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The Israeli Walking Dead: The Prevalence of Zombie Firms in Israel, Their Characteristics, and Survival Likelihood

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Abstract

In this paper I analyze zombie firms in one of the most unique economies in the world, Israel, relying on four definitions of zombie firms. Using two of these definitions, I find that the percentage of zombie firms increased between 2013 and 2020. Depending on the definition, between 4.5% and 15% of the firm-years are classified as zombie. Additionally, the zombie status is highly persistent: controlling for other firm characteristics, firms that are classified as zombie in a given year are more likely to remain in the sample as zombie firms next year, instead of turning healthy or being delisted.

1. Introduction

"12% of all companies globally are now 'zombie firms,' according to the Bank of International Settlements. 16% of US companies are zombies. In the early 1990s, the zombie rate was just 2%." -Jim Edwards, editor-in-chief of Business Insider news division [1]

On March 16, 2020, renowned economist Ruchir Sharma wrote an alarming New York Times op-ed titled "This Is How the Coronavirus Will Destroy the Economy." Sharma speculated that an increase in zombie firms resulting from the Covid-19 pandemic could be the root of a destruction of the economy. Although Sharma's prediction has yet to be borne out, his piece is but one of countless examples of the recent attention placed on zombie firms due to their growing numbers and impact on the economy.

A zombie firm is an active enterprise that, based on its current trajectory, does not have a viable long-term future. Essentially, a zombie firm is an unprofitable enterprise with no excess capital to kickstart growth. These firms take more from the economy than they contribute, and they are typically considered to be high-risk and therefore high-yield investments. When markets are efficient and competitive, a zombie firm should either be forced to exit the market or seek to restructure [Gouveia and Osterhold, 2018]. This does not always occur, however, and zombie firms often continue to exist instead of terminating via takeover or bankruptcy [Banerjee and Hofmann, 2020].

In this paper, I contribute to the literature on zombie firms in three ways. First, I expand upon prior studies that focus on advanced economies (e.g. Banerjee and Hofmann [2018]). Specifically, I document the prevalence of zombies in Israel, one of the most distinctive economies in the world. As explained in Section 4, Israel offers a particularly interesting setting for studying zombie firms – among other factors, the mandatory military service in Israel could lead to firms being more resilient and therefore less likely to become zombie. Second, I compare the likelihood of remaining in the sample versus being acquired or delisted for zombie firms and firms that are never classified as zombies. Finally, I provide additional insights into the persistence of zombie status, by analyzing the firm's status in the year after being classified as a zombie.

2. Summary of Literature

2.1 Factors Leading to the Increase of Zombie Firms

- *Weak Banks* — banks are incentivized to roll over loans to non-viable firms rather than writing off the loans [Caballero et al., 2008].
- *The downward trend in interest rates* — in theory, lower interest rates should increase the interest coverage ratio as they lower the interest expense. All else equal, this should result in a lower number of zombies. However, lower interest rates can also reduce the pressure on creditors to have

[1] https://www.businessinsider.com/zombie-firms-statistics-on-low-interest-rates-and-leveraged-loans-2018-10

pristine balance sheets, which could result in banks extending more "evergreen loans." This is what occurred in Japan in the 1990s [Banerjee and Hofmann, 2018].

- *The rise of corporate debt instruments* — this factor is in many ways an outcome of the downward trend in interest rates. In the past two decades, there has been a growth of instruments, such as leveraged loans and high-yield bonds, partly contributable to institutional investors taking on high-yield investments to meet future obligations. As zombies are high-risk investments, the high-yield market would provide an ideal environment for the survival of zombies [Altman et al., 2022].

2.2 Definitions of Zombie Firms

The extant literature provides numerous definitions of zombie firms, using criteria ranging from the interest coverage ratio (ICR) to Tobin's Q to Altman's Z-score. For example, Altman et al. [2022] classify as zombies companies with a 3-year moving average ICR of less than 1 and a 3-year moving average Z-score and Z"-score [2] below 0; McGowan et al. [2018] classify as zombie firms all companies that are older than 10 years with an ICR below 1 for 3 consecutive years; in Banerjee and Hofmann [2020] a firm is considered a zombie if its ICR is below 1 and its assets' market value to replacement cost (Tobin's Q) is below the sector median for at least 2 consecutive years.

Other definitions of zombie firms are used in e.g. Bank of Korea [2013]: firms with an ICR below 1 for 3 consecutive years; Storz et al. [2017]: firms with negative return on assets (ROA) and net investments and with earnings before interest, taxes, depreciation and amortization (EBITDA) over total financial debt that is lower than 5% for at least 2 consecutive years; Acharya et al. [2019]: firms that receive subsidized financing and with a rating of BB or lower; and Acharya et al. [2020]: firms with an ICR below the median and with leverage above the country-industry median, and with a cost of debt lower than the cost of debt for the most creditworthy comparable firms.

Each definition seemingly has its advantages and flaws. For example, the advantage of employing a definition that uses the interest coverage ratio is that it is easily comparable across countries. However, a disadvantage of this is that it is inconsistent with the notion that a zombie firm is a company that is artificially kept alive through subsidized credits because credit subsidies artificially increase the interest coverage ratio. Similarly, the McGowan et al. [2018] definition focuses solely on mature firms older than 10 years as potential zombie firms. Banerjee and Hofmann [2020], however, criticize this approach, pointing out that a younger company too may be unviable. Finally, by including the Tobin's Q criterion, the definition used in Banerjee and Hofmann [2020] has the advantage of capturing investor expectations regarding the firm's future profit potential. This helps to avoid classifying currently non-profitable companies as zombies, if they are expected to be profitable in the future (such as start-ups).

[2] The Z, Z' and Z" scores are defined in Section 3.1.

2.3 Studies on the Prevalaence of Zombie Firms

Several studies (e.g. El Ghoul et al. [2021], Altman et al. [2022]) document the increase in the percentage of zombie firms across the world. For example, Altman et al. [2022] find that in 1990 just under 1.5% of firms were considered zombies compared to the 7.0% of firms considered zombies in the year 2020. Interestingly, the percentage of zombie firms varies greatly across different countries.

2.4 Keeping Zombies Alive

There is not a consensus in the literature on whether zombies should be kept alive or are better removed from the economy. One view is that zombies are unviable companies that are artificially kept alive, such as via subsidized financing. This view draws on the theory of creative destruction [Schumpeter, 1942]. Creative destruction is the dismantling of established processes in order to make way for improved methods of production. Schumpeter characterized creative destruction as innovations in the manufacturing process that increase productivity, describing it as the "process of industrial mutation... that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." As per the concept of creative destruction, letting zombie firms go bankrupt instead of artificially keeping them alive would improve overall welfare.

In this respect, previous studies find that zombie firms weaken economic performance [McGowan et al., 2018] for several reasons. First, zombies are less productive than non-zombie firms and crowd out more productive firms ("congestion effect"). Second, Banerjee and Hofmann [2020] find that when the share of zombie firms increases, productivity growth for the country could decline significantly.

On the other hand, some zombies might be viable in the long term if one takes into account the value of the real options they possess. While the conventional NPV rule ignores the value of real options, "sometimes an investment that appears uneconomical when viewed in isolation may create options that enable the company to undertake other investments in the future should market conditions turn favorable. An example is research and development. By not accounting properly for the options that R&D investments may yield, naïve NPV analyses lead companies to invest too lit-

tle." [Dixit and Pindyck, 1995] In the real options framework, keeping zombies alive could be optimal, especially in innovative industries and more generally in industries with good investment opportunities.

3. Methodology

3.1 Bankruptcy Prediction Models

3.1.1 Altman Z Score

The Altman Z-score provides a measure of the credit risk of a firm that has stood the test of time, despite its simplicity. The original Altman Z-score [Altman, 1968] was derived using multiple discriminant analysis (MDA) on a sample including bankrupt and non-bankrupt manufacturing companies.[3]

$$Z = 1.2\,X_1 + 1.4\,X_2 + 3.3\,X_3 + 0.6\,X_4 + 1.0\,X_5 \quad (1)$$

where X_1 = Working Capital / Total Assets; X_2 = Retained Earnings / Total Assets; X_3 = EBIT / Total Assets; X_4 = Market Capitalization / Total Liabilities; X_5 = Sales / Total Assets. Altman determined that a Z-score below 1.8 is considered an indicator of distress and a score greater than 3.0 is considered an indicator of a healthy firm [Altman, 1968].

In a follow-up study, Altman modified the Z-score to accommodate private firms [Altman, 1983]. As compared to the original Z-score, this version substituted the book value of equity for the market value of equity:

$$Z' = 0.717\,X_1 + 0.847\,X_2 + 3.107\,X_3 + 0.420\,X_4 + 0.998\,X_5 \quad (2)$$

where X_1 = Working Capital / Total Assets; X_2 = Retained Earnings / Total Assets; X_3 = EBIT / Total Assets; X_4 = Book Value of Equity / Total Liabilities; X_5 = Sales / Total Assets.

A second modification of the original Z-score model is the Z''-score model, developed for manufacturers, non-manufacturing industries, and emerging market firms [Altman et al., 1995]:

$$Z'' = 6.56\,X_1 + 3.26\,X_2 + 6.72\,X_3 + 1.05\,X_4 \quad (3)$$

[3]Earlier attempts to use financial ratios to predict bankruptcy include Tamari [1966] and Beaver [1966]. In particular, Tamari [1966] focuses on a sample of Israeli industrial firms, including 28 bankrupt or virtually bankrupt firms. In both of these analyses, the methodology is essentially univariate, and Altman's main contribution was to introduce a multivariate model that allows one to consider the effect of several ratios instead of the separate effect of each ratio.

where X_1, X_2, X_3, and X_4 are defined as in Equation (2).

3.1.2 Merton/KMV Model

A different class of bankruptcy prediction models is based on Merton [1974] contingent-claims approach for valuing risky debt. Merton's insight was to view equity as a call option on the firm's assets, with a strike price equal to the face value of the debt. Default occurs when the value of the assets is below the face value of the debt – then the equity holders do not "exercise" their option to own the firm, and firm ownership passes to the debt holders. The probability of default is the probability that the option will not be exercised, which can be derived from the Black-Scholes option-pricing formula.

Importantly, because it is based on the option pricing theory, the probability of default estimated using the Merton model factors in the volatility of the firm's assets. This is in contrast to Altman's Z-Score model, and other ratio-based bankruptcy prediction models. The Merton model has the disadvantage that it relies on stock prices accurately measuring the value of the firm's equity, and it cannot be applied to private firms or to firms in developing markets.

3.1.3 DRSK Model

The DRSK model is a hybrid model that combines a statistical approach with a structural approach, in that it not only uses a logistic regression to estimate the probability of default based on several factors but also considers the distance to default derived from the Merton model [Bondioli et al., 2021]. The probability of default estimated from this model for horizons ranging from 3 months up to 5 years is available through the DRSK function in Bloomberg. In this paper, I use the one-year default probability derived from the Bloomberg DRSK model.

3.2 Four Definitions of Zombie Firms

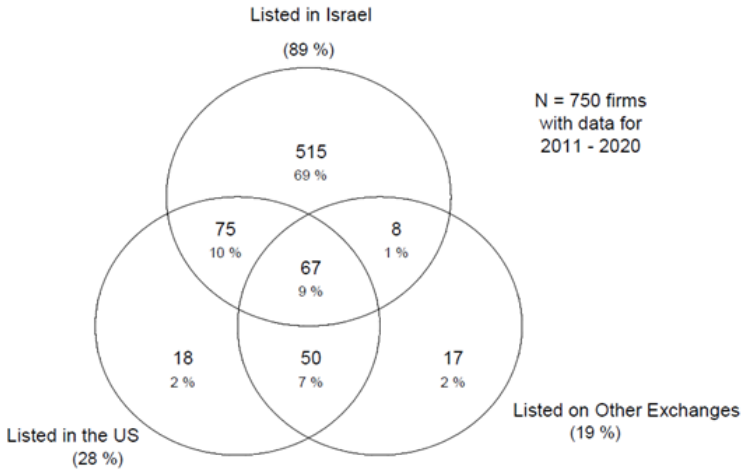
Although there are around a dozen definitions of zombie firms, with a comprehensive list being presented in the Methodology section, for the sake of this analysis I use the following four alternative definitions:

Definition 1: `ZOMBIE_ALTMAN`. Following Altman et al. [2022], a firm is considered a zombie if its three-year moving-average interest coverage ratio is less than 1 and the three-year moving average of either the Z'-score or Z''-score[4] is below 0.

Definition 2: `ZOMBIE_MCGOWAN`. Following McGowan et al. [2018], a firm is considered a zombie

[4]The Z, Z', and Z'' scores are defined in Section 3.1.

Figure 1: The distribution of Israeli firms according to their exchange listings, 2011-2020



if it is older than 10 years and its interest coverage ratio is below 1 for three consecutive years.

Definition 3: `ZOMBIE_BANERJEE`. Following Banerjee and Hofmann [2020], a firm is considered a zombie if its interest coverage ratio is below 1 and its Tobin's Q is below the sector median for at least two consecutive years.

Definition 4: `ZOMBIE_DRSK`. A firm is classified as a zombie if the Bloomberg one-year default probability at year-end is greater than or equal to 10%. Bloomberg classifies issuers into three broad categories: investment grade, high yield, and distressed. The 10% threshold is the cutoff between high yield and distressed.

4. Overview of the Israeli Economy

The Israeli economy is a free-market economy, and it has undergone a dramatic transformation in the last 25 years, mainly led by the high-tech sector, which accounted for 45% of Israeli exports in 2017. The national currency is the Israeli New Shekel (ILS).

Israel's leading industries are technology, agriculture, health and life sciences, and pharmaceuticals. Bloomberg ranked Israel as the 7th most innovative country, surpassing the rankings of the United States and China by 4 and 8 places, respectively.[5] Israel also has more companies listed on the NASDAQ than any other country besides America and China (U.S. 2021 Investment Climate Statement[6]).

[5]Taken from the Bloomberg 2021 Innovation Index
[6]https://www.state.gov/investment-climate-statements/

Many explanations have been proposed for how Israel created such an innovative, entrepreneurial atmosphere, including the following:

1. **Research and Development.** Research has shown the early role that military R&D played in creating the nation's tech industry [Swed and Butler, 2015]. The government also subsidized venture capital and university R&D to boost the technology sector during the 1990s. The term "Start-Up Nation," coined by Senor and Singer [2009], is a reference to Israel's tech ecosystem, which rivals Silicon Valley and produces more startup companies than India, Japan, Canada, and the United Kingdom combined. Given the size of the country, Israel has more startups per capita than any other nation.

2. **Innovation Clusters.** Studies have shown that innovation breeds continued innovation. In the case of Israel, having established a reputation as a source of successful startups, the country has become a magnet for funding and additional talent [Engel and Del-Palacio, 2011].

3. **Mandatory Military Service.** In Israel, military service is mandatory for citizens and permanent residents. Senor and Singer [2009] argue that mandatory military service helps build an entrepreneurial culture. Particularly in the Israeli military, it is common for service members to question authority, which differs sharply from the American military. This atmosphere fosters an environment of innovation and creative thinking.

In addition, according to Senor and Singer [2009], the survival mindset encourages a "can't lose" attitude. This effect has implications for firm financial policies

which are especially relevant for this paper. In this respect, Benmelech and Frydman [2015] found material differences between US companies that have a chief executive officer that had experience in the military before their business career and those that did not. Namely, they found that CEOs who have served in the military tend to not use excessive leverage, their firms are less likely to be involved in fraud and tend to perform better in times of industry distress. The results of Benmelech and Frydman [2015] suggest that, given the mandatory military service in Israel, Israeli firms might be more resilient and therefore less likely to become zombies.[7]

On the other hand, as discussed in the Literature Review section, one of the factors leading to the increase in the number of zombie firms worldwide is the downward trend in interest rates. This is also evident in Israel where the yield on the 10-year Israel Government bond decreased from 4.71% in 2010 to 0.78% in 2020.[8]

Therefore, given the various factors, some global and some specific to the Israeli economy, which could lead to either more or fewer zombie firms in Israel, the prevalence and characteristics of Israeli zombie firms is an empirical question that I attempt to address in this study.

5. Data

5.1 Sample Construction

The main data source for this analysis is Bloomberg Professional. I start by downloading the list of all equity securities, excluding rights and units, issued by firms incorporated and headquartered in Israel, that have at least one year with non-missing assets between 2010 and 2020 and at least one non-missing daily return between 2011 and 2020. The dataset consists only of publicly traded companies, as privately owned firms are not mandated to disclose sufficient financial information to determine the firm's zombie status. After applying these criteria, the dataset includes 1,375 equity securities for 750 distinct firms. For the list of firms thus identified, I then obtain annual financial information for 2010 – 2020, also from Bloomberg Professional. In addition, because the Altman et al. [2022] and McGowan et al. [2018] classifications require three years of data to identify zombie firms, in the main empirical analysis I focus on the period from 2013 to 2020.

These 1,375 securities in the final sample include 1,234 common stocks, 108 depositary receipts, 26 partnership shares, and 7 REITs. According to the current market status, as of April 2022, 768 securities are still active, 144 securities were delisted because the issuing firms were acquired, and 361 securities were delisted for reasons other than M&A.[9]

Figure 1 presents the distribution of Israeli firms according to their exchange listings: 69% of the sample firms are listed only in Israel (on the Tel Aviv Stock Exchange), while the remaining 31% of these firms are listed only abroad or are dual-listed. Some of the biggest Israeli companies are listed in Israel, in the US, and on other global exchanges. For example, Teva Pharmaceuticals' ordinary shares have been listed on the Tel Aviv Stock Exchange since 1951. The company's ADRs have been traded in the US since 1982, first on NASDAQ, and, since 2012, on the NYSE. In addition, Teva also has depositary receipts traded on a few other international exchanges, including the Australian and the Mexican exchanges among others.

5.2 Descriptive Statistics

Table 1 presents descriptive statistics for 2013-2020 for all firms and also excluding finance and real estate firms. Finance and real estate firms are excluded from the rest of the analysis because their operations and financial characteristics are fundamentally different than those of industrial firms. To eliminate the effect of outliers, I also remove the top and bottom 1% of the observations for all ratio variables, except for R&D, CapEx, debt, and cash, where only the top 1% of the observations are excluded (these variables are naturally bounded below by 0).

The size distribution is highly skewed: the mean (median) firm in the sample had assets of 1,921 (107) million USD. When finance and real estate firms are removed, the median and mean for the remaining firms are smaller and with a smaller difference. This is because the top echelon of firm size distribution is dominated by financial firms, especially when size is measured as the book value of total assets. Based on assets, all the top five firms in 2020 are in the financial sector, while based on market capitalization, only one of the top five firms (Bank Hapoalim BM) is in the financial sector; the other four of the largest five firms in terms of market capitalization are either

[7] Although the impact of military service on the incidence of zombie firms is beyond the scope of this paper, there are two ways that this question could be addressed. One approach is to examine cross-country data, comparing Israel with countries that have different military policies. A second approach would be to collect data on Israeli managers' military experience before their business careers and to examine the effect of experience on firm policies and outcomes. Currently, this data is not readily available, yet the question remains particularly relevant in the Israeli context where military service is required.

[8] Historical yields on Israeli government bonds are available in Bloomberg.

[9] For the remaining 102 securities, the current market status in Bloomberg is either "Private Company", "Price Not Available", "Suspended" or "Unlisted". For the purpose of this analysis, I assume that these securities are delisted.

Table 1: Descriptive Statistics

	All Firms				Excluding Finance & Real Estate Firms			
Variable	Obs.	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.
Assets (USD mln)	4,222	1,921.4	107.1	9,994.5	3,096	659.2	79.8	3,676.9
Sales (USD mln)	4,036	369.9	56.9	1,213.7	2,963	343.2	58.6	1,251.4
Market Cap (USD mln)	3,810	464.8	67.1	1,978.1	2,808	441.0	56.8	2,172.5
Employees	3,634	1,193.1	179.0	3,344.5	2,668	1,260.2	220.0	3,549.8
Age	4,222	40.6	31.0	18.2	3,096	39.7	31.0	17.5
ROA	3,988	−0.110	0.032	0.532	3,039	−0.142	0.028	0.581
ROE	3,844	−0.138	0.056	0.779	2,797	−0.194	0.045	0.866
R&D	4,180	0.052	0.000	0.144	3,055	0.071	0.000	0.165
CapEx	4,142	0.025	0.011	0.039	3,041	0.028	0.014	0.040
Debt	4,112	0.279	0.225	0.285	3,042	0.241	0.177	0.268
Net Debt	4,064	0.052	0.092	0.449	2,999	−0.016	0.037	0.445
Interest Coverage Ratio	2,812	1.576	2.568	119.128	2,174	−1.076	2.922	127.431
Tobin's Q	3,734	1.865	1.148	2.380	2,757	2.068	1.264	2.583
Z-Score	3,199	1.372	1.692	9.422	2,582	1.346	2.043	9.710
Z'-Score	3,543	−0.091	1.098	6.543	2,848	−0.193	1.359	6.933
Z''-Score	3,689	−1.389	4.982	29.278	2,964	−1.931	5.089	29.674
1-Year Default Probability	3,882	0.013	0.001	0.039	2,824	0.016	0.001	0.043
5-Year Default Probability	3,882	0.057	0.026	0.081	2,824	0.067	0.033	0.089

Note. Age is the number of years since the firm was founded (the founding year is coded as 1). ROA is earnings before interest and taxes (EBIT) over total assets (book value). ROE is EBIT over the book value of equity. R&D is R&D expenses over total assets. CapEx is capital expenditures over total assets. Debt is long-term borrowing plus short-term borrowing over total assets. Net Debt is long-term borrowing plus short-term borrowing minus cash and marketable securities, scaled by total assets. The Interest Coverage Ratio is EBIT over interest expense. Tobin's Q is total assets plus market capitalization minus the book value of common equity, scaled by total assets. The Z, Z', and Z'' scores are defined in the Methodology section. All data, except for the founding year, are from Bloomberg Professional. The founding year is from Capital IQ, supplemented with Google search. To mitigate the effect of outliers, descriptive statistics are computed after winsorizing the top and bottom 1% of observations for all ratio variables, except for R&D, CapEx, Debt, and Cash, where only the top 1% is excluded (these variables are naturally bounded below by zero).

in the technology sector (Check Point Software, Nice Ltd and Wix.com Ltd) or in the health care sector (Teva Pharmaceuticals). Moreover, as finance and real estate firms tend to have higher leverage, the debt ratio is lower when they are removed from the sample.

Figure 2, Panel A, presents the percentage of firms reporting zero interest in each sector in 2017-2019 (Panel A1) and 2020 (Panel A2). The percentage of zero-debt firms is higher in sectors with low asset tangibility, such as health care, technology and communications. In these sectors, the costs of financial distress are significant because firms typically don't have a lot of tangible assets to pledge as collateral, and therefore the optimal leverage ratios tend to be low. However, the proportion of zero-debt firms decreased across all sectors in 2020, indicating that firms' access to debt financing was supported by various relief measures taken during the COVID crisis. For example, only 7% of health care firms report zero debt at the end of 2020, compared to 41% in 2017-2019. Interestingly, although only 7% of health care firms report zero debt, 22% of these firms report zero interest expenses in 2020, which suggests that the new borrowing for previously unlevered firms took the form of subsidized interest loans.

6. Results

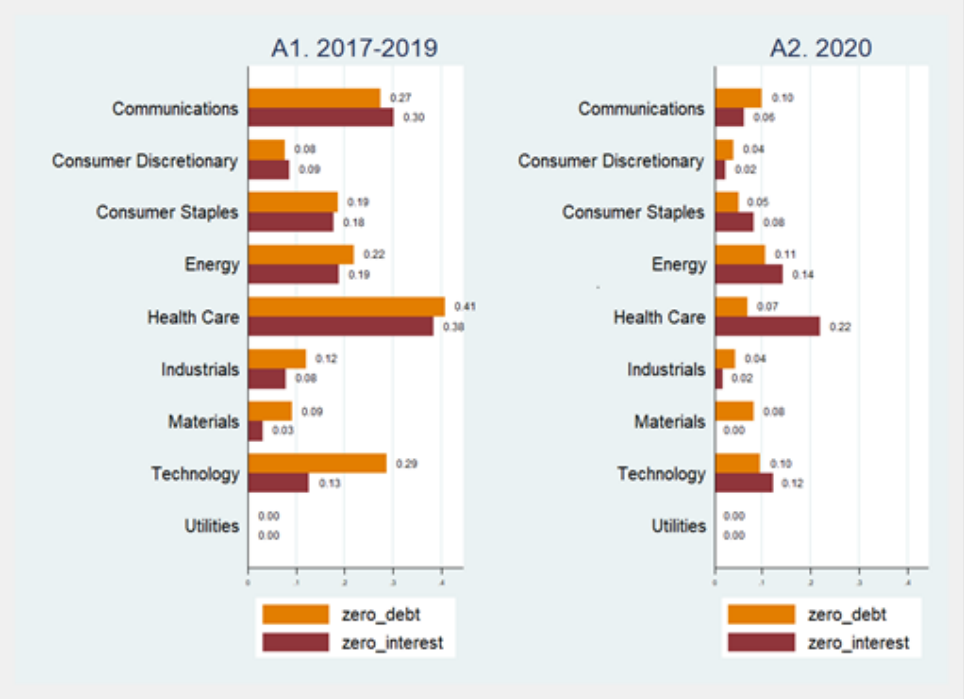
6.1 Prevalence of Zombie Firms

Tables 2 and 3 document the prevalence of zombie firms by year and industry sector, respectively. 11.27% of the firm-years with non-missing data are classified as zombie using the Altman definition. This statistic is in line with that reported by the Bank of Israel: "The phenomenon of zombie businesses was significant in Israel and around the world even before the pandemic. According to the Bank of Israel, some 12% of publicly traded companies fit this definition in 2018 and 2019, and they were concentrated primarily in the field of oil and gas exploration, real estate, and industry."[10] Comparing this to findings from Altman et al. [2022] reveals that the incidence of zombie firms was higher in Israel than in the US, where around 9% of the firms are classified as zombie during this period.

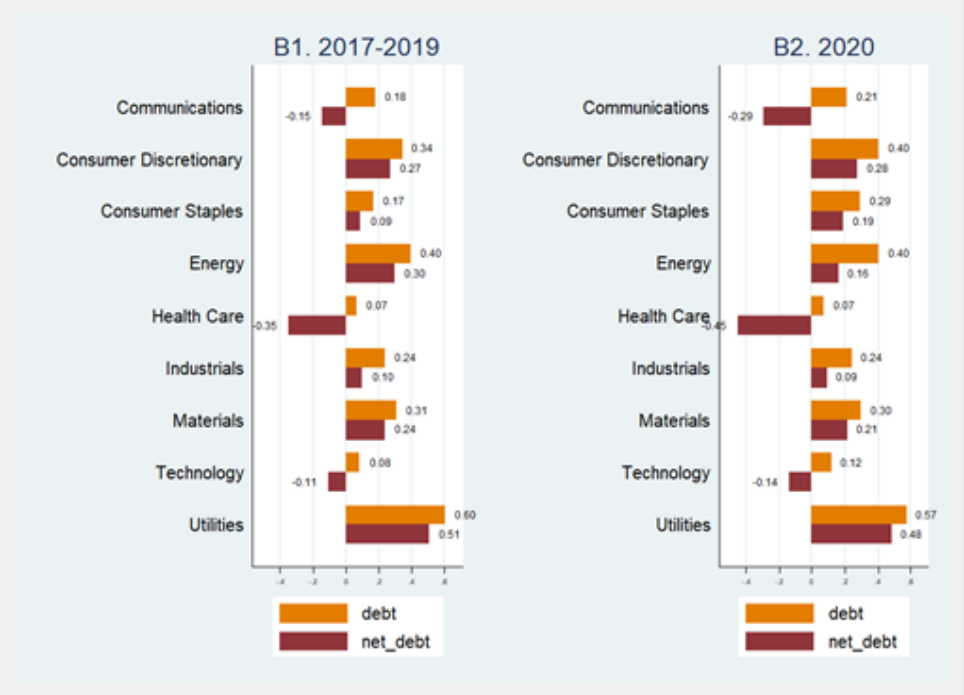
Using the McGowan definition, 15.16% of the firm-years are classified as zombie, while 8.8% of the firm-years are classified as zombie using the Banerjee def-

[10] https://www.haaretz.com/israel-news/business/2021-04-06/ty-article/.premium/israels-covid-grants-propped-up-70-000-zombie-firms/0000017f-f539-ddde-abff-fd7d66970000

Figure 2: Debt Ratios by Sector



(a) The Percentage of Firms with Zero Debt by Sector



(b) Median Debt and Net Debt, as Percent of Assets, by Sector, Conditional on Positive Debt

Note. For Panel A, the percentage of zero-debt firms in each sector is calculated for each year during the 2017–2019 period, and the average percentage across the three years is shown in the figure. For Panel B, the median debt and net debt ratios in each sector are calculated for each year during the 2017–2019 period, and the average of these medians across the three years is shown in the figure.

inition, and only 4.5% of the firm-years are classified as zombie based on Bloomberg 1-year default probability. Although the Altman and the McGowan measures show an increase over the sample period, the number of zombie firms is in general evenly distributed across the sample years.

Table 2: The Percentage of Zombie Firms by Year

Panel A: Definitions 1 (ZOMBIE_ALTMAN) and 2 (ZOMBIE_MCGOWAN)

Year	Obs.	Definition 1: ZOMBIE_ALTMAN			Definition 2: ZOMBIE_MCGOWAN		
		Suff. Data Obs.	Zombie Firms	% Zombies	Suff. Data Obs.	Zombie Firms	% Zombies
2013	408	266	25	9.40%	302	47	15.56%
2014	397	256	31	12.11%	295	40	13.56%
2015	392	255	26	10.20%	290	36	12.41%
2016	386	259	26	10.04%	291	42	14.43%
2017	380	258	31	12.02%	288	46	15.97%
2018	383	251	24	9.56%	276	40	14.49%
2019	379	233	31	13.30%	267	46	17.23%
2020	371	245	34	13.88%	273	49	17.95%
Total	3,096	2,023	228	11.27%	2,282	346	15.16%

Panel B: Definitions 3 (ZOMBIE_BANERJEE) and 4 (ZOMBIE_DRSK)

Year	Obs.	Definition 3: ZOMBIE_BANERJEE			Definition 4: ZOMBIE_DRSK				
		Suff. Data Obs.	Zombie Firms	% Zombies	Suff. Data Obs.	Invest. Grade	High Yield	Distressed (Zombie)	% Zombies
2013	408	304	26	8.55%	378	234	130	14	3.70%
2014	397	283	24	8.48%	360	231	112	17	4.72%
2015	392	289	28	9.69%	354	233	97	24	6.78%
2016	386	289	31	10.73%	348	240	90	18	5.17%
2017	380	276	25	9.06%	342	255	71	16	4.68%
2018	383	273	17	6.23%	338	236	90	12	3.55%
2019	379	263	25	9.51%	353	250	90	13	3.68%
2020	371	272	22	8.09%	351	222	116	13	3.70%
Total	3,096	2,249	198	8.80%	2,824	1,901	796	127	4.50%

Note: "Obs." is the total firm-year observations in the sample. "Suff. Data Obs." is the subset of observations with sufficient data to evaluate the zombie definition. "Zombie Firms" is the number of firms classified as zombies under that definition. The four zombie definitions are described in Section **??**. Under Definition 4 (ZOMBIE_DRSK), Bloomberg classifies issuers into three credit categories—investment grade, high yield, and distressed—based on the one-year default probability; firms in the distressed category are classified as zombies, and the "% Zombies" column reports the share of distressed firms relative to "Suff. Data Obs."

No single industry accounts for more than one-third of the zombie firm-years: in Table 3, the highest share is for Technology zombies – according to the Altman definition, 31% (70 out of 228) of the zombie firms are technology firms. But, using the Banerjee definition, which considers Tobin's Q, in addition to the interest coverage ratio, only 16% (32 out of 198) of the zombie firms are technology firms.

The Altman, McGowan and Banerjee definitions overlap for 82% of the 1,862 firm-years with non-missing data for all three variables: 2% (80%) of these observations are classified as zombies (non-zombies) by all three definitions. Given the much lower incidence of zombie firms according to the Bloomberg (DRSK) definition, the association between this classification and the other three classifications is naturally weaker.

6.2 Delek Group and Africa Israel Investments

Two firms that were classified as zombies at some point during the sample period are Delek Group and Africa Israel Investments. Their zombie spells had completely different endings: while Delek Group successfully recovered from the zombie status, Africa Israel's debt restructuring saga ultimately lead to the sale and delisting of the company.

Delek Group is an Israeli exploration and production conglomerate and one of Israel's largest companies. Given Delek's size and status, it has historically had a stable 1-year default probability. Toward the beginning of the Covid-19 pandemic, this changed dramatically. Delek's shares were down 83% from March 2019 to March 2020. This caused Delek's 1-year default probability to increase to distressed rates, being greater than 25% according to Bloomberg, up from 0.1%. Based on the DRSK definition, at this time Delek was classified as a zombie firm. The Altman and the McGowan definitions require the interest coverage ratio to be less than 1 on average (Altman) or for each year (McGowan); Delek did not fulfill either of these requirements, because their debt-service ability deteriorated suddenly; so Delek was not classified as zombie according to these two definitions. There was insufficient data to determine if Delek would classify as a zombie under the Banerjee definition. Delek moved into a fire sale, trying to sell some of its assets

Table 3: The Percentage of Zombie Firms by Industry Sector

Panel A: Definitions 1 (ZOMBIE_ALTMAN) and 2 (ZOMBIE_MCGOWAN)

Sector	Obs.	Definition 1: ZOMBIE_ALTMAN			Definition 2: ZOMBIE_MCGOWAN		
		Suff. Data Obs.	Zombie Firms	% Zombies	Suff. Data Obs.	Zombie Firms	% Zombies
Communications	170	116	15	12.93%	135	30	22.22%
Cons. Disc.	441	309	29	9.39%	327	47	14.37%
Cons. Staples	299	187	12	6.42%	231	30	12.99%
Energy	286	169	23	13.61%	199	33	16.58%
Health Care	522	257	54	21.01%	310	64	20.65%
Industrials	581	401	20	4.99%	438	32	7.31%
Materials	205	151	5	3.31%	161	22	13.66%
Technology	541	390	70	17.95%	436	78	17.89%
Unclassifiable	8	6	0	0.00%	8	3	37.50%
Utilities	43	37	0	0.00%	37	7	18.92%
Total	3,096	2,023	228	11.27%	2,282	346	15.16%

Panel B: Definitions 3 (ZOMBIE_BANERJEE) and 4 (ZOMBIE_DRSK)

Sector	Obs.	Definition 3: ZOMBIE_BANERJEE			Definition 4: ZOMBIE_DRSK				
		Suff. Data Obs.	Zombie Firms	% Zombies	Suff. Data Obs.	Invest. Grade	High Yield	Distressed (Zombie)	% Zombies
Communications	170	128	23	17.97%	147	88	55	4	2.72%
Cons. Disc.	441	307	33	10.75%	414	244	145	25	6.04%
Cons. Staples	299	236	16	6.78%	275	207	61	7	2.55%
Energy	286	211	10	4.74%	225	144	62	19	8.44%
Health Care	522	308	35	11.36%	461	291	147	23	4.99%
Industrials	581	430	24	5.58%	548	362	169	17	3.10%
Materials	205	149	17	11.41%	197	147	44	6	3.05%
Technology	541	436	32	7.34%	509	384	99	26	5.11%
Unclassifiable	8	8	4	50.00%	8	6	2	0	0.00%
Utilities	43	36	4	11.11%	40	28	12	0	0.00%
Total	3,096	2,249	198	8.80%	2,824	1,901	796	127	4.50%

Note. "Obs." is the total firm-year observations in the sample for each sector. "Suff. Data Obs." is the subset of observations with sufficient data to evaluate the zombie definition. "Zombie Firms" is the number of firms classified as zombies under that definition. Industry sectors follow the Bloomberg classification. The four zombie definitions are described in Section **??**. Under Definition 4 (ZOMBIE_DRSK), Bloomberg classifies issuers into three credit categories—investment grade, high yield, and distressed—based on the one-year default probability; firms in the distressed category are classified as zombies, and the "% Zombies" column reports the share of distressed firms relative to "Suff. Data Obs."

to repay creditors and stay afloat. These strategic decisions by Delek were seemingly successful as the company was able to avoid default and fully recover. As of April 2022, their 1-year default probability is hovering around the 3% range, according to Bloomberg estimations.

Africa Israel Investments Ltd. is an investment company active in areas such as real estate, construction, infrastructure, and manufacturing. Following the 2008 financial crisis, the company was affected by the drop in real estate values and subsequently defaulted on a series of bonds and underwent a debt restructuring in 2010. This restructuring did not provide prolonged financial stability for Africa Israel – the company sank into difficulties leading again to debt restructuring and bondholders taking a haircut. This financial difficulty caused the 1-year default probability to increase from around 1% in June 2014 to 15% in June 2016. At this time, the company was classified as a zombie according to the Banerjee and the DRSK definitions. The Altman and the McGowan definitions require a firm to have a 3-year interest coverage ratio below 1 which Africa Israel did not have. One year following being classified as a zombie, Africa Israel was no longer a zombie according to the Banerjee definition, however, it was still classified as a zombie according to the DRSK definition. As a result of the distress leading to the sale of the company to Lapidoth Capital, Africa Israel was officially delisted from the Tel Aviv Stock Exchange in January 2020.

In order to understand whether the different outcomes experienced by Delek and Africa Israel represent more general patterns, in the next sections I examine the entire sample of Israeli firms, focusing on the persistence of zombie status and on the probability of survival once the firm is classified as a zombie.

6.3 Persistence of Zombie Status

From an economic perspective, if zombies tend to reenter the market and contribute meaningfully to

Table 4: The Distribution of Zombie Status Between and Within Firms

Panel A: `ZOMBIE_ALTMAN`

	Overall		Between		Within
Zombie	Freq.	%	Freq.	%	%
0	1,795	88.73	370	91.36	93.81
1	228	11.27	85	20.99	68.13
Total	2,023	100.00	455	112.35	89.01
			($n = 405$)		

Panel B: `ZOMBIE_MCGOWAN`

	Overall		Between		Within
Zombie	Freq.	%	Freq.	%	%
0	1,936	84.84	380	89.62	91.33
1	346	15.16	135	31.84	57.00
Total	2,282	100.00	515	121.46	82.33
			($n = 424$)		

Panel C: `ZOMBIE_BANERJEE`

	Overall		Between		Within
Zombie	Freq.	%	Freq.	%	%
0	2,051	91.20	403	98.29	92.83
1	198	8.80	99	24.15	36.25
Total	2,249	100.00	502	122.44	81.67
			($n = 410$)		

Panel D: `ZOMBIE_DRSK`

	Overall		Between		Within
Zombie	Freq.	%	Freq.	%	%
0	2,697	95.50	460	98.71	94.56
1	127	4.50	81	17.38	38.28
Total	2,824	100.00	541	116.09	86.14
			($n = 466$)		

Note. The Between column shows the number of firms with non-missing zombie status for at least one year, as well as the number of firms classified as a zombie (Zombie = 1) or non-zombie (Zombie = 0) for at least one year. For example, in Panel A, 405 firms have at least one year of non-missing zombie status under the Altman definition; 85 firms (20.99% of all firms with non-missing zombie status) are classified as zombies in at least one year, and 370 firms (91.36%) are classified as non-zombie (healthy) in at least one year. Because a firm can switch status across years, the Between percentages can sum to more than 100%. The Within column shows that, conditional on ever being a zombie (the 85 firms in the Between column for Panel A), on average 68.13% of the firm-years are classified as zombie; the Within Percent thus measures the stability of zombie status within a firm.

the economy, then enabling them to survive may be worthwhile. On the other hand, if zombie firms tend to retain that status for several years before eventually exiting the market, then maintaining them for several years would not be productive. From an investing perspective, this question has relevance, especially for distressed investors.

To begin with, I measure zombie persistence as the percent of the time a firm is classified as a zombie. Table 4 shows the decomposition of the overall frequency documented in the previous tables into a between-firm and a within-firm component. Panel A of Table 4 shows that, conditional on being classified as a zombie for at least one year (the 85 firms in the Between column), on average 68.13% of the firm-years are zombie. The McGowan definition is the broadest and, as such, resulted in the highest percentage of zombies, with 135 firms (31.84% of the sample) being deemed zombies at least once during the period (Panel B). The Banerjee and the DRSK definitions result in less stable classifications of zombie firms. The 99 firms ever classified as a zombie according to the Banerjee definition are zombie for only 36% of the sample period on average.

6.4 Zombie Status and the Probability of Survival - Univariate Analysis

In this section, I investigate whether zombie firms tend to recover and turn healthy, or whether, once turned zombie, they tend to remain zombie until the end of the sample period, or until they exit the sample. First, in Panel A of Table 5, I tabulate the zombie status in the current year (0/1, 1 indicating a zombie firm, and 0 indicating a healthy firm), and the firm status in the following year. Firm status is defined by combining the most recent market status for the firm's securities (Active / Acquired / Delisted) and the firm-level financial information, both downloaded from Bloomberg. If the current year is the last year with data available for the firm, and if the current status of the firm is "Acquired", the firm is considered to be acquired in the following year. "Delisted" means that the firm is delisted for any reason other than being acquired. If a security is delisted from an exchange, but the firm has other equity securities that continue to trade on other exchanges, the firm itself is considered active. If the firm remains in the sample, the firm status in the following year can be either "Zombie" or "Healthy (or "Missing Data", if the firm is in the sample, but the zombie variable is missing). Because the last year with available data is 2020, for this analysis the sample period is restricted to 2013-2019.

According to the Altman definition, approximately 71.13% of the zombie firms remain in the sample as zombie firms, and only 12% turn healthy the following year (23 "recovered zombies"), while 7.22% (14 firms) are delisted. According to the DRSK definition, 50% of the zombie firms recover to healthy status, and only 30% remain zombie next year. For all definitions, the chi square test of independence across rows and columns is rejected at the 1% level (p-value = 0.000), indicating that there is a significant association between the zombie status in the current year and the firm status in the following year.

Table 5: Zombie Status and Future Firm Status – Univariate Analysis

Panel A: Zombie Status and Firm Status the Following Year

	Counts						Row Percentages				
Zombie	Acq.	Delisted	Healthy	Missing Data	Zombie	Total	% Acq.	% Del.	% Hlth.	% Miss.	% Zomb.
Definition 1: `ZOMBIE_ALTMAN`											
0	21	31	1,380	131	21	1,584	1.33%	1.96%	87.12%	8.27%	1.33%
1	1	14	23	18	138	194	0.52%	7.22%	11.86%	9.28%	71.13%
Pearson $\chi^2(4) = 1{,}100$, p-value $= 0.000$											
Definition 2: `ZOMBIE_MCGOWAN`											
0	21	36	1,516	88	51	1,712	1.23%	2.10%	88.55%	5.14%	2.98%
1	4	13	59	17	204	297	1.35%	4.38%	19.87%	5.72%	68.69%
Pearson $\chi^2(4) = 1{,}000$, p-value $= 0.000$											
Definition 3: `ZOMBIE_BANERJEE`											
0	26	27	1,571	113	64	1,801	1.44%	1.50%	87.23%	6.27%	3.55%
1	1	2	64	16	93	176	0.57%	1.14%	36.36%	9.09%	52.84%
Pearson $\chi^2(4) = 543.61$, p-value $= 0.000$											
Definition 4: `ZOMBIE_DRSK`											
0	37	48	2,168	50	56	2,359	1.57%	2.03%	91.90%	2.12%	2.37%
1	1	11	57	11	34	114	0.88%	9.65%	50.00%	9.65%	29.82%
Pearson $\chi^2(4) = 298.15$, p-value $= 0.000$											

Panel B: Zombie Status and Current Firm Status

	Counts				Row Percentages		
Zombie	Active	Acquired	Delisted	Total	% Active	% Acquired	% Delisted
Definition 1: `ZOMBIE_ALTMAN`							
0	246	28	46	320	76.88%	8.75%	14.38%
1	63	2	20	85	74.12%	2.35%	23.53%
Pearson $\chi^2(2) = 7.23$, p-value $= 0.027$							
Definition 2: `ZOMBIE_MCGOWAN`							
0	219	27	43	289	75.78%	9.34%	14.88%
1	103	7	25	135	76.30%	5.19%	18.52%
Pearson $\chi^2(2) = 2.75$, p-value $= 0.253$							
Definition 3: `ZOMBIE_BANERJEE`							
0	235	31	45	311	75.56%	9.97%	14.47%
1	82	3	14	99	82.83%	3.03%	14.14%
Pearson $\chi^2(2) = 4.88$, p-value $= 0.087$							
Definition 4: `ZOMBIE_DRSK`							
0	296	38	51	385	76.88%	9.87%	13.25%
1	51	5	25	81	62.96%	6.17%	30.86%
Pearson $\chi^2(2) = 15.47$, p-value $= 0.000$							

Note. Panel A tabulates the zombie status in the current year against the firm's status in the following year. Firm status is determined by combining the most recent market status of the firm's securities (Active, Acquired, or Delisted) with firm-level financial information from Bloomberg. If the current year is the firm's last year of available data and the current security status is "Acquired," the firm is considered acquired in the following year. "Delisted" refers to delisting for any reason other than acquisition. If a security is delisted from one exchange but the firm has other equity securities that continue to trade elsewhere, the firm is considered active. If the firm remains in the sample, its following-year status can be "Zombie," "Healthy," or "Missing Data" (the latter when the firm is in the sample but the zombie variable is missing). Panel B tabulates the current-year zombie status against the current firm status. The Pearson χ^2 statistic tests the null hypothesis of independence between zombie status and firm status. Because the last year of data is 2020, Panel A's analysis is restricted to 2013–2019. The four zombie definitions are described in Section **??**.

In Panel B of Table 5, I conduct a similar analysis in Panel A, but using only one observation per firm. Now the zombie status is 1 if the firm is defined as zombie for at least one year, and 0 if the firm is defined as healthy during all years in the sample. The current status of each firm can be either "Active", "Acquired" or "Delisted". I find that 74% of the 85 firms that were ever classified as a zombie according to the Altman definition remain in the sample by 2020, while 23.53% were delisted, and only 2 firms were acquired. Of the 320 firms that were never classified as zombie, only 14.38% were delisted and 8.75% were acquired by the end of the sample period. The chi square test of independence is significant at the 5% level (p-value = 0.027). The chi square test of independence is also highly significant for the DRSK definition. Out of the 81 firms that were ever classified as zombie (distressed) firms based

on the Bloomberg one-year default probability, 31% were delisted; while out of the 385 firms that were never classified as a zombie (distressed) based on this criterion, only 13.25% were delisted.

6.5 Zombie Status and the Probability of Survival – Multivariate Analysis

6.5.1 Logit Model

In Table 6, I report the estimated coefficients and the p-values from a logit model for the probability of dropping out of the sample, as a function of the zombie status in the current year and controlling for other firm characteristics. Given that the sample ends in 2020, so we do not observe the firm status in 2021, the sample period used for the logit model is 2013-2019. A logit model is estimated separately for each zombie definition ($ZOMBIE\_ALTMAN$, $ZOMBIE\_MCGOWAN$, $ZOMBIE\_BANERJEE$ and $ZOMBIE\_DRSK$). The zombie status is not significant when using the Altman, McGowan and Banerjee definitions, but it is positive and significant when using the Bloomberg (DRSK) probability of default. The coefficient on $ZOMBIE\_DRSK$, 1.357, is significant at the 1% level (p-value=0.009). The positive coefficient implies that a change in zombie status increases the odds of dropping out of the sample, all else equal. More precisely, the 1.357 coefficient means that for a zombie firm the odds of dropping out of the sample next year is $e^{1.357} = 3.884$ times that for a healthy firm.

6.5.2 Multinomial Logit Model

In Table 7, I present estimation results for a multinomial logit model for the firm status in the following year as a function of the zombie status in the current year and controlling for other firm characteristics. $STATUS\_NEXT\_YEAR$ can take four possible values: "Healthy", "Zombie", "Acquired" and "Delisted". Similar to the logit model, the multinomial logit model is estimated using data for 2013-2019.

Table 7 shows that being classified as a zombie firm in the current year has a positive and significant effect on the probability of being a zombie the following year (relative to turning healthy). The magnitude of the coefficient for `ZOMBIE_ALTMAN`, 5.111 (Panel A), indicates that for a zombie firm the odds of being a zombie next year (relative to being healthy next year) is $e^{5.111} = 166$ times that for a healthy firm (Panel B). In addition, using the Altman definition, the zombie status does not have a significant effect on the probability of being acquired (again relative to remaining in the sample as a healthy firm the following year); but the effect on the probability of being delisted is also positive and significant: for a zombie firm the odds of being delisted the following year (relative to being healthy) is $e^{2.436} = 11.4$ times that for a healthy firm (Panel B).

Using the McGowan definition of zombie status, the effect of zombie status is positive and significant in all three equations, which means that zombie firms are more likely to remain zombie, to be acquired and to be delisted, all relative to turning healthy. Using the Banerjee definition, only the effect on remaining a zombie is significant. Finally, using the Bloomberg (DRSK) definition, the results for zombie status are similar to the results obtained using the Altman definition.

All in all, in Panels A and B of Table 7 I find that the zombie status is highly persistent: using any of the four definitions of zombie status, being zombie in the current year increases the probability that the firm will remain a zombie next year. Using three of the four definitions, being zombie in the current year the probability of being delisted next year, while the effect on being acquired is significant only using the McGowan definition (the only definition that screens out young firms).

It is also important to examine the effect of zombie status on the probability of being delisted or acquired, relative to remaining zombie, as these outcomes are fundamentally different: if zombie firms are more likely to be delisted or acquired, then the resources that were previously used by unviable firms will be used elsewhere in the economy (creative destruction); on the other hand, if zombie firms are more likely to remain zombie, instead of turning healthy and instead of being delisted or acquired, then the survival of zombie firms is an inefficiency which must be addressed by policymakers in order to ensure that the resources are allocated to their best use.

To test the statistical significance of the effect of zombie status on the probability of being delisted or acquired, relative to remaining zombie, in Panel C of Table 7 I re-estimate the multinomial logit model, now using $STATUS\_NEXT\_YEAR$ = "Zombie" as the reference category. As can be inferred from Panel B, in Panel C I find that the exponentiated coefficients (e^{β}) are less than 1, which indicates that a firm that is classified as zombie in the current year is less likely to be healthy, acquired or delisted next year relative to the remaining zombie. Moreover, these effects are statistically significant in almost all columns. For example, for a firm classified as zombie using the Altman definition, the odds of being delisted next year (relative to remaining zombie) is 0.069 that for a healthy firm [11]; this effect is statistically significant

[11] The effect of being a zombie on the odds of being delisted versus remaining a zombie next year can also be calculated as the ratio of the exponentiated coefficients in the equations for $STATUS\_NEXT\_YEAR$ = "Delisted" and $STATUS\_NEXT\_YEAR$ = "Zombie", both reported in

Table 6: Zombie Status and Firm Status the Following Year – Logit Model

	(1) ALTMAN	(2) MCGOWAN	(3) BANERJEE	(4) DRSK
ZOMBIE	0.174	0.156	−0.506	1.357***
	(0.749)	(0.715)	(0.407)	(0.009)
Debt	0.677	0.596	0.398	−0.210
	(0.366)	(0.410)	(0.546)	(0.731)
Cash	1.037	0.926	0.634	−0.524
	(0.190)	(0.208)	(0.346)	(0.433)
ROA	0.461	0.662	0.072	0.758
	(0.545)	(0.364)	(0.886)	(0.229)
Tobin's Q	0.051	0.027	0.008	−0.005
	(0.561)	(0.731)	(0.913)	(0.950)
R&D	1.074	1.035	0.832	1.489
	(0.280)	(0.294)	(0.340)	(0.115)
CapEx	−11.175	−12.037*	−12.814*	−13.239**
	(0.137)	(0.098)	(0.063)	(0.040)
ln(Assets)	−0.052	−0.074	−0.080	−0.086
	(0.665)	(0.498)	(0.428)	(0.343)
Age	0.012	0.015*	0.012	0.015*
	(0.235)	(0.099)	(0.195)	(0.059)
Listed in the US	0.664*	0.665*	0.604*	0.846***
	(0.095)	(0.075)	(0.084)	(0.006)
Constant	−4.690***	−4.635***	−4.063***	−3.900***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1,835	2,049	2,126	2,483
Log Likelihood	−183.974	−207.786	−235.676	−279.872
Chi-Squared	17.246	17.093	17.284	27.578
p-value	0.069	0.072	0.068	0.002

Note. The dependent variable is an indicator equal to 1 if the firm drops out of the sample the following year and 0 otherwise. The main explanatory variable, ZOMBIE, is an indicator for the firm's zombie status in the current year, defined using the Altman definition (column (1)), the McGowan definition (column (2)), the Banerjee definition (column (3)), or the DRSK definition (column (4)). "Listed in the US" is an indicator equal to 1 if the firm is listed in the US and 0 otherwise. In this model, ROA is EBIT plus R&D expenditures over total assets. All other variables are defined in Table 1. p-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

at the 1% level. The results are inconsistent with the notion of creative destruction, suggesting instead that the persistence of the zombie status is an inefficiency that policymakers should address by revising the insolvency and/or the M&A regulations.

7. Conclusion

In this paper I study the Israeli zombie firms. I document that the number of zombie firms has increased over the period from 2013 to 2020 using two out four alternative definitions of zombie firms. I also find that the zombie status is highly persistent. In a multinomial logit model controlling for other firm characteristics, I find that firms classified as zombie in the current year are more likely to remain zombie than to be delisted, and in turn are more likely to be delisted than to turn healthy the following year.

Several areas would be appropriate for further research. A first follow-up area is to analyze the impact of zombie firm resource usage, including investments, on non-zombies. In other words, a study could attempt to answer how Israeli zombie firms affect healthy firms. This question is particularly relevant for policymakers, as it would provide information about the consequences of zombie prevalence. For example, a future analysis could seek to determine whether the presence of zombie firms lowers employment or growth among healthy firms.

Second, a future study could focus on the relevance of the CEO's prior experience, especially prior military experience, on the likelihood of a company becoming a zombie. Some of the existing literature seemingly implies a negative correlation between a CEO's military experience and the company's zombie status. Finally, additional research should seek to develop a unified definition of a "zombie firm." As noted above, due to the lack of consensus, this paper employed four different definitions. A unified definition would allow for clearer and more straightforward analyses of zombie firms in the future.

Panel B: 11.423 / 165.916 = 0.069. Panel C is included in order to highlight the statistical significance of these effects.

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Table 7: Zombie Status and Firm Status the Following Year – Multinomial Logit Model

Panel A: Reference Category = Healthy; Coefficients (β)

	(1) ZOMBIE_ALTMAN			(2) ZOMBIE_MCGOWAN			(3) ZOMBIE_BANERJEE			(4) ZOMBIE_DRSK		
	Zombie	Acq.	Delist.	Zombie	Acq.	Delist.	Zombie	Acq.	Delist.	Zombie	Acq.	Delist.
ZOMBIE	5.111***	0.943	2.436***	4.278***	1.969***	1.329**	2.942***	0.277	0.277	1.857***	1.165	1.675***
	(0.000)	(0.390)	(0.001)	(0.000)	(0.002)	(0.030)	(0.000)	(0.792)	(0.722)	(0.000)	(0.287)	(0.006)
Debt	2.013**	−0.179	2.713**	0.913*	−0.780	2.161***	0.705	−0.664	1.299*	2.977***	−1.579	1.390*
	(0.013)	(0.904)	(0.013)	(0.071)	(0.589)	(0.007)	(0.261)	(0.606)	(0.085)	(0.000)	(0.217)	(0.073)
Cash	−0.646	−0.155	1.851*	−0.197	0.115	1.553	−0.763	0.507	0.681	−1.014	−0.922	−0.165
	(0.449)	(0.902)	(0.092)	(0.712)	(0.919)	(0.121)	(0.218)	(0.613)	(0.461)	(0.220)	(0.335)	(0.875)
ROA	−1.946***	2.498	−1.403	−0.619*	2.258	−0.025	−2.182***	0.644	0.095	0.023	1.850	0.062
	(0.008)	(0.141)	(0.132)	(0.056)	(0.143)	(0.973)	(0.000)	(0.584)	(0.885)	(0.962)	(0.116)	(0.927)
Tobin's Q	−0.093	0.190	−0.101	0.014	0.090	−0.077	−2.775***	0.057	−0.176	−0.391***	0.071	−0.219
	(0.380)	(0.207)	(0.471)	(0.798)	(0.509)	(0.553)	(0.000)	(0.646)	(0.252)	(0.006)	(0.571)	(0.237)
R&D	1.041	2.918	1.352	0.261	1.585	1.347	0.948	1.645	0.725	1.497	2.101	1.668
	(0.320)	(0.139)	(0.322)	(0.734)	(0.403)	(0.289)	(0.465)	(0.260)	(0.541)	(0.159)	(0.162)	(0.219)
CapEx	−2.891	−12.700	−12.888	−1.781	−15.225	−12.935	1.350	−16.436	−11.496	1.679	−15.853*	−11.263
	(0.522)	(0.232)	(0.273)	(0.534)	(0.170)	(0.245)	(0.682)	(0.127)	(0.252)	(0.688)	(0.092)	(0.222)
ln(Assets)	−0.390***	0.166	−0.384*	−0.204**	0.180	−0.411**	−0.074	0.256*	−0.503***	−0.710***	0.121	−0.426***
	(0.007)	(0.311)	(0.058)	(0.011)	(0.231)	(0.022)	(0.377)	(0.065)	(0.002)	(0.000)	(0.321)	(0.006)
Age	−0.004	−0.003	0.025*	0.003	−0.004	0.035***	0.004	−0.009	0.033***	0.018*	0.002	0.031***
	(0.725)	(0.855)	(0.056)	(0.658)	(0.770)	(0.004)	(0.507)	(0.535)	(0.006)	(0.055)	(0.883)	(0.003)
Listed in the US	0.429	1.760***	−0.881	0.144	1.587***	−0.722	0.507*	1.402**	−0.621	0.929**	1.786***	−0.442
	(0.326)	(0.009)	(0.241)	(0.600)	(0.009)	(0.313)	(0.075)	(0.012)	(0.362)	(0.012)	(0.000)	(0.461)
Constant	−2.592***	−6.268***	−4.445***	−2.806***	−5.897***	−4.597***	0.011	−5.714***	−3.391***	−2.180***	−5.292***	−3.626***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.986)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Observations		1,484			1,716			1,752			2,126	
Log Likelihood		−321.839			−525.789			−548.264			−479.963	
Chi-Squared		662.908			710.090			439.678			216.300	
p-value		0.000			0.000			0.000			0.000	

Panel B: Reference Category = Healthy; Exponentiated Coefficients (e^{β})

	(1) ZOMBIE_ALTMAN			(2) ZOMBIE_MCGOWAN			(3) ZOMBIE_BANERJEE			(4) ZOMBIE_DRSK		
	Zombie	Acq.	Delist.	Zombie	Acq.	Delist.	Zombie	Acq.	Delist.	Zombie	Acq.	Delist.
ZOMBIE	165.916***	2.567	11.423***	72.106***	7.164***	3.779**	18.948***	1.319	1.320	6.407***	3.207	5.340***
	(0.000)	(0.390)	(0.001)	(0.000)	(0.002)	(0.030)	(0.000)	(0.792)	(0.722)	(0.000)	(0.287)	(0.006)

Panel C: Reference Category = Zombie; Exponentiated Coefficients (e^{β})

	(1) ZOMBIE_ALTMAN			(2) ZOMBIE_MCGOWAN			(3) ZOMBIE_BANERJEE			(4) ZOMBIE_DRSK		
	Healthy	Acq.	Delist.	Healthy	Acq.	Delist.	Healthy	Acq.	Delist.	Healthy	Acq.	Delist.
ZOMBIE	0.006***	0.015***	0.069***	0.014***	0.099***	0.052***	0.053***	0.070**	0.070***	0.156***	0.501	0.834
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.012)	(0.001)	(0.000)	(0.547)	(0.789)

Note. The dependent variable is the firm's status in the following year, estimated via multinomial logit. "Acq." denotes Acquired and "Delist." denotes Delisted. In Panels A and B the reference (base) outcome is Healthy; in Panel C the reference outcome is Zombie. Panel A reports raw coefficients (β); Panels B and C report exponentiated coefficients (e^{β}), i.e. relative risk ratios. The four zombie definitions are described in Section **??**; all explanatory variables other than "Listed in the US" are defined in Table 1. p-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

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