Calculating Corporate Default Risk: Zombie Firm Model

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Abstract

As the number of zombie firms has increased globally, investors need to be able to identify these companies since its meet all the terminology of firms that indicated they have a high risk of bankruptcy. With the availability of other default risk models that are already commonly used, the use of zombie firm model identification has not yet been widely implemented as an alternative. This paper analyses whether zombie firm model can give a consistent result compare other existing models to predict default risk such as Altman Z-Score or Merton Naïve Distance to Default Models, by using financial data and daily closing trading price of companies that exist and still traded in Indonesian Stock Exchange for period 2011 – 2020 except for financial sector. For final analysis, we do Wilcoxon Rank test to find tendency of zombie firm existence over the years.

Key Words: Zombie Firm, Altman Z-Score, Merton Naïve Distance to Default, Wilcoxon Rank Test.

1. Introduction

Zombie firm phenomenon has been a global awareness since the first time introduced by Caballero et. al., (2008) in their research about the missing period in Japan 1990iest. With the COVID-19 situation entering its 3rd year, it has impact on the raising concern between governments, bank centrals, academics, media, and event judges that handle the bankruptcy claim regarding the increase numbers of zombie firms in the late several years (Altman et al., 2021). Banerjee and Hofmann (2018, 2020) indicate that zombie firms have increase significantly in the last 30 years, where only 2% in early 1990 became 12% in 2018, even though the global economy has shown improvements within the years. In Asia, according to Nikkei Report (Noguchi, 2019), zombie firms exist and concentrate in countries such as India 26% (increase 13% in the last 10 years); Indonesia 24% (increase 11%) and South Korea 18% (increase 4%). The walking dead company has fits to all default characteristics, but this company still operates with only relying on fund inflow only sufficient to pay interest and operational costs without being able to repay its loan.

The fact that the number of zombie firms has increase in recent years, it brings questions on how investors are going to approach this phenomenon with their investment activities. As investment itself is a commitment of certain funds or other resources in the expectation of getting a return in the future (Bodie et al., 2018). Therefore, in order to achieve this, investors use several indicators to determine investment feasibility whether a company can going concern for a long time period and will give return to its shareholders. The creative destruction concept that is introduce by Joseph A Schumpeter in the early 1940iest states weak companies that had no innovation should be out of the market and replace by stronger and more innovative companies (Schumpeter, 2003). In the end investor should prioritize their investment in innovative and inventive companies, in form of capital flow to gain high return, not to the companies that only capable to secure funding from investor but use it to pay its interest and operating costs without be able to increase its competitiveness in its market. As the market stock price indicates the company value with the assumptions that it will going concern (Bodie et al., 2018), the increase of number zombie firms simultaneously across the global and home market, it is important the investor should be able to recognize these companies and the company management to assess the possibility of their company going default in early warning to enable them to take any the proper investment decision and strategies. Other default

indicators that have been introduce and widely use, such as Altman Z-score and Merton Naïve Distance to Default, only are able to indicate levels of default risk without identifying whether the company falls into the zombie category or not.

Research about zombie firms and its relation to default risk has not yet been widely exercise, especially in Indonesia. Novita et al., (2019) conduct an analysis on impact of zombie status of companies that listed on Indonesia Stock Exchange except the non-financial and diversification strategies done by these companies during period of financial crisis of 2007 – 2009. Analysis done by Madyan et al., (2020) focus on the relationship between zombie firm status with its corporate social responsibility performance with corporate governance and ownership status as their moderator variables. Period of research limited to 2010 – 2017 and it contains 288 companies. Due to the limitation of research in zombie firm model and use it as alternative model for identification for risk of default companies, it will be useful to have further research in this area with the consideration that this research can add value to the existing research about default risk and zombie firm model itself.

The remaining of this paper will be organized as follows: Section 2 will describe the literature reviews along with the model identifying zombie firms used in this research and the chosen alternative of default risk indicator as comparison. Section 3 consists of further detail on variables, models and research methodology, where the main results and discussion of this paper will be presented in Section 4. We will conclude the research in Section 5.

2. Literature Review

Zombie firm determination varies between time and nature of research. Caballero et. al., (2008) categorize the zombie firm definition as if a company received bank credit with an interest rate lower than apply by the bank to other companies that have a better financial position and credit worthy. Caballero et. al., use their formulated interest rate that should be applied every period. Imai, (2016) identifies zombie firms using Caballero and Fukuda & Nakamura, (2011) definitions since they complement each other. According to Imai, a company falls to the zombie definition if they not only get the financial help stated by Caballero et. al., but also has its profit creation less than zero as introduced by Fukuda and Nakamura for more than three years in a row.

Banerjee and Hofmann (2018) point out at least 3 restrictions for the zombie model introduce by Caballero at. al., (2018) if this being implemented globally: (1) determining subsidized interest rate for certain companies are difficult to be implemented, (2) banks have its own reasons to give subsidies for different companies due to their previous relationship with those companies, (3) with implementation of standard central bank's interest rate that getting lower for longer period, the subsidies interest rate will also going to fall or even either near to zero or negative. For these reasons, Banerjee and Hofmann simplify the zombie firm classification with two criteria: if it has Interest Rate Coverage Ratio (ICR) less than one for two years in a row and it's Tobin's Q ratio below the median industry Q ratio (Banerjee and Hofmann, 2020). They added Q Ratio as an indicator that the company does not have any potential to grow in the future.

Acharya et al., (2020) use two criteria to identifying the zombie firm: (a) company's ICR below median and its leverage ratio above the median, where median value determines in industry-country-year level, and (b) the company received low interest rate where the ratio of interest relative costs compare to total its outstanding loan is lower than interest rate paid by AAA-firms in the respective year. De Martiis et al., (2020) use Banerjee and Hofmann definition with additional machine learning and decision tree processes in identifying zombie firms. For this research, we implement the same model and approach that was introduced by Banerjee and Hofmann with the difference that we do not use 2 years in a row as a limitation for identifying zombie firms. Instead, we still consider a company in zombie position if the same financial condition happens in the following years within the years of observation. We do not consider a company as a zombie if the condition only occurs once.

Altman Z-score use financial ratios as tools to predict default risk for a company. Introduced in 1968 for public companies, Altman use 5 ratios that had significant contributions to build up the Z value. This original model has been challenge but also used widely by others until now. Altman (1983) points out that the previous Z-score model was only applicable to public companies. Therefore, they make some adjustments to the financial ratio by changing the market value of equity to the company's book value liabilities into book value equity, to make it applicable to be used by private companies. Later in 2014, Altman et al., introduce another Z-score formula by deleting the Sales to Total Assets ratio and updating the equation in whole. The latest research uses very extensive financial data, coming from 34 countries with numbers of samples of 2,602,563 healthy companies and 38,215 default companies, mostly private. For this research paper, we use the classic Z-score, since all the sample are public companies, as a comparison to the zombie firm model.

Distance to Default (DD) originated from Black-Sholes research in 1973 (Black & Scholes, 1973); it estimate the debt market value of the company (Merton, 1974). Bharath & Shumway (2008) simplify the model in order that it can be applied easily and to avoid using complicated valuations, they call the model Naïve DD. In their research, Bharath and Shumway showed that their model results were slightly more accurate compared to the classic Merton DD. In this research, we are using Naïve DD as another model to be compared with zombie firm model result.

3. Research Design and Method

3.1. Sample Selection

This research uses firm-level data gathered from Refinitiv™ Eikon for all listed companies that traded between 2011 – 2020 on Indonesian Stock Exchange market, except for companies that are included in financial services sectors. These companies are classified based on Global Industry Classification Standard (GCIS®). We also use the daily traded stock price within the period and use the previously available price for stocks that were not traded at the time. We analysed 634 companies that listing and still traded between 2011 – 2020 that grouped by 10 sectors (not include financial sector): Communications Services 41 companies, Consumer Discretionary 104 companies, Consumer Staples 91 companies, Energy 52 companies, Health Care 25 companies, Industrials 123 companies, Information Technology 29 companies, Materials 86 companies, Real Estate 77 companies and Utilities 6 companies.

3.2. Models, Variables and Methods.

In this research, all tested variables followed the default models that being compared using time series data provided by Refinitiv Eikon™, where the result of each model compared to identify which companies that has fall in to all the 3 default models (Zombie Models – Altman Z-score – Merton Naïve DD). We made constructs from these divisions for further correlation tests of each construct. The table below explains the operations between models.

Table 1: Model Operations

Operation Models	Variable Name	Symbol	Variable Definition
Zombie Firm	Interest Coverage Ratio	ICR	Earnings Before Interest and Tax / Interest expenses
	Q Ratio	QR	(Total Market Value of Equity + Market Value liabilities) / (Total Book Value of Equity + Book Value of Debt)
Altman Z-Score	1.2X1	WCTA	1.2 x (Working Capital / Total Assets)
	1.4X2	RETA	1.4 x (Retain Earnings / Total Assets)
	3.3X3	EBITTA	3.3 x (EBIT / Total Assets)
	0.6X4	MVEBVL	0.6 x (Market Value of Equity / Book Value of Liabilities)
	X5	STA	Sales / Total Assets
Merton Naïve DD	Naïve DD	DD	N (-naïve DD), where Naïve DD = $$\frac{\ln[(E + F)/F] + (r_{it-1} + 0.5 \text{ naïve } \sigma_v^2)T}{\text{naïve } \sigma_v \sqrt{T}}$$ and Naïve σ_v = $$\frac{E}{E + F}\sigma_E + \frac{F}{E + F}(0.05 + 0.25 * \sigma_E)$$

In determining Q ratio from Zombie model, market value of equity is calculated based on total outstanding shares (issued either traded freely or not) times stock price at the end of the period. Market value of liabilities assumed the same value as the total book value of company liabilities. A company falls into the default category if it has Interest Coverage Ratio (ICR) less than one and its Q Ratio less than the median industry Q ratio. The same with Zombie model, on Altman Z-score, market value equity calculated based on total outstanding shares times traded closing price by the end of period. A company indicates on default if its Z-score falls in distress zone (Z < 1.81), whereas it will be on grey zone if the z-score is between 1.81 and 2.99 and it categorize as safe if it has Z-score more than 2.99.

Following Bharath and Shumway, 2008, Merton Naïve model, E is the market value of equity (using the same calculation as Zombie and Altman Z-scores models). F determined from total book value of debt that is stated on company financial report. σ_E is company share volatility, derived from the standard deviation of each company's daily traded share price, calculated annually during the research period. r_{it-1} is return on company stock at year t-1 (previous year). T or time horizon is assumed to be one year.

At the final stage we analyse the trend, whether a company that identified as zombie would have the possibility to recover and escape from the zombie status in the future or not, within year-to-year analysis using Wilcoxon rank test, following the same approach that use by Setiawan et. al. (2019)

4. Result and Discussion

4.1. Zombie Firm Model Identification

We identified companies as zombies if they meet the conditions where its ICR < 1 and its Q ratio are less than the median of industrial sectors' Q ratio. Figure 1 shows trend of increment from number of companies that have ICR < 1 and Q ration less than median of industry. Based on calculation, consistently, Industrial and Materials sectors contribute numbers of companies that have ICR < 1 from year to year. However, since 2019, numbers of companies that have ICR < 1 in Consumer Discretionary sectors increased by 35% and 65% (from 23 companies in 2018 to 31 in 2019 and 51 in 2020).
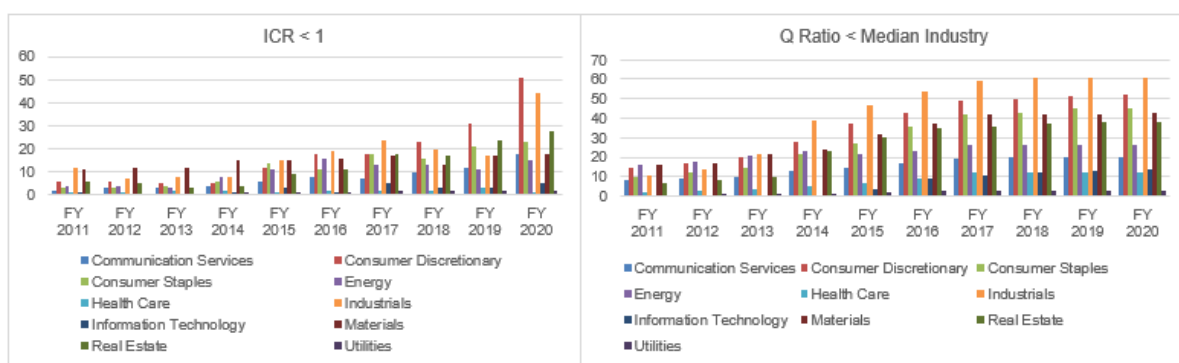

Figure 1: ICR < 1 and Q Ratio < Median Industry

During COVID-19 conditions, most of the sectors have increased their number of companies that have ICR < 1 in 2020 compared to 2019 and 2018, except Heath Care sector, where the only sector that has proportional numbers of companies with ICR < 1 less from last year. One of the reasons was due to the massive increase in EBIT of this sector, while interest costs did not show a substantial increase. For Q Ratio < median industry, Industrial sector still dominated as sector that had number of companies that were below the median. The trend has increased since 2014; however, for 2020 we did not see any movement compared to 2019. It shows that in 2020 with COVID-19 condition, all companies suffered the same that caused the median of industry also changed in the same way with individual companies Q Ratio.

With the combination of these two variables, the number of zombie firms identified has increased from the early observation period until the latest. As shown in Figure 2 on the left side, the number of zombie firms did not show any substantial changes between 2011 – 2013. There were 14 companies identified as zombie in 2011; 21 in 2019 and 23 in 2013, where mostly contributed by Materials sector (5, 6, 8 for each respective years). Since 2015, there were rapid increases in some of the sectors such as Customer Discretionary, Consumer Staples, Industrials, and Real Estate. Some sectors had numbers of companies that recovered from zombie status in 2017 – 2018 (until 2019 for Industrials); however, it increased again in 2019 and 2020. The highest jump in terms of numbers of zombie firms in 2020 happened for Industrial sectors from 10 companies in 2019 jumped to 26 companies in 2020. On the right side, we can compare the trend with the not zombie firms.

Figure 2: Numbers of Zombie and Non-Zombie Firms

4.2. Altman Z-Score and Merton Naïve DD Identification

Indicator used by Altman Z-score to identify companies having risk of default mostly determined by using financial ratios except for market value of equity. For consistency, we calculate the market value of equity by using the same calculation that is applied in Zombie Firms Model. Companies that have Z-score of less than 1.81 are identified as companies in distress zone and have a high probability of default. Using the same data that was implemented on Zombie model, we identified numbers of listing companies that fall into these categories.

In Figure 3, we examined that the increment of companies that have a z-score below 1.81 in 2020, in which has increased 101% from 2011 (301 companies in 2020 from 150 in 2011). The Industrial sector also dominated the contribution on numbers of companies that identified in distressed zone. Although the trend slowing down in 2018 and 2019, it up again in 2020. The same pattern shown by Communications Services, but this sector only up slightly in 2020. Health Care has shown a constant line where by 2020 it has 2 companies recovered from the distressed zone, although it went up in 2019 from 3 companies in 2018 into 7 companies. Customer Discretionary was the other sector beside Industrial that had massive increment in terms of number of companies that high probability of default by 2020.

We identified companies that meet the Merton Naïve Distance to Default Model by using the same data and the results are shown in Figure 4. Consistent with the results of Zombie Firm and Altman Z-score models, Industrial sector has the highest companies that identify as having a probability of default. Although in 2017 the numbers went down massively, from 26 companies in 2016 to 7, but then starting in 2018 it went up to 25 companies in 2020. The same patterns are shown by Consumer Staples and Materials sectors, even though by 2020 the numbers were not as high as Industrial. Interestingly, by 2020 in Health Care sector, we identified there were 4 companies that had high probability of default, increased from 2019 (2 companies) and 2018 (1 companies). The result is different with other default models that have been explained before. Other interesting phenomena was Material sector managed to recover in 2017, where it previously dominated the models in 2013 – 2015 (lower from Industrial in 2016). Customer Discretionary was the 2nd highest sector that contributed to the model after industrial. Only Utilities sector that has a very low number of companies identified in this model.
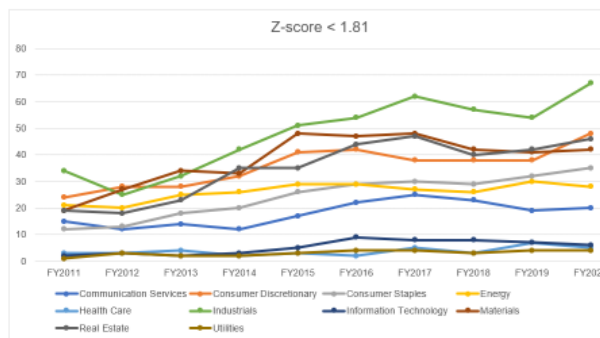

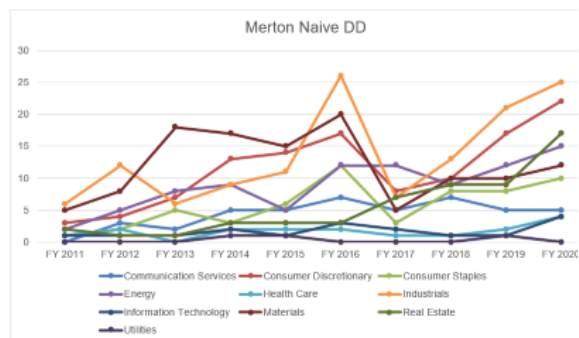Figure 3: Number of Firms in Stress Zone Based on Altman Z-Score Model

Figure 4: Number of High-Risk Company According to Merton DD Model

4.2. All Models Identification

From all the models, we compare the results for each of the companies that were identified as either having a high risk of default and not in each of the models to see whether there were common companies that were shown in Zombie also shown in the comparing models. Based on Table 2, there is evidence that level consistencies between the Zombie Firm Model and Merton are higher compared to Zombie – Altman for identification of financial conditions of a company. Both comparisons gave the highest percentage in the early years of observation and started to decrease in the following years. Figure 5 gives more clarity in terms of trend and level of consistencies between models.

Table 2: Model Consistencies Data

| Models	Criteria	Number of Companies									
		FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY 2020
Zombie	Zombie Firm	14	21	23	34	48	69	81	78	88	96
	Not Zombie Firm	620	613	611	600	586	565	553	556	546	538
Altman	Distressed Zone	150	152	182	207	258	282	294	269	274	301
	Grey and Safe Zone	484	482	452	427	376	352	340	365	360	333
Merton	High risk DD	21	38	48	64	63	102	50	68	86	114
	Not-Hight risk DD	613	596	586	570	571	532	584	566	548	520
Zombie vs Altman	Consistent	490	493	471	453	410	409	405	425	430	407
	Not Consistent	144	141	163	181	224	225	229	209	204	227
	Consistent %	77,29%	77,76%	74,29%	71,45%	64,67%	64,51%	63,88%	67,03%	67,82%	64,20%
	Not Consistent %	22,71%	22,24%	25,71%	28,55%	35,33%	35,49%	36,12%	32,97%	32,18%	35,80%
Zombie vs Merton	Consistent	603	585	581	570	543	519	525	530	516	506
	Not Consistent	31	49	53	64	91	115	109	104	118	128
	Consistent %	95,11%	92,27%	91,64%	89,91%	85,65%	81,86%	82,81%	83,60%	81,39%	79,81%
	Not Consistent %	4,89%	7,73%	8,36%	10,09%	14,35%	18,14%	17,19%	16,40%	18,61%	20,19%
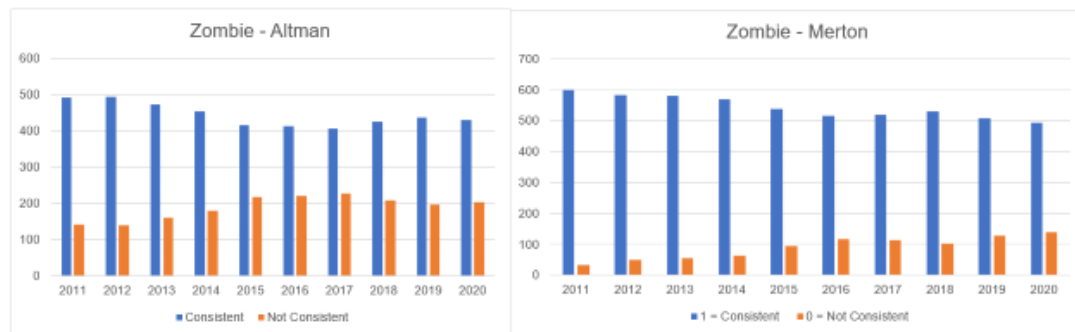
Figure 5: Model Consistencies Trend

4.3. Zombie Firm Identification Trend

To analyse whether a company that identifies as zombie tends to stay in the same level of condition in the following years, we conducted Wilcoxon Rank Test on a year-to-year basis, with the results as shown in Tables 3 and 4 below. First, we tested the significance level of differences between ICR to Q Ration on a yearly basis and the results showed that both variables are significantly different one to the other with Z-value increasing rapidly since 2013 with a significant P-value 0,000.

Table 3: Wilcoxon Test: significant differences between variables within same year

		FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020
ICR to Q Ratio	Z-value	-3.095b	-2.314b	-3.680b	-4.582b	-5.959b	-6.806b	-6.786b	-7.129b	-7.884b	-7.420b
	P-value	0,002	0,021	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

b. Based on positive ranks.

For the possibility of one company being out of zombie categories in the following years shown in below table where both ICR and Q-Ratio resulted from the positive rank (2013 to 2014 and 2016 to 2017) with level of significance low. However, in 2018 to 2019 and 2019 to 2020, the number of zombie firms increased by more companies stayed in zombie condition, and additional new zombies happened in 2018 to 2019 and 2019 to 2020, even though it was not statistically significant.

Table 4: Wilcoxon Test - Test Variable Trend Within Years

		FY2011 to 2012	FY2012 to 2013	FY2013 to 2014	FY2014 to 2015	FY2015 to 2016	FY2016 to 2017	FY2017 to 2018	FY2018 to 2019	FY20119 to 2020
ICR	Z-value	-1.115b	-.676b	-1.167b	-3.634b	-1.205b	-1.598b	-1.047c	-1.311c	-1.178c
	P-value	0,265	0,499	0,243	0,000	0,228	0,110	0,295	0,190	0,239
Q Ratio	Z-value	-1.619b	-1.383c	-1.618b	-2.724c	-.307c	-2.408b	-.847b	-1.718c	-1.134c
	P-value	0,105	0,167	0,106	0,006	0,759	0,016	0,397	0,086	0,257

b. Based on positive ranks.
c. Based on negative ranks.

5. CONCLUSION

Results of this research showed that Zombie Firms Models can be used as another alternative to identify company probability of default. The Zombie Firms Model calculation gives same consistent result default risk identification compared to the other alternative models such as Altman Z-Score or Merton Naïve Models. Zombie Firms Model calculation is closer to Merton Naïve Model than Altman Z-score in term of high percentage of consistencies.

Wilcoxon rank test showed that ICR and Q ratio data are significantly different one from the other with the significant value increase since 2013. The possibility of one company would be able to out of its zombie status can be calculated based on whether both ICR and Q ratio derived from the same rank position or not. If both variables based on positive rank on the same year's comparison, then the company will have bigger possibility to escape from its zombie status in the following years even though statistically the possibility is not significant.

Interest Coverage Ratio (ICR) and Earnings Before Interest and Tax are variable determination used by Zombie Firms Models might has some weaknesses especially when analysing multi sectors industries since every sector has different accounting methods applied. These differences would result in different ICR and EBIT value. Moreover, in this research we do not include any force delisting companies as comparison. Therefore, we suggest that further research would be beneficial in deeper analysis of the use of Zombie Firm as a framework for corporate default models by targeting specific industry research or to include the actual delisting companies as part of the next level identification of consistencies between models. We also recommend that the next research focus on the interaction between zombie firm variables compared to the other corporate indicators, such as its correlation with the trading price or corporate market value.

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