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Applying Four Quantitative Prediction Techniques to Detect Fraud in Financial Statements

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1. Introduction

In September of 2014, British multinational grocery and general merchandise retailer Tesco Plc ("Tesco") admitted that it had overstated its half-year profit forecast by £263m (Felsted and Oakley, 2014). Dave Lewis, the new Tesco chief executive, who took over in 2014, said he had "discovered that profits for the six months to the end of August (2014) were overstated by £263m due to the 'accelerated recognition of commercial income and delayed accrual of costs'" (Ruddick, 2014, para. 1). Immediately after the overstatement was revealed, Tesco suspended its United Kingdom's (U.K.) chief executive, Chris Bush, U.K. finance director, Carl Rogberg, U.K. food commercial director, John Scouler, and food sourcing director, Matt Simister (hereinafter "directors")[1] (Neville, 2014). *A priori*, it was not entirely clear whether the acts of these individuals in manipulating Tesco's financial statement rose to the level of criminal culpability. What is clear, however, is that the overstatement affected a number of stakeholder groups, many of whom expressed their dissatisfactions with Tesco's financial governance practices and its exercise of corporate fiduciary duties (Lynch, 2014; Wearden, 2014; Weaver, 2015).

This article examines the Tesco profit overstatement to evaluate whether four bankruptcy/financial distress techniques—the Altman Z-Score, the Olson O-Score, the Zmijewski X-Score, and the Beneish M-Score (hereinafter the "Z-Score", "O-Score", "X-Score", and the "M-Score")—could have been useful to detect the overstatement in a timelier manner. In particular, the study describes the techniques, calculates the results for Tesco, and compares the four techniques to each other. The article then proceeds to provide a commentary about which technique(s) is/are best, and then summarises the results. The following research question guides the inquiry: How accurate are financial distress techniques in analyzing Tesco's financial conditions prior to and during the period of the profit overstatement? Comparing Tesco with the three largest U.K. supermarket chains by market value—Sainsbury's, Morrison's, and Asda—the findings demonstrate a decline in firm performance for Tesco, beginning in 2013 and continuing more dramatically in 2014. Consistent with the decline in performance, the Z, O, X and M- scores change significantly in 2014 and deviate both from the traditional values for Tesco and those of its peers.

The study contributes to the financial distress literature and practice in several ways. Considering the accounting frauds over the last two decades, traditional audit methodologies, such as manual verification of accounts and sample techniques, may no longer be adequate to predict signs of financial distress (see Lokanan, 2017). In this regard, the article contributes to the financial distress literature by highlighting the analytical and practical values of using financial ratios as useful tools for predicting corporate distress. While auditors have been encouraged to employ financial techniques to predict financial distress, traditional sample methodologies are still the preferred approach.

The present study employs four techniques to predict financial distress in companies. These approaches not only broaden the application of multiple analytical techniques, but also enrich the analytics of financial distress prediction. Every single technique has its own uncertainties and researchers have tried for years to build the ultimate prediction technique with very little success. Each technique used in this article should be seen as providing different insights that can be synthesised or used in conjunction with other techniques to improve stability in predicting financial distress.

The results also have implications for teaching and learning. For instructors teaching upper and graduate-level financial accounting courses, the study can be used as a case study to critically analyse and interpret companies' financial information, both from the stock market and annual reports. In this regard, the study will assist students to develop practical knowledge in the application of financial distress techniques from both an accounting and finance perspective. The application of these techniques to the Tesco case ensures that students understand some of the key financial distress techniques that can be used to improve the decision-making process in companies. Knowledge of financial distress

[1] The terms 'directors' and 'managers' are used interchangeably throughout the study because it is not necessary to disentangle the terms because references are made to both in the stakeholder and corporate accounting fraud literature.

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techniques also will assist students to synthesise financial information derived from financial statements and evaluate their importance for different stakeholders.

The rest of the study proceeds as follows. First, I provide a brief overview of the accounting manoeuvres used to inflate Tesco's profit. I then proceed to review the literature on the financial distress techniques used in this article. Next, I discuss the methodology used to collate and analyse the data employed in the article. Empirically, I built a unique dataset of the financial ratios for the four largest supermarkets in the U.K. I then discuss the findings of the financial distress techniques employed in the research. Finally, practical implications along with areas for future research are highlighted in the conclusion.

2. Literature Review

While there are many alternative financial distress techniques, most of the work that has been assembled to date has focused on multiple discriminant analysis (MDA) and the conditional probability techniques. Altman's (1968) work was among the first to develop the MDA technique, otherwise known as the Z-Score. The ensuing decades saw the rise of Ohlson (1980) and Zmijewski's (1984) probit techniques and the Beneish (1997) mathematical technique, or the M-Score. These four techniques form the bulk of insolvency and financial distress research and have become variously known as the Altman Z-Score, the Ohlson-O Score, the Beneish M-Score, and the Zmijewski X-Score. The next section of the literature review discusses these four financial distress techniques in more detail.

2.1 Altman Prediction Technique (Z-Score)

The Altman (1968) Z-Score technique was developed by NYU Stern Professor, Edward Altman. The Altman multivariate bankruptcy prediction is made up of three zones of discrimination. Firms with a Z-Score greater than 2.67 are seen as solvent, firms with a Z-Score below 1.81 are said to be in distress and firms with a Z-Score between 1.81 and 2.67 are said to be in the "grey zone". The technique uses accounting variables and comprises of five ratios representing liquidity, solvency, profitability, leverage and asset turnover. The Altman Z-Score formula is:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

Where:

X1 = Working Capital/Total Assets
X2 = Retained Earnings/Total Assets
X3 = EBIT/Total Assets
X4 = Book Value of Equity/Total Liabilities
X5 = Sales/Total Asset

The Altman Z-Score has been used extensively to identify firms in financial distress or approaching bankruptcy (Charalambos, 2002; Altman and Hotchkiss, 2006; Altman and Rijken, 2011; Altman, Alessandro, and Alberto, 2013; Altman et al., 2016; Mehta and Bhavani, 2017). Prior research on the Z-Score as a predictor of bankruptcy shows that firms with poorer financial conditions and smaller Z-Scores are more likely to engage in fraudulent financial reporting (Charalambos, 2002; Altman et al., 2013; Hawariah, Kamaluddina and Mohd Sanusia, 2014). More accurately, the general indicators of the Z-Score are associated with fraudulent financial statements (Halteh, Kumar, and Gepp, 2018; Charalambos, 2002; Bauer and Agarwal, 2014; Mehta and Bhavani, 2017). Others have found that the Z-Score has higher probability and degree of accuracy in detecting financial distress and bankruptcy prediction than market-based techniques (Kwak et al., 2005; Agarwal and Taffler, 2008).

Parallel, but somewhat synonymous with these findings, is another stream of research which has found that investors can use the Z-Score technique with reasonable accuracy to analyse the financial position of companies (Xu and Zhang, 2009; Altman et al., 2013; Gnyana, 2015; Panigrahi, 2019). Tinoco and Wilson (2013) found that the Z-Score presented a very good classification of accuracy in predicting financial distressed firms and could go a long way to assist investors in strategising investment decisions. Lyandres and Zhdanov (2013) also found that the inclusion of the Z-Score variables related to investment opportunities improved the predictive power of the technique.

The Altman Z-Score has been extremely accurate in its prediction and has received positive responses and very few shortcomings (Altman et al., 2013). One of the most cited shortcomings is that a low Z-Score may indicate an increased risk of financial statement fraud; however, research has shown that even companies with low Z-Scores do not necessarily commit fraud (Tinoco and Wilson, 2013; Altman et al., 2016; Halteh et al., 2018; Indriyanti, 2019). Altman (1970) himself noted that the Z-Score is a multiple discriminant technique and is not probabilistic, but, rather, descriptive-comparative. In other words, the Altman Z-Score should be used as a warning device concerning the proximity of imminent financial distress rather than a definitive prediction tool of a firm becoming insolvent (Altman

et al., 2013). Corporate failure is not a sudden event; it is rare that a firm with a strong balance sheet will file for bankruptcy in the immediate future (Agarwal and Taffler, 2008, p. 1550). Usually, failure is the culmination of adverse performance, which can be captured by the Z-Score (Agarwal and Taffler, 2008, p. 1550).

2.2 Ohlson Prediction Technique (O-Score)

The Ohlson (1980) O-Score is a bankruptcy prediction technique used to analyse the financial strength of a company. Ohlson's (1980) logit technique uses nine ratios and coefficient weighting to determine the overall score. The Ohlson O-Score formula is:

$$Y = -1.3 - 0.4Y1 + 6.0\,Y2 - 1.4Y3 + 0.8Y4 - 2.4\,Y5 - 1.8Y6 + 0.3\,Y7 - 1.7\,Y8 - 0.5Y9$$

Y = overall index:
Y1 = log (total assets/GNP Price-level index)
Y2 = total liabilities/total assets
Y3 = working capital/total assets
Y4 = current liabilities/current assets
Y5 = one if total liabilities exceed total assets, zero otherwise
Y6 = net income/total assets
Y7 = funds provided by operations/total liabilities
Y8 = one if net income was negative for the last two years, zero otherwise
Y9 = change in net income

The Ohlson technique consists of liquidity, profitability and solvency ratios and is consistent with the existing literature on bankruptcy prediction techniques (see Altman, 1968; Young and Coleman, 2009; Kumar and Kumar, 2012). Ohlson's (1980) approach maps the value to a probability bounded between 0 and 1 and is interpreted as having a cut-off point at 0.5. A result that is greater than 0.5 indicate that the company has a high chance of default. A company with a score that is less than 0.5, is predicted to have a lesser chance of default.

Recent reviews on the efficacy of the O-Score as a prediction of financial distressed have proven to be very accurate. Previous research has shown that the O-Score performed accurately in predicting failure, although its performance deteriorated overtime (Kumar and Kumar, 2012; Bauer and Agarwal, 2014; Altman et al., 2017). Research recommends the O-Score as a good basis for bankruptcy prediction (Hillegeist et al., 2004; Kumar and Kumar, 2012). Other studies found that the O-Score was fairly accurate in examining whether the risk of bankruptcy is a systemic risk, but that the O-Score becomes more accurate the higher the risks of failure (Begley, Ming, and Watts, 1996; Dichev, 1999; Pongsatat, Ramage, and Lawrence, 2004; Xu and Zhang, 2009). The important findings from these studies are that the O-Score can be applied with a high degree of accuracy and is successful in identifying high risk companies, rather than companies at low risk of bankruptcy.

That said, the O-Score also has its shortcomings, one such being the difficulty in its application. Some have argued that the log which represent Y_1 (total assets/GNP Price-level index) simply does not exist in established databases, which makes computation of the O-Score impossible (Xu and Zhang, 2009; Lawrence et al., 2015; Indriyanti, 2019; Tanjung, 2020). Others have noted that the weakness in the technique is that it does not consider firm level market transaction data (Begley et al., 1996; Hillegeist et al., 2004; Agarwal and Taffler, 2008). Another shortcoming of the Ohlson technique is that it has fixed parameters, which treat error structure as "white noise" with little room for behavioural control (Hensher and Jones, 2007, p. 243). This shortcoming means that the O-Score does not account for changes over time and, consequently, fails to take into consideration the changing circumstances of companies' financials as they evolve from a period of financial struggles to one of financial stability (Grice and Dugan, 2003; Hillegeist et al., 2004; Hensher and Jones, 2007).

2.3 Zmijewski Prediction Technique (X-Score)

Zmijewski (1984) developed a bankruptcy prediction technique that constructed a probit function with accounting ratios that represent a company's profitably, liquidity and leverage position using the following formula:

$$\text{Zmijewski} = -4.3 - 4.5X1 + 5.7X2 + 0.004X3$$

Where

$X1 = net\ income/total\ assets$
$X2 = total\ liabilities/total\ assets$
$X3 = current\ assets/current\ liabilities$
X = the overall index

Like Ohlson's (1980) logit technique, the Zmijewski (1984) probit function maps the value of the X score between 0 and 1. Firms with P-value (probabilities) greater than or equal to 0.5 are considered bankrupt, while firms with P-value less than 0.5 are considered as stable with no imminent threat of bankruptcy.

The Zmijewski (1984) technique is widely used. However, while the accuracy rate of the Zmijewski (1984) technique was 99% in the original research, the extant literature provides minimal evidence of its generalisability (Begley et al., 1996; Grice and Dugan, 2001). That said, unlike the Ohlson (1980) technique, the Zmijewski (1984) technique is seen as not sensitive to industry classifications (Grice and Dugan, 2001; Platt and Platt, 2002; Tanjung, 2020). This result, some argue, is a strength of the applicability of the Zmijewski (1984) technique as it allows researchers to apply it in different sectors and jurisdictions with greater accuracy rate and explanatory power than some of the other techniques (Chen and Wei, 1993; Carcello, Hermanson and Huss, 1995; Carcello and Neal, 2000).

Despite its universal appeal, the Zmijewski (1984) technique has been criticised for its uncertainty. Even though the Zmijewski (1984) technique was initially developed to predict bankruptcy in firms, the extant literature is silent on whether the technique is useful to identify firms that are likely to go bankrupt or whether it is a technique to identify firms that are experiencing financial distress (Grice and Dugan, 2001). Like the Altman (1968) and the Ohlson (1980) techniques, the ratios that made up the Zmijewski (1984) technique were not selected on a theoretical basis, but through an iterative process that judged their performance in previous studies (Grice and Dugan, 2003). Another shortcoming of the Zmijewski (1984) technique is that the original study employed "financial ratios that discriminated among industrial firms" and, hence, suffered from systematic sample bias (Grice and Dugan, 2003, p. 85).

2.4 Beneish Prediction Technique (M-Score)

The Beneish M-Score is a mathematical technique that is used to analyse whether a company has manipulated its financial statements (Beneish, 1997). The M-Score uses 5-variable and 8-variable financial ratios to test for financial fraud in companies' financial reports. Each variable is constructed so that higher values are associated with a greater probability of manipulation (Beneish, Lee and Nichols, 2013, p. 76). The M-Score is much like the Z-Score but is used mostly to detect earnings manipulation in companies' financial reports. The M-Score formulae are:

5-Variable Technique:

$$M = -6.065 + .823\ DSRI + .906\ GMI + .593\ AQI + .717\ SGI + .107\ DEPI$$

8-Variable Technique:

$$M = -4.84 + 0.92\ DSRI + 0.528\ GMI + 0.404\ AQI + 0.892\ SGI + 0.115\ DEPI - 0.172\ SGAI + 4.679\ TATA - 0.327\ LVGI$$

Where:

DSRI - Days' sales in receivable index
GMI - Gross margin index
AQI - Asset quality index
SGI - Sales growth index
DEPI - Depreciation index
SGAI - Sales and general and administrative expenses index
LVGI - Leverage index
TATA - Total accruals to total assets

Once calculated, the results from the eight variables are combined to form the M-Score. More recently, Beneish et al. (2013) updated the M-Score so that a score of lower than -1.78 (previously -2.22) suggests that the company did not manipulate its earnings, while an M-Score that is higher than -1.78 (previously -2.22) indicates that the company has manipulated its financial statements (Beneish, 1999a).

The M-Score has been used extensively with accurate results (see Beneish, 1999b; Rosner, 2003; Beneish and Nichols, 2007; Roxas, 2011; Fazli, Mohamed and Rahmat, 2016; Alfian and Triani, 2019). Reviews of the technique have shown that it is efficient in detecting earnings management and fraudulent financial statement (Beneish et al., 2013; Mahama, 2015). The Beneish M-Score is able to accurately predict the financial health of the company and signals red flags of earning manipulation in selected case studies (Chadha, 2014). Others have employed the Beneish M-Score as a tool to identify earnings manipulation and assess the earnings quality of financial statements to great effect (Fridson, 2002; Alfian and Triani). Beneish et al. (2013) found that firms with a higher likelihood of earnings manipulation experience lower future earnings, but, in the long term, investors expect these firms to have higher future earnings.

While the Beneish M-Score has been very accurate in estimating the probability of manipulation, it has been criticised for not identifying deteriorating fundamentals in companies' financials and their adoption of aggressive accounting practices (Mehta and Bhavani, 2017; Alfian and Triani, 2019). Some studies found that the Beneish technique can only flag problematic areas in financial statements that are reviewed by auditors (Harrington, 2005) and that the 8-variable version is less effective in predicting risks (Ugochukwu, Okoye, and Azubuike, 2013). Equally, other studies have found that the Beneish M-Score suffers from operationalisation and in defining the metrics used to perform the financial analysis (Amoa-Gyarteng, 2014). Despite its drawbacks, however, the Beneish M-Score has been fairly accurate in estimating the probability of manipulation to overstate earnings in financial reports (Beneish and Nichols, 2005; Beneish et al., 2013).

2.5 Consensus and Differences with the Techniques

The overall consensus from the extant literature is that the techniques mostly relate performance to profitability, liquidity, and leverage. The Altman (1968) technique uses five accounting variables, while the Ohlson (1980) and Zmijewski (1984) techniques use nine and three accounting variables, respectively. The Beneish M-Score uses five and eight variables that are made up of liquidity, profitability and solvency ratios. The Altman (1968) MDA technique is relatively successful as a predictor of financial distress even though some studies question its usability (Wu, Gaunt and Gray, 2010). The Ohlson (1980) and Zmijewski (1984) techniques performed adequately in earlier studies, but they deteriorated as bankruptcy and financial distress measures in more recent studies. The Beneish M-Score was seen as very accurate in identifying earnings manipulations across various time periods and jurisdictions.

It is not clear whether these techniques are particularly useful in identifying firms that are likely to go bankrupt or, more generally, to identify firms experiencing financial distress (Grice and Dugan, 2003, p. 81). This article can make an impact by using the four ratio-based accounting techniques to examine Tesco's financial statements in relation to its competitors and test for financial distress before the profit adjustment (also see Crumbley, Fenton, Jr, and Smith, 2019). Stated formally, the following propositions are put forward:

- The Altman Z-Score can identify supermarkets in financial distress or approaching bankruptcy.
- The Olson O-Score can identify supermarkets in financial distress or approaching bankruptcy.
- The Zmijewski X-Score can identify supermarkets in financial distress or approaching bankruptcy.
- The Beneish eight-factored and five-factored variables can help to uncover supermarkets that are likely to manipulate their earnings.

3. Methodology

The research evaluated Tesco's performance by gathering data for comparable analysis and undertaking an assessment of common financial measures with three other U.K.-based supermarkets. A four-year time interval running from 2010 (the year in which Tesco was first cited for aggressive accounting practices) to 2014 (the year when the fraud was detected) was chosen for analysis. While there are indications that the scandal started in 2012 (see Crumbley et al. 2019; Lokanan, 2015; Neville, 2014; Ruddick, 2014), 2010 was chosen as the base year to allow for comparison of Tesco's financial performance with other U.K. supermarkets in the two years leading up to the scandal. Also note that, in its criminal investigation, the Serious Fraud Office (SFO) found that Tesco had been overstating its earnings for "some years" (Lynch, 2014). As such, a four-year time interval was deemed sufficient to identify accounting anomalies leading up to the announcement of the overstatement.

3.1 Data Source

Data were collated from the annual financial reports of the four supermarkets. To put Tesco's profit overstatement into perspective, Tesco's financial performance was compared with its main competitors, Sainsbury's, Morrison's, and Asda to investigate the association between financial distress and fraudulent financial statements. Even though Tesco's market share is about 29%, Sainsbury's, Morrisons and Asda were used as a comparison because of similar operations with a large U.K. consumer base. Comparison between Tesco and its competitors was necessary to identify for industry trends and patterns in their financial performance. It is also expected that a comparative analysis will reveal similarities and differences in the companies' financial performance over time.

The annual financial reports of these companies contain their financial statements. In particular, the companies' income statements, balance sheets and notes to the accounts were used to identify the data needed for the calculations. Collating the data was relatively straightforward, as all the companies were publicly traded companies with their financial statements being accessible from their respective websites. Data from the supermarkets' financials were collated in an Excel file and used to calculate liquidity, profitability, efficiency, and solvency ratios. The financial statement data were also employed to calculate the Altman Z-Score, Ohlson O-Score, Zmijewski X-Score, and the

Beneish M-Score. Adjusted figures were used to calculate the Altman Z-Score and Ohlson O-Score for Tesco in 2014. Tesco originally predicted its profit would be around £1.1bn, but the figure was scaled back by £263m—originally £250m. The adjustment came from overstated profits by £118m in the first half of 2014, by £70m in the 2013/14 financial year and by £75m in 2012/13, amounting to a total of £263m (Gompertz, 2015, para. 2 and 21)**.** The use of the Z, O, X and M-Scores is not intended to predict Tesco's bankruptcy, rather, they are measures of how closely Tesco's performance mirrors that of the other major retail competitors in the grocery supermarket sector.

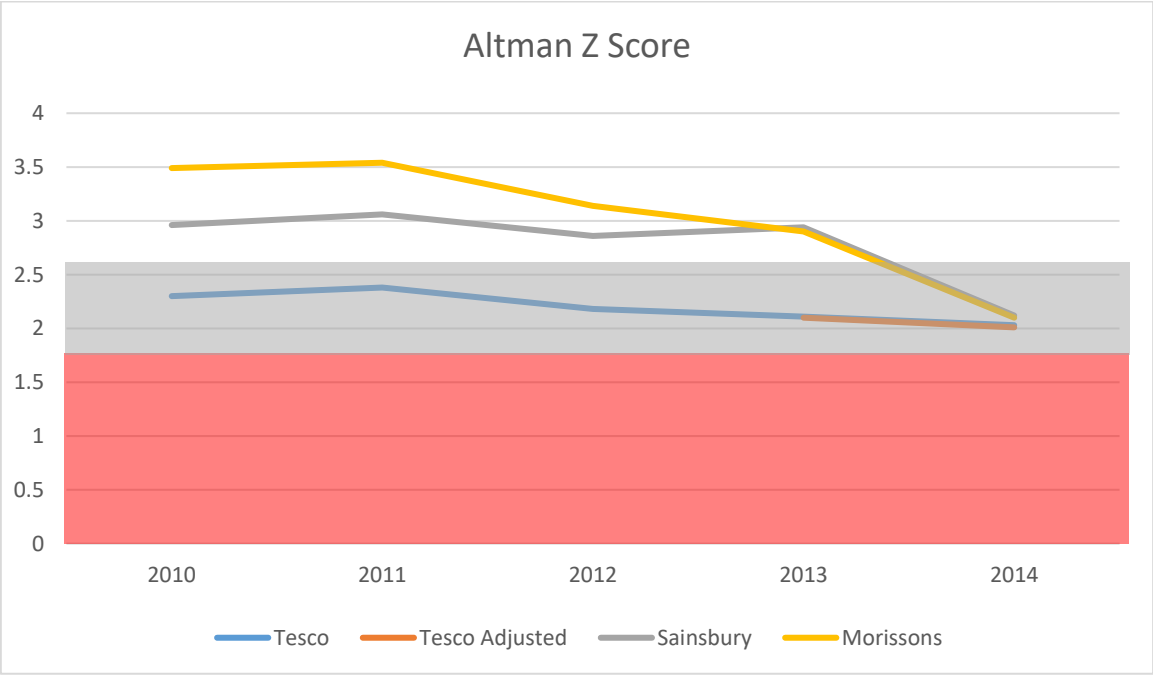
4. Findings and Analysis

4.1 Distress Prediction Analysis

4.1.1 Altman's Z-Score[2] Multiple Discriminant Analysis

The second stage of this two-part analysis looks at the results from the Altman Z-Score, the Ohlson O-Score, the Zmijewski X- Score and the Beneish M-Score.[3] As can be seen in Figure 2, all the supermarkets had a high enough Z-Score from 2010 to 2014 and did not need to worry about the probability of default. What might have been of concern to Tesco, however, was its overall financial strength in comparison to its competitors. A closer look at the trend lines in Figure 2 shows that Tesco's Z-Score consistently declined after 2011 and was, at all material times, below those of its competitors. As a matter of fact, from 2010 to 2013, Sainsbury's and Morrisons' financial performances were relatively robust, as is evident in their trend lines being in the safe zone for those years.

Figure 2: Altman Z-Score



While Tesco's Z-Score for the five years does not show any signs of immediate danger, the downward slope does indicate that the company's risks were increasing significantly, and it was heading toward financial distress. Except for 2014 (and that is probably because of its profit overstatement), Tesco's liquidity ratio working capital/total assets (WC/TA) or (X1) underperformed those of its competitors (see Appendix A, B, C, D and E, hereinafter "Appendices") and suggest that the company would have problems covering its short-term liabilities (debts). While Tesco may not have had to worry about meeting its debt obligations in the immediacy, it was under pressure to improve profit and reduce current liabilities (Farrell, 2014). One way of achieving the desired result was through aggressive 'bullying' of suppliers to reduce their prices for the products and demand rebates (Barrett, 2015; Williams, 2015; Panigrahi, 2019).

For the most part, Tesco's solvency ratio retained earnings/total assets (RE/TA) or (X2) were worse than both Sainsbury's and Morrisons and would have raised concerns that, despite its market share and broader operations, the solvency ratio was not enough to generate enough earnings compared to those of its other competitors in the grocery chain (see Appendices). It is important to consider Tesco's overstatement of profits in this context. Except for 2014, Tesco's RE/TA hovers slightly above 20% between 2010 and 2013. This percentage indicates that the company did not

[2] The calculations for the Altman Z, Ohlson O, Beneish M and Zmijewski X-Scores can be found in Appendices B, C, D and F.
[3] Asda was excluded from the Altman Z-Score and Beneish M-Score calculation because of missing data.

have the capacity to retain most of its earnings and was, rather, funding its operations by borrowing through its retained earnings. With retained earnings decreasing in 2014 to £9,728m and lower with the adjusted figure of £9, 465m (see Appendix A and B), this situation is a sign that Tesco had limited growth potential and that management had not identified how to improve the company's profitability (Butler, 2014; Butler and Wood, 2014).

Both WC/TA and RE/TA indicate that the ability of Tesco to retain earnings is a key driver of shareholder wealth creation (Pike and Neale, 2009). Thus, the relative safety of Tesco, as indicated by the Z-Score, changes when more scrutiny is given to the company's liquidity and solvency ratios. As is evident from the directors' action, what seems more apparent is that the growth of total asset (and the ability of the company to show it can retain its earnings) is more important to short-term shareholder wealth creation than other traditional profitability measures, such as EBIT/TA or X3 (Carton, 2006, p. 249).

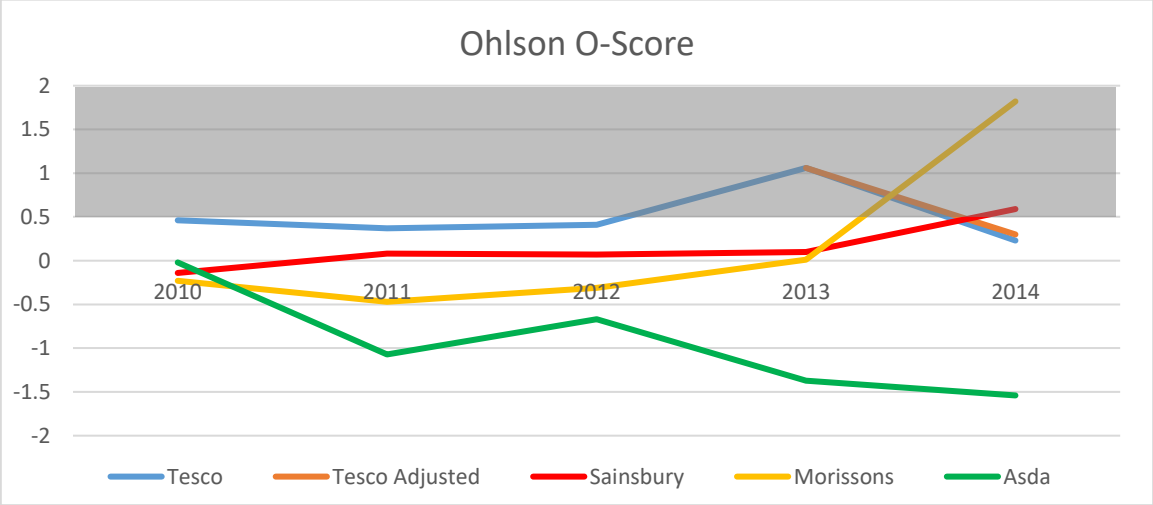
For both Tesco's EBIT/TA (a version of return on asset) and market value of equity to total liabilities (ME/TL) or X4, Tesco had similar ratio values with its competitors in the five years examined (see Appendices). The ME/TL is important to directors and shareholders because it shows the market reaction to the company's financial position (Pike and Neale, 2009). Tesco, like its other competitors, had very low ME/TL. In fact, none of the companies had an ME/TL of over 2.0 (see Appendices). A low ME/TL indicates that Tesco's market value is not stable and that there is a decreased market confidence in the company's financial position.

Tesco's most notable difference lies in its asset turnover (S/TA) or X5 ratio. A closer look at the Appendices shows Tesco's S/TA's ratio to be weaker than its competitors. On average, Tesco's competitors' S/TA was about 7% higher for the years examined. While Tesco had greater revenue streams than the others (Felsted, Oakley, and Agnew, 2014), it also had much greater assets and, ultimately, did not seem to use these to the same degree of efficiency as its competitors (Wood and Farrell, 2014). A low S/TA sends the wrong signal to investors and suppliers of Tesco's ability to grow its market share. Tesco's stagnation in revenue over the years is ample evidence of this claim.

As can be seen in Altman Z-Score formula, total assets form the denominator of four of the five ratios. As such, the efficient use of assets is pivotal in determining the financial strength of an organisation (Chadwick, 2001). One can, therefore, safely assume that Tesco's directors were aware of this inefficiency and its effects on the company's ability to generate earnings and profits as well as shareholders' perceptions of the company's ability to maximise their investments (see Wood, 2014; Wood and Farrell, 2014; Panigrahi, 2019). Consequently, it is highly likely that Tesco's directors felt pressure to improve its bottom line amidst the poor efficiency results and overstated the company's profits. That said, while Tesco's profit overstatement would likely increase the EBIT/TA, it would also shrink the other three ratios—WC/TA, RE/TA and S/TA—all with total asset as the denominator.

4.1.2 Ohlson O-Score

Figure 3: Ohlson O-Score



The Ohlson O-Score measures financial distress and is considered to be a much more robust measure to predict corporate failure than the Altman Z-Score (Young and Coleman, 2009; Lee, Chen and Tsai, 2014; Tanjung, 2020). Figure 3 shows the O-Score for Tesco and its competitors. Contrary to the Z-Score, the higher the O-Score, the worse it is expected that the company's financial performance will be (Ohlson, 1980). As can be seen in Figure 3, the shaded grey area is above the safety line and indicates that Tesco was heading toward financial distress in 2012 but was able to get out of the distress zone after the profit adjustment in 2013. Unlike the Z-Score, the O-Score reveals a more erratic

performance for Tesco. From 2010 to 2012, Tesco's O-Score had been just in the safety zone of 0.5, while its competitors were comfortably safe. Tesco's financial health began to deteriorate in the latter part of 2012, as can be seen by the fact that its O-Score rises above the safety line (in contrast to its competitors) and then hovers around in the safe zone about the time the profit overstatement was announced in September of 2014.

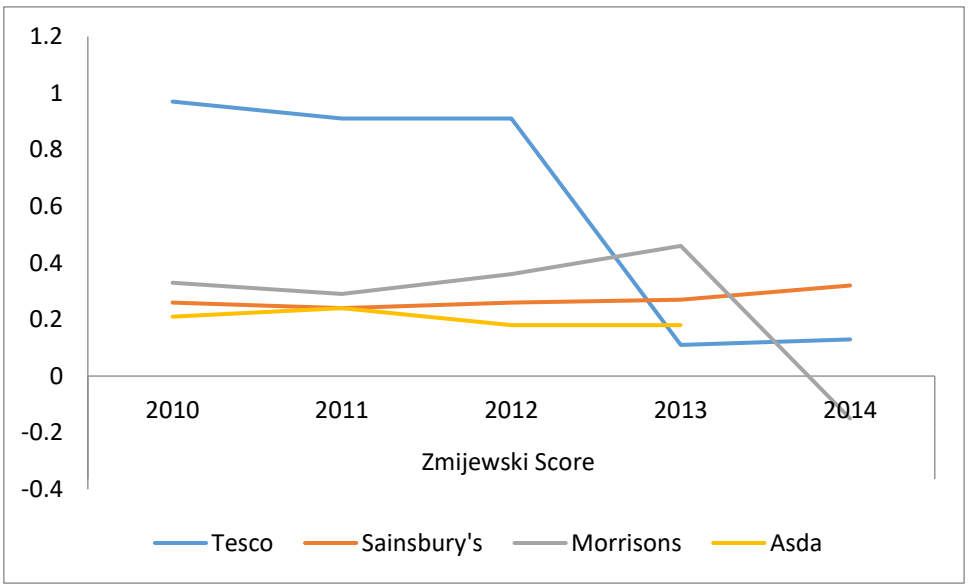
The two ratios that stand out in Tesco's O-Score are Y2 (total liabilities to total assets) and Y9 (net profit change). A closer look at Tesco's O-Score in Appendix A reveals that both Y2 and Y9 produced reasonably high results, which subsequently contributed to taking its default probability above the safety line. There are two concerns with these results. First, the issue with relatively high liabilities (as seen in Y2) impacts the O-Score and can affect stakeholders' perceptions of the company. As can be seen in the Appendices, Tesco had a higher leverage ratio in comparison to its competitors. For all the years examined, an average of over 65% of Tesco's operation was financed by creditors or debt in comparison to its competitors (see Appendices). Tesco's increased leverage exposes its operations to a higher level of financial risks from shocks in the market and can be an issue for creditors who are concerned about their payments (see also Chen and Wei, 1993; Altman et al., 2013; Indriyanti, 2019; Tanjung, 2020).

Second, the notable difference in Y9 indicates that the negative change in net income in 2013, affected Tesco's O-Score in comparison to its competitors (see Appendices). The decrease in Tesco's net income in 2013, may have put increased pressure on its directors to improve the company's financial performance. As can be seen in Appendix A, Tesco's Y9 increased to a high of 0.95 in 2014 from 0.04 in 2010. The increase in net income is also evident in Tesco's trend line in Figure 3. A closer look at Figure 3 shows that Tesco came out of the default zone in 2014. One possible explanation for this outcome is the overstatement of £263 million, which contributed to Tesco's high net income and, subsequently, affected its O-Score for 2014. However, when the profit overstatement is adjusted for 2014, Tesco's O-Score appears less impressive than originally stated. As can be seen in Figure 3, Tesco's adjusted trend line tilted slightly upwards towards the distress zone to reflect this adjustment.

4.1.3 Zmijewski X-Score

Figure 4 presents the results of the Zmijewski X-Score. As mentioned earlier, a company with an X-Score greater than or equal to 0.5 is considered bankrupt. A close look at Figure 4 below shows that all the companies except Tesco were pretty much safe throughout the period examined. However, Tesco's X-Scores between 2010 and 2012 were always hovering above 0.5 or thereabout and are signs that the company was in serious financial distress. Note also that Tesco's X-Score decreased to less than 0.5 in 2013 and 2014, just about the period when the profit adjustment was announced. The X-Score corroborates the findings of the Z and O-Scores that Tesco was in financial distress right about the time in which the profit statement was made public.

Figure 4: Zmijewski X- Score[4]



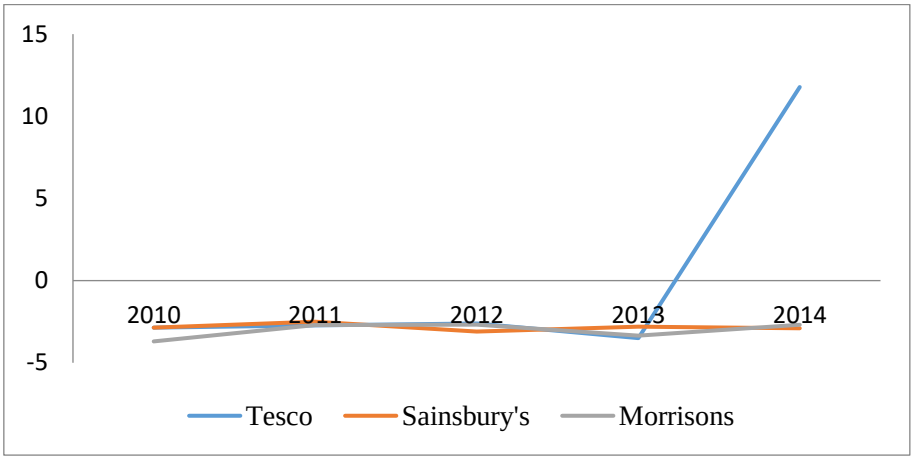
4.1.4 Beneish M-Score

Figure 5 presents the results of the Beneish 5-variable technique. Recall that Beneish et al. (2013) noted that an M-Score lower than -1.78 indicates that a company did not manipulate its earnings, while an M-Score higher than -1.78 indicates

[4] Data were not available to calculate the X-Score for Asda in 2014.

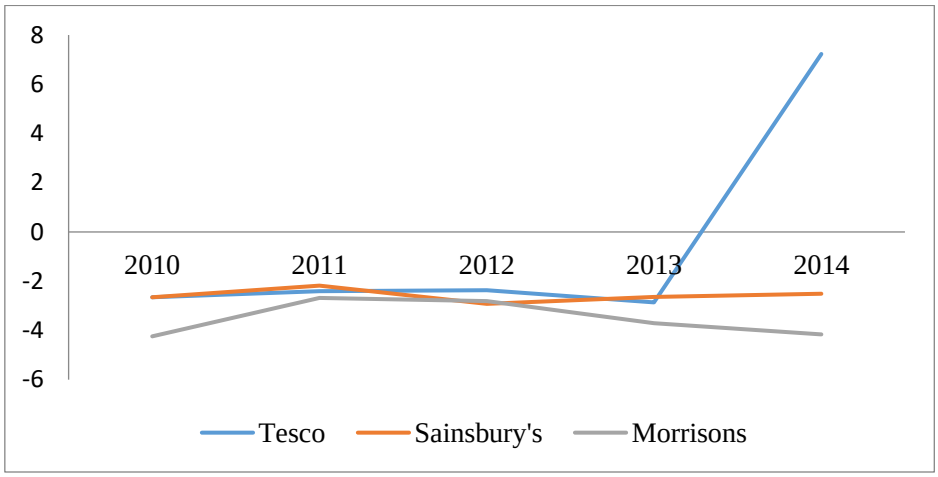
that it did. As is evident from Figure 4 and Appendices B, C and D, the Beneish 5-variable version of the M-Score for all the grocery chains is lower than the -1.78 used to gauge the likelihood of manipulation. However, the results of the M-Score are consistent with the Z, O and X-Scores in that, right about 2014, when the Tesco manipulation occurred, the 5-variable M-Score increased to 12, which is a strong indication of earnings manipulation.

Figure 5: Beneish 5-Variable M-Score



Note that the 5-variable version of the Beneish technique excludes SGAI, DEPI and LEVI. Given this omission, the financial performance data of the three grocery chains were then run against the Beneish 8-variable technique. The Beneish 8-variable technique is divided into a manipulation group (DSRI, AQI, DEPI and TATA) and a motivation group (GMI, SGI, SGI, and LEVI) (Beneish et al., 2013). As can be seen in Figure 5 below and Appendices B, C and D, the 8-variable M-Score for all the grocery chains was lower than the cut-off, -1.78, which indicates that there was no manipulation. The companies were within the same range from 2010 to 2013. However, like the Beneish 5-variable technique, the M-Score for Tesco increased to 7 in 2014, which indicates that Tesco had a far riskier strategy than its competitors and was manipulating its earnings.

Figure 5: Beneish 8-Variable M-Score



The most significant factors contributing to the M-Score manipulation statistic for Tesco in 2014 are SGI and DEPI. The SGI ratio measures the general and administrative expenses of sales versus the prior year (Beneish and Nichols, 2007). It is said that companies with an SGI index greater than 1.0 spend more on expenditures to increase sales and future profits (Wahlen, Baginski, and Bradshaw, 2015, p. 465). In cases where the increase in selling and administrative expenses does not correlate with higher sales and profit, there may be greater motivation for these companies to manipulate their earnings. As can be seen in Table 4, Tesco's SGI was 1.117. While the SGI index by itself is not a measure of manipulation, in Tesco's case manipulation was in the form of adjusting its profit by shifting revenue or booking phoney revenues to a later period.

The DEPI ratio measures the rate of depreciation in the current year versus the previous year (Beneish et al., 2013). A DEPI that is greater than 1 (i.e., a slow depreciation rate) may indicate that the company is revising the useful life of assets upward or allocating depreciation cost to expense (rather than capitalising it) in order to make the company's balance sheet more income friendly (Wahlen et al., 2015, p. 465). As can be seen in Table 4, Tesco's DEPI

for 2014 was 4.098. Tesco's high DEPI may indicate that management prolonged the rate of depreciation (i.e., slowed it down) to lengthen the depreciable lives of the assets in an effort to increase net earnings.

Table 4: Tesco 8-Variable Statistics for 2014

Derived Variables	2014 Results
DSRI	0.943
GMI	0.543
AQI	0.754
SGI	1.117
DEPI	4.098
SGAI	0.548
Total Accruals/TA	-0.044
LVGI	0.893

5. Conclusion

The study provides a case analysis of Tesco's 2014 earnings overstatement. It examines the financial performance of the company in the years leading up to the event by using financial ratios and the Z, O, X and M-Scores. A similar analysis is conducted for Tesco's peers in the U.K. grocery industry. The analysis demonstrates a decline in firm performance for Tesco, beginning in 2013 and continuing more dramatically in 2014. The Z, O, X and M scores change significantly in 2014, consistent with this decline in performance, deviating both from the traditional values for Tesco and those of its peers. For the most part, the four measures fall within the normal range in 2013 and prior years and complement one another in signalling that Tesco was in financial distress before the profit adjustment was made.

The argument that the Altman Z-Score identifies firms in financial distress was confirmed in this study. Consistent with other studies on financial distress techniques (Begley et al., 1996; Dechow et al., 1996; Agarwal and Taffler, 2008), the present study found that the Z-Score was an effective measure to test for the probability of bankruptcy in Tesco's financial reports (Altman, 2000; Hawariah et al., 2014). More specifically, the Z-Score indicated that Tesco's risk was increasing significantly and that the company was in financial distress when the adjustment was made.

Like the Z-Score, the argument that the Olson O-Score can identify firms in financial distress was also corroborated by the findings. While the O-Score identified more erratic performance for Tesco, it was accurate in detecting the manipulation at the time the profit overstatement was made public in 2014. These results are consistent with other studies in that the O-Score, like the Z-Score, is an accurate predictor of bankruptcy and allows for the prediction of discrete outcomes (Pongsatat et al., 2004; Lee et al., 2014). More importantly, the results from the O-Score show that company size (i.e., asset), leverage and liquidity position play a crucial role in detecting manipulation.

The assertion that the Zmijewski X- Score can identify firms in financial distress was confirmed with the findings. As opposed to the Z-Score, which uses total assets as the denominator in four out of the five measures, the Zmijewski's probit technique emphasises the magnitude of debt in two of the variables when detecting financial distress of companies. It is apparent from the findings that the larger Tesco's debt, the more accurate is the X-Score in predicting the possibility of financial distress (e.g., see Carcello and Neal, 2000; Grice and Dugan, 2001; Platt and Platt, 2002). For the most part, the X-Score corroborates the findings of the other techniques in that the atypical results and poor performance of Tesco are isolated to 2014.

The assertion that the Beneish M-Score can uncover companies that are likely (high probability) to massage their earnings was confirmed with the findings. As a matter of fact, both Beneish techniques found significant results that Tesco was not engaged in earnings manipulation until 2014, when the profit adjustment was announced. That said, a comparison of the results from the application of the 5-variable technique and the 8-variable technique reveals that the former was slightly lower than the latter and strengthens the study's results by further supporting that there was material misstatement in Tesco's financial statements in 2014.

Future research may want to explore these limitations more carefully to consider whether certain accounting practices promote unethical behaviour in organisations. One possible avenue is to examine the trade-off or disincentive for auditors to detect fraud and lose the client versus shareholders lawsuit threats. Materiality maybe the key in this trade-off issue. Another potential area is to conduct research on supplier rebates and other commercial income to explore the way they are recognized in annual reports. By investigating techniques used by companies in both the retail and other industries, researchers and fraud investigators can use forensic tools to determine whether Tesco is unique in its approach or that other companies are unethically booking rebates from suppliers to inflate profits. Future research on

these issues will add to our understanding of the practices that promote fraudulent behaviours in organisations and the forensic tools that can be used to prevent them from happening.

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Appendix A: Tesco Financial Data

Tesco	2010 (£m)	2011 (£m)	2012 (£m)	2013 (£m)	2014 (£m)
Share Price. Actual Value £	4.2125	4.0885	3.1540	3.7200	3.3515
Outstanding Shares	7,985	7,985	8,047	8,032	8,054
Market Valuation	33,637	32,647	25,380	29,879	26,993
Sales	56,910	60,455	64,539	63,406	63,557
EBIT	3,457	3,917	3,985	2,382	2,631
Pre-Tax Income	3,176	3,641	3,835	2,057	2,259
Net Income	2,336	2,671	2,814	24	970
Retained Earnings	9,356	11,197	12,369	10,535	9,728
Current Assets	11,765	12,039	12,863	13,096	15,572
Total Assets	46,023	47,206	50,781	50,129	50,164
Current Liabilities	16,015	17,731	19,249	18,985	21,399
Total Liabilities	31,342	30,583	32,980	33,468	35,442
Working Capital Calculation	-4,250	-5,692	-6,386	-5,889	-5,827
Gain on Property Transactions	27	108	83	66	52
Depreciation and Amortisation	479	482	499	517	550
Funds from Operations	3,628	4,015	4,251	2,508	2,757

Altman Z-Score

X1= Working Capital/Total Assets	-0.09	-0.12	-0.13	-0.12	-0.12
X2= Retained Earnings/Total Assets	0.20	0.24	0.24	0.21	0.19
X3 = EBIT/Total Assets	0.08	0.08	0.08	0.05	0.05
X4 = Market Value of Equity/Total Liabilities	1.07	1.07	0.77	0.89	0.76
X5 = Sales/Total Assets	1.24	1.28	1.27	1.26	1.27
Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1X5	**2.30**	**2.38**	**2.18**	**2.11**	**2.03**

Tesco Ohlson O-Score

Y1 = Log (Total Assets/GNP Price Level Index)	8.66	8.67	8.71	8.70	8.70
Y2 = Total Liabilities/Total Assets	0.68	0.65	0.65	0.67	0.71
Y3 = Working Capital/Total Assets	-0.09	-0.12	-0.13	-0.12	-0.12
Y4 = Current Liabilities/Current Assets	1.36	1.47	1.50	1.45	1.37
Y5 = One if total Liabilities Exceed Total Assets, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y6 = Net income/Total Assets	0.05	0.06	0.06	0.00	0.02
Y7 = Funds from Operations/Total Liabilities	0.12	0.13	0.13	0.07	0.08
Y8 = One if negative Net Income for latest 2 years, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y9 = Net Income Current Year (NIT)-Net Income Prior Year (NIT-1)/NIT+NIT-1	0.04	0.07	0.03	-0.98	0.95
Y = -1.3 – 0.4Y1+ 6.0 Y2– 1.4Y3+ 0.8Y4– 2.4 Y5– 1.8Y6+ 0.3 Y7– 1.7 Y8–0.5Y9	**0.46**	**0.37**	**0.41**	**1.06**	**0.23**

Appendix B: Tesco Adjusted Financial Data

Tesco Adjusted	2010 (£m)	2011 (£m)	2012 (£m)	2013 (£m)	2014 (£m)
Share Price. Actual Value £	4.2125	4.0885	3.1540	3.7200	3.3515
Outstanding Shares	7,985	7,985	8,047	8,032	8,054
Market Valuation	33,637	32,647	25,380	29,879	26,993
Sales	56,910	60,455	64,539	63,406	63,557
EBIT	3,457	3,917	3,985	2,232	2,368
Pre-Tax Income	3,176	3,641	3,835	1,907	1,996
Net Income	2,336	2,671	2,814	24	707
Retained Earnings	9,356	11,197	12,369	10,535	9,465
Current Assets	11,765	12,039	12,863	13,096	15,309
Total Assets	46,023	47,206	50,781	50,129	49,901
Current Liabilities	16,015	17,731	19,249	18,985	21,399
Total Liabilities	31,342	30,583	32,980	33,468	35,442
Working Capital Calculation	-4,250	-5,692	-6,386	-5,889	-6,090
Gain on Property Transactions	27	108	83	66	52
Depreciation and Amortisation	479	482	499	517	550
Funds From Operations	3,628	4,015	4,251	2,358	2,494

Altman Z-Score

X1= Working Capital/Total Assets	-0.09	-0.12	-0.13	-0.12	-0.12
X2= Retained Earnings/Total Assets	0.20	0.24	0.24	0.21	0.19
X3 = EBIT/Total Assets	0.08	0.08	0.08	0.04	0.05
X4 = Market Value of Equity/Total Liabilities	1.07	1.07	0.77	0.89	0.76
X5 = Sales/Total Assets	1.24	1.28	1.27	1.26	1.27
Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1X5	**2.30**	**2.38**	**2.18**	**2.10**	**2.01**

Ohlson O-Score

Y1 = Log (Total Assets/GNP Price Level Index)	8.66	8.67	8.71	8.70	8.70
Y2 = Total Liabilities/Total Assets	0.68	0.65	0.65	0.67	0.71
Y3 = Working Capital/Total Assets	-0.09	-0.12	-0.13	-0.12	-0.12
Y4 = Current Liabilities/Current Assets	1.36	1.47	1.50	1.45	1.40
Y5 = One if total Liabilities Exceed Total Assets, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y6 = Net Income/Total Assets	0.05	0.06	0.06	0.00	0.01
Y7 = Funds from Operations/Total Liabilities	0.12	0.13	0.13	0.07	0.07
Y8 = One if negative Net Income for latest 2 years, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y9 = Net Income Current Year (NIT)- Net Income Prior Year (NIT-1)/NIT+NIT-1	0.04	0.07	0.03	-0.98	0.93
Y = -1.3 – 0.4Y1+ 6.0 Y2– 1.4Y3+ 0.8Y4– 2.4 Y5– 1.8Y6+ 0.3 Y7– 1.7 Y8–0.5Y9	**0.46**	**0.37**	**0.41**	**1.06**	**0.30**

Zmijewski X-Score

	X1	X2	X3	**Zwijewski Score**
2010	0.16	2.13	0.38	0.97
2011	0.16	1.84	0.67	0.91
2012	0.16	1.85	0.67	0.91
2013	0.01	1.99	0.70	0.11
2014	0.07	2.41	0.73	0.13

Beneish M-Score

Input Variables	**2010**	2011	2012	2013	2014	2015
Net Sales	56910	60931	62872	62385	62554	55978
CGS	52303	55871	58519	58398	58635	54075
Net Receivables	1557	1947	2244	2118	1881	1785
Current Assets (CA)	11765	11869	12863	13096	15572	11958
PPE (Net)	24203	24398	25710	24870	24490	20440
Depreciation	-7580	-8172	-9062	-10773	-12095	-16351
Total Assets	46023	47206	50781	50129	50164	44214
SGA Expense	1575	1658	1594	1005	1193	1949
Net Income (before Xitems)	2327	2655	2806	2800	974	-5741
CFO (Cash flow from operations)	4745	4239	4408	2837	3185	484
Current Liabilities	16015	17731	19249	18985	21399	19810
Long-term Debt	11521	9595	9978	10131	9340	10520
M-Score (5-variable technique)	-2.86	-2.73	-2.6	-3.5	11.78	-2.07
M-Score (8-variable technique)	-2.65	-2.41	-2.37	-2.86	7.23	-2.87

Appendix C: Sainsbury's Financial Data

Sainsbury's	2010 (£m)	2011 (£m)	2012 (£m)	2013 (£m)	2014 (£m)
Share Price Actual Value £	3.389	3.575	3.055	3.714	3.139
Outstanding Shares	1,822	1,882	1,868	1,881	1,899
Market Valuation	6,175	6,728	5,707	6,986	5,961
Sales	19,964	21,102	22,294	23,303	23,949
EBIT	710	851	874	882	1,009
Pre-Tax Income	733	827	799	772	898
Net Income	585	640	598	602	716
Retained Earnings	2,963	3,374	3,715	3,401	3,560
Current Assets	1,853	1,721	2,032	1,914	4,369
Total Assets	10,855	11,399	12,340	12,695	16,540
Current Liabilities	2,793	2,942	3,136	3,115	6,765
Total Liabilities	5,889	5,975	6,711	6,857	10,535
Working Capital Calculation	-940	-1,221	-1,104	-1,201	-2,396
Gain on Property Transactions	27	108	83	66	52
Depreciation and Amortisation	479	482	499	517	550
Funds from Operations	1,185	1,201	1,215	1,223	1,396

Altman Z-Score

X1= Working Capital/Total Assets	-0.09	-0.11	-0.09	-0.09	-0.14
X2= Retained Earnings/Total Assets	0.27	0.30	0.30	0.27	0.22
X3 = EBIT/Total Assets	0.07	0.07	0.07	0.07	0.06
X4 = Market Value of Equity/Total Liabilities	1.05	1.13	0.85	1.02	0.57
X5 = Sales/Total Assets	1.84	1.85	1.81	1.84	1.45
Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1X5	**2.96**	**3.06**	**2.86**	**2.94**	**2.12**

Ohlson O-Score

Y1 = Log (Total Assets/GNP Price Level Index)	8.04	8.06	8.09	8.10	8.22
Y2 = Total Liabilities/Total Assets	0.54	0.52	0.54	0.54	0.64
Y3 = Working Capital/Total Assets	-0.09	-0.11	-0.09	-0.09	-0.14
Y4 = Current Liabilities/Current Assets	1.51	1.71	1.54	1.63	1.55
Y5 = One if total Liabilities Exceed Total Assets, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y6 = Net Income/Total Assets	0.05	0.06	0.05	0.05	0.04
Y7 = Funds from Operations/Total Liabilities	0.20	0.20	0.18	0.18	0.13
Y8 = One if negative Net Income for latest 2 years, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y9 = Net Income Current Year (NIT)-Net Income Prior Year (NIT-1)/NIT+NIT-1	0.34	0.04	-0.03	0.00	0.09
Y = -1.3 – 0.4Y1+ 6.0 Y2– 1.4Y3+ 0.8Y4– 2.4 Y5– 1.8Y6+ 0.3 Y7– 1.7 Y8–0.5Y9	**-0.14**	**0.08**	**0.07**	**0.10**	**0.59**

Zmijewski X-Score

	X1	X2	X3	**Zmijewski Score**
2010	0.05	0.54	0.66	0.26
2011	0.06	0.52	0.58	0.24
2012	0.05	0.54	0.65	0.26
2013	0.05	0.55	0.61	0.27
2014	0.05	0.64	0.65	0.32

Beneish M-Scores

	2010	2011	2012	2013	2014
Net Sales	19964	21102	22294	23303	23949
CGS	-18882	-19942	-21083	-22026	-22562
Net Receivables	215	343	286	306	433
Current Assets (CA)	1853	1721	1914	2032	4369
PPE (Net)	13056	13565	14258	14973	14701
Depreciation	-4853	-4781	-4929	-5169	-4821
Total Assets	10855	11399	12340	12695	16540
SGA Expense	-399	-417	-419	-457	-444
Net Income (before Xitems)	585	640	614	598	716
CFO (Cash flow from operations)	1206	1138	1291	1268	1227
Current Liabilities	2793	2942	3136	3115	6765
Long-term Debt	3096	3033	3575	3846	3770
M-Score (5-variable technique)	-2.87	-2.50	-3.10	-2.81	-2.90
M-Score (8-variable technique)	-2.65	-2.18	-2.92	-2.64	-2.51

Appendix D: Morrisons' Financial Data

Morrisons	2010 (£m)	2011 (£m)	2012 (£m)	2013 (£m)	2014 (£m)
Share Price. Actual Value £	2.914	2.724	2.284	2.5048	1.829
Outstanding Shares	2,641	2,641	2,586	2,428	2,326
Market Valuation	7,696	7,194	5,906	6,082	4,254
Sales	15,410	16,479	17,663	18,116	17,680
EBIT	907	904	973	949	-95
Pre-Tax Income	858	874	947	879	-176
Net Income	598	632	690	647	-238
Retained Earnings	2,008	2,463	2,440	2,273	1,714
Current Assets	1,092	1,138	1,322	1,342	1,430
Total Assets	8,760	9,149	9,858	10,527	10,729
Current Liabilities	2,152	2,086	2,303	2,334	2,873
Total Liabilities	3,811	3,729	4,462	5,297	6,037
Working Capital Calculation	-1,060	-948	-981	-992	-1,443
Gain on Property Transactions	4	0	0	0	9
Depreciation and Amortisation	308	319	340	368	900
Funds from Operations	1,162	1,193	1,287	1,247	715

Altman Z-Score

X1= Working Capital/Total Assets	-0.12	-0.10	-0.10	-0.09	-0.13
X2= Retained Earnings/Total Assets	0.23	0.27	0.25	0.22	0.16
X3 = EBIT/Total Assets	0.10	0.10	0.10	0.09	-0.01
X4 = Market Value of Equity/Total Liabilities	2.02	1.93	1.32	1.15	0.70
X5 = Sales/Total Assets	1.76	1.80	1.79	1.72	1.65
Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1X5	**3.49**	**3.54**	**3.14**	**2.90**	**2.10**

Ohlson O-Score

Y1 = Log (Total Assets/GNP Price Level Index)	7.94	7.96	7.99	8.02	8.03
Y2 = Total Liabilities/Total Assets	0.44	0.41	0.45	0.50	0.56
Y3 = Working Capital/Total Assets	-0.12	-0.10	-0.10	-0.09	-0.13
Y4 = Current Liabilities/Current Assets	1.97	1.83	1.74	1.74	2.01
Y5 = One if total Liabilities Exceed Total Assets, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y6 = Net Income/Total Assets	0.07	0.07	0.07	0.06	-0.02
Y7 = Funds from Operations/Total Liabilities	0.30	0.32	0.29	0.24	0.12
Y8 = One if negative Net Income for latest 2 years, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y9 = Net Income Current Year (NIT)-Net Income Prior Year (NIT-1)/NIT+NIT-1	0.16	0.03	0.04	-0.03	-2.16
Y = -1.3 – 0.4Y1+ 6.0 Y2– 1.4Y3+ 0.8Y4– 2.4 Y5– 1.8Y6+ 0.3 Y7– 1.7 Y8–0.5Y9	**-0.23**	**-0.47**	**-0.31**	**0.01**	**1.82**

Zmijewski X-Score

	X1	X2	X3	**Zmijewski Score**
2010	0.12	0.77	0.51	0.33
2011	0.12	0.69	0.55	0.29
2012	0.13	0.83	0.57	0.36
2013	0.12	1.01	0.57	0.46
2014	-0.05	1.29	0.50	-0.15

Beneish M-Scores

Input Variables	**2010**	2011	2012	2013	2014
Net Sales	15410	16479	17663	18116	17680
CGS	-14348	-15331	-16446	-16910	-16606
Net Receivables	201	268	320	168	180
Current Assets (CA)	1094	1138	1342	1322	1440
PPE (Net)	9234	9883	10568	11554	12350
Depreciation	-2054	-2326	-2625	-2938	-3725
Total Assets	4949	5420	5397	5230	4692
SGA Expense	-224	-323	-329	-326	-1250
Net Income (before Xitems)	598	632	690	647	-238
CFO (Cash flow from operations)	1004	1141	1264	1432	1031
Current Liabilities	2152	2086	2303	2334	2873
Long-term Debt	1659	1643	2159	2963	3164
M-Score (5-variable technique)	-3.70	-2.70	-2.68	-3.34	-2.69
M-Score (8-variable technique)	-4.24	-2.68	-2.81	-3.70	-4.16

Appendix E: Asda Financial Data

Asda	31/12/2009 (£m)	31/12/2010 (£m)	31/12/2011 (£m)	31/12/2012 (£m)	31/12/2013 (£m)
Share Price. Actual Value £	n/a	n/a	n/a	n/a	n/a
Outstanding Shares	n/a	n/a	n/a	n/a	n/a
Market Valuation	n/a	n/a	n/a	n/a	n/a
Sales	19,819	20,535	21,661	22,814	23,299
EBIT	591	424	463	434	519
Pre-Tax Income	571	492	507	484	605
Net Income	445	368	368	380	482
Retained Earnings	2,360	2,598	2,968	3,283	3,658
Current Assets	4,347	3,792	3,707	2,926	3,472
Total Assets	9,549	8,160	9,026	8,355	8,984
Current Liabilities	5,116	3,424	4,001	2,878	3,139
Total Liabilities	5,533	3,674	4,398	3,245	3,499
Working Capital Calculation	-769	368	-294	48	333
Gain on Property Transactions	0	0	0	0	0
Depreciation and Amortisation	317	329	324	347	358
Funds from Operations	888	821	831	831	963

Ohlson O-Score

Y1 = Log (Total Assets/GNP Price Level Index)	7.98	7.91	7.96	7.92	7.95
Y2 = Total Liabilities/Total Assets	0.58	0.45	0.49	0.39	0.39
Y3 = Working Capital/Total Assets	-0.08	0.05	-0.03	0.01	0.04
Y4 = Current Liabilities/Current Assets	1.18	0.90	1.08	0.98	0.90
Y5 = One if total Liabilities Exceed Total Assets, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y6 = Net Income/Total Assets	0.05	0.05	0.04	0.05	0.05
Y7 = Funds from Operations/Total Liabilities	0.16	0.22	0.19	0.26	0.28
Y8 = One if negative Net Income for latest 2 years, zero otherwise	0.00	0.00	0.00	0.00	0.00
Y9 = Net Income Current Year (NIT)-Net Income Prior Year (NIT-1)/NIT+NIT-1	0.04	-0.09	0.00	0.02	0.12
Y = -1.3 – 0.4Y1+ 6.0 Y2– 1.4Y3+ 0.8Y4– 2.4 Y5– 1.8Y6+ 0.3 Y7– 1.7 Y8–0.5Y9	**-0.02**	**-1.07**	**-0.67**	**-1.37**	**-1.54**

Zmijewski X-Score

	X1	X2	X3	Zmijewski Score
2010	0.05	0.45	1.11	0.21
2011	0.04	0.49	0.93	0.24
2012	0.05	0.39	1.02	0.18
2013	0.05	0.39	1.11	0.18