent firms appear to disregard all but one of the dimensions. Another is that, based how much importance they attach to each dimension, GCC firms resemble USA firms more than UK firms.

540 The patterns across solvent firms are different. Solvent firms are most alike in their regard for Dimension 3 to which they generally attach moderate weighting. In Dimension 1, solvent firms in the GCC attach about as much weight as those in the USA and more weight than those in the UK. The pattern is somewhat similar in Dimension 2; solvent firms in both the GCC and the USA attach more weight
545 to Dimension 2 than those in the UK but, unlike Dimension 1, the USA weighting is clearly larger than that of the GCC. Solvent firms in the GCC attach much less weight to Dimension 4 than those in the USA and, particularly, the UK.

The results suggest the greatest similarity among solvent firms is that they appear to diversify their efforts; they are not very specific, in that they do not focus on only
550 one, or predominantly one, of the four dimensions while overlooking the others. In terms of how much importance they place on specific dimensions, solvent firms in the GCC, the UK and the USA are most similar in their regard for the third dimension, “usage of debt versus usage of own assets”, to which they all ascribe moderate levels of importance. Thus, our results reveal that the solvent companies in the three regions

555 appear to diversify their efforts to exhibit financial health and long-term sustainability by considering a number of financial metrics, i.e. solvency, profitability and operating efficiency. Furthermore, solvent firms have the ability to use assets and debt capital to increase profitability and liquidity, where higher levels of profitability and liquidity with lower levels of leverage indicate decreased risk of insolvency.

560 On the other hand, there is little similarity in the levels of weight that solvent firms in the GCC, the UK and the USA attach to the other three dimensions. The USA and GCC are more similar in terms of giving most weight to Dimension 1, "Effectiveness of sales and cash generation activities", as well as Dimension 2, "Trade-off between debt management and cash generation/profitability". This result is not surprising due to
565 the clear and significant growth in economic and trade cooperation between the GCC and USA. The growth is as a result of increased diversification of USA investments in the GCC, especially in the energy industry, according to Posner and Schmidt (1992). Thus, it is possible to say that the economic and trade integration has had a significant impact on trade and business management in the Gulf countries. Moreover, this clearly
570 provides evidence of the similarity in the managerial styles between GCC and the USA in terms of using and managing their debt. Generally, in recent decades, the GCC region has significantly developed by adopting similar managerial structures to the USA regarding knowledge exchange education.

We can also observe more particular patterns within these broad patterns. In-
575 solvent firms in the GCC and the USA appear to attach low weight to dimension 1, unlike in the UK, where insolvent firms regard Dimension 1 as having much more weight. Insolvent firms in the GCC attach much less weight to Dimension 2 than those in the USA and, to a lesser extent, the UK. In contrast, insolvent firms in the GCC attach more weight to Dimension 3 than those in the UK and, particularly, the USA.
580 Insolvent firms are most alike in Dimension 4, which they generally regard as being low weight.

Unlike solvent firms, insolvent firms appear to be very specific in the GCC they appear to focus mainly on the "usage of debt versus usage of own assets", while in the USA, they appear to focus only on the "trade-off between debt management
585 and cash generation/profitability". Insolvent firms in the UK, which are the least specific, appear to attach most weight to "effectiveness of sales and cash-generating activities". Thus, although they all equally disregard the fourth dimension, "trade-off

between profitability and cash-generating activities”, the aspects they consider most important, as captured by the MDS dimensions, differ between the GCC, the UK and the USA. The results confirm that insolvent firms face very unique challenges cross countries. In case of insolvent GCC firms, they struggle to generate profit using their own resources; rather, they finance their operations by borrowing and accumulating debts, which increase obviously the probability of the risk insolvency.

There is no consistent pattern in the weight differentials between insolvent and solvent firms. In this respect, UK and USA firms are more similar to each other than they are to GCC firms. The patterns of differences in weights in Dimensions 2, 3 and 4 are the same across the USA and the UK two countries: insolvent firms place more weight on Dimension 2 and less on both dimensions 3 and 4 than solvent firms do. This is the opposite to the GCC, as, in the GCC, insolvent firms place less weight on Dimension 2 and more on both Dimensions 3 and 4. The exception is Dimension 1, which is regarded with more weight by insolvent firms than solvent ones in the UK, whereas the opposite is true in both the GCC and the USA. As such, while the GCC shares this one similarity with the USA in weight differentials, it does not share any similarity with the UK in any of the dimensions.

We can conclude, as Khoja et al. (2014) did, that insolvent firms are much more specific than solvent firms. This shows the low level of the efficiency of operations and investment quality. It also appears that they have difficulty in managing assets to generate a profit. In terms of the polarity of differences, i.e. whether insolvent firms regard a particular dimension to have more weight than solvent firms do, or vice versa, the GCC appears to have very little in common with the USA and, in particular, with the UK.

3.2.7. Property fitting: relationship of macroeconomic conditions with MDS dimensions

The final step in the analysis was to examine the effects of macroeconomic variables on the four MDS dimensions. We did so using *Property fitting*, or *Pro-fit*. Pro-fit is a method for fitting independent properties to the MDS configuration once it has been extracted, i.e. post-optimally. Typically, Pro-fit involves analysing how independent properties of interest are related to the MDS dimensions using correlation or regression analysis (see, for example, (Mar-Molinero and Mingers, 2006; Schiffman et al., 1981).

Table 7

Correlations of macroeconomic variables with MDS dimensions

Macro Factor	Statistics	Dimensions			
		Dim_1	Dim_2	Dim_3	Dim_4
Stock Index	Coefficient	-0.571	0.193	-0.236	-0.18
	p-value	0.00	0.149	0.079	0.179
Inflation Rate	Coefficient	0.435	-0.316	0.135	0.18
	p-value	0.001	0.019	0.313	0.179
Interest Rate	Coefficient	0.582	-0.257	0.151	0.18
	p-value	0.00	0.055	0.26	0.179
Oil Price	Coefficient	0.207	-0.199	0.045	0.005
	p-value	0.123	0.138	0.737	0.968

620 There were two steps in the Pro-fit. Firstly, we calculated the proximity between each macroeconomic variable and each financial ratio using Kendall's Tau-b correlation coefficient. We chose Kendall's Tau-b because it is non-parametric and, therefore, suitable for the data which are non-normal. Secondly, we calculated the correlation (also using Kendall's Tau-b) between each macroeconomic variable and each of the
625 MDS dimensions. We based this calculation on the proximity value for each ratio calculated in the first step and the coordinate value for that ratio on that MDS dimension (Table 4).

The results presented in Table 7 indicate that Dimension 1, which we believe indicates the "effectiveness of sales and cash-generating activities", is positively related to inflation and interest rates and negatively to the stock index. Dimension
630 2, which we interpreted as the "trade-off between debt management and cash generation/profitability", is negatively related to the inflation rate. The other two dimensions do not appear to be significantly related to any of the macroeconomic variables. The results also show that the price of oil is not related to any of the ratio dimensions.

635 Consistent with other studies (Rose et al., 1982; Young, 1995), we found significant relationships between the dimensions of ratios and the macroeconomic variables. The results suggest that inflation, interest rates and the stock index are significantly related to Dimension 1, "effectiveness of sales and cash generating activities". Inflation is also related to Dimension 2, "trade-off between debt management and cash generation/profitability". Since neither insolvent firms in the GCC nor those in the USA
640 consider dimension 1 as important, the observed correlations imply, by overlooking

Dimension 1, that insolvent firms in the GCC and the USA may also be overlooking the macroeconomic factors which are associated with Dimension 1.

645 Additionally, we tested whether the differences in the sector weights on each dimension are statistically significant. Using bootstrapping, we took 100 samples of the data, each sample being of equal size to the original dataset. We then conducted three-way MDS on each sample. This produced 100 samples of sector weights for each dimension. To analyse differences among sector weights, for each dimension, we conducted One-Way Analysis of Variance (ANOVA) with the weight as dependent
650 variable and sector as independent in SPSS 25. The ANOVA results showed that all the F-values were high, with all p-values less than 0.0001.

4. Conclusion and Implications

In this paper, we addressed the issue of characterising corporate financial distress in different contexts, using three-way multidimensional scaling with cluster analysis
655 combined with property fitting. In this respect, the study contributes to the corporate insolvency literature by proposing an in-depth and novel analysis for exploring the role not only of financial ratios in financial distress but also of macroeconomic indicators and industrial information in different dynamic environments. In addition, unlike the distress studies, this study increases the pool of evidence regarding the character of
660 insolvency in a variety of contexts.

As is typically the case in corporate insolvency research, this study suffers from a limited population of failed firms to draw upon. However, it did produce three main original findings and associated implications: First, our findings offer an important additional explanation for the roles of macroeconomic developments, represented by
665 inflation, interest rates and stock market liquidity, in financial distress. Second, our MDS results provide strong evidence for the similarity of the solvent firms in three different regions in terms of their ability to coordinate short- and long-term financial stability plans and their survivability despite the surrounding external economic pressures. Third, our results reveal that insolvent firms face individual difficulties across
670 nations. Overall, our results suggest that differences (or similarities) between firms in the GCC and those in the UK and the USA are much more nuanced than straightforward. This has one clear implication for creditors, investors and competitors, as applying findings from, or applying models calibrated in, the USA or the UK to the

GCC is likely to produce misleading conclusions. The financial health of firms should
675 be examined in situ within the local macro environment. There is also a clear im-
plication for managers of firms, as concentrating attention on one aspect of financial
performance appears to increase the risk of insolvency. The results also suggest that
specificity extends to the given macro environment; we cannot assume that the as-
pects which are most symptomatic of insolvency in the UK or the USA will be reliable
680 identifiers of insolvency in the GCC.

An interesting future direction for this research would be to expand analysis to
the financial distress in cases of multinational corporations in different sectors by
using complex network approaches. Multinational companies have a complex pattern
in terms of responding to extreme events in host countries. This research strives to
685 determine whether the negative impact of economic conditions and extreme events
(e.g., natural disasters, man-made disasters, financial and economic crises) in the host
countries has been greater for multinational corporations compared with domestic
companies.

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