

The Zombie Firm Effect and the Inefficient Allocation of Capital

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Abstract

Research sponsored by the Organization for Economic Co-operation and Development (OECD) uncovered a productivity slowdown plaguing western economies that is associated with the greater presence of zombie firms. A zombie firm is defined as a firm with operating income for at least 10 consecutive years and has an interest coverage ratio less than 1 for 3 consecutive years. This study uses a breakdown of the Dupont Analysis (return on equity) to study the effects of the zombie firm phenomenon on U.S. public companies.

Professional accountants play an important role in the resource allocation decisions by investors because financial reporting assists in making financial markets work more efficiently and effectively.

Understanding the impact of zombie firms on the U.S. economy is important. Prior research shows that maintaining investments in zombie firms crowds out investment in more productive firms (i.e., zombie congestion). Results from this study show:

- a greater presence of zombie firms in the U.S. economy over the study period,
- the zombie firms' presence contributes to lower profit margins and asset efficiency, and
- other factors lacking in the general economy adversely influence productivity.

Key words: zombie firms; Dupont Analysis; return on equity; productivity

Introduction

In the aftermath of the recent Great Recession, the Organization for Economic Co-operation and Development (OECD) uncovered a “productivity slowdown” occurring in the western economies that is associated with the emergence of “zombie” firms (McGowan et al., 2017). Zombie firms consist of companies that have operating income for at least 10 consecutive years and have an interest coverage ratio less than 1 for 3 consecutive years. Zombie firms’ balance sheets are characterized by high debt levels and their income statements display marginal profits or losses because of substantial interest charges. Zombie firms struggle to achieve even moderate returns to their shareholders. Estimates of the prevalence of zombie firms range from 12% of non-financial publicly traded firms in the major western economies (Banerjee and Hofmann, 2018) to 16% of Canadian publicly traded firms (McLeod, 2018).

McGowan et al. (2017) assert that the productivity slowdown is related to the greater dispersion in productivity between the most and least productive firms. Not only has the productivity gap widened, but the number of highly productive profitable firms has declined over the past 40 years. For example, 109 companies accounted for one-half the profits of all U.S. publicly traded firms in 1979, but by 2015 that figure had declined to 30 companies (13D Research, 2017). The widening productivity gap between the most and least productive firms coupled with the fewer number of highly profitable firms means that firms at the low end of the productivity scale significantly reduce overall productivity in the economy. Zombie firms are more likely positioned at the low end of the productivity scale.

Professional accountants play an important role in the resource allocation decisions in the general economy. The Financial Accounting Standards Board’s (FASB) Statement of Financial Accounting Concepts No. 8 states that a primary purpose of financial accounting is to make financial markets work more efficiently and effectively by assisting investors in their decisions to allocate scarce financial resources in the economy. The purpose of this study is to examine the zombie firms’ negative impact on the profitability and asset efficiency of U.S. publicly traded firms. It is important to present U.S. companies’ results because most of the OECD’s studies focus on European or Japanese firms. This study provides important insights into the zombie firm phenomenon within a U.S. context.

The remainder of this research paper is organized as follows:

- Zombie Firms’ Emergence and Impact on Productivity;
- Zombie Firms’ Effects on Profitability and Asset Efficiency;
- Research Design and Methodology;
- Results and Discussion; and
- Conclusion.

Zombie Firms' Emergence and Impact on Productivity

The zombie firms' emergence begins with an examination of Japan's economy during the 1990s when a severe economic crisis afflicted the Japanese economy. Many Japanese firms that were saddled with debt managed to survive because Japanese banks continued to extend credit to them. The banks extended credit because of their close relationship with the indebted firms (Peek and Rosengren, 2005). Cross shareholdings and interlocking boards of directors between business firms and financial institutions are a common occurrence in Japan (i.e., keiretsu group). By supplying credit, the Japanese banks also weakened their financial position and capital ratios. As the decade progressed, many of the indebted Japanese business firms became zombie firms. The Japanese zombie firms exhibit lower investment growth, lower employment growth, and widen the productivity gap (Caballero et al., 2008). Further, the zombie firms' existence in the Japanese economy created a barrier to entry for innovative firms possessing higher productivity (Caballero et al., 2008). Thus, prolonging zombie firms' presence and not allowing them to exit their markets created detrimental economic consequences throughout the Japanese economy.

The Great Recession that began in 2008 has been followed by an economic malaise that continues to exist in many western economies. McGowan et al. (2017, p. 3) state, "The results show that the prevalence of and resources sunk in zombie firms have risen since the mid-2000s and that the increasing survival of these low productivity firms at the margins of exit congests markets and constrains the growth of more productive firms."

One of the primary reasons for the continued existence of zombie firms has been the low-interest rate monetary policy followed by the developed countries' central banks since the onset of the Great Recession. A low-interest rate environment creates financial incentives for risk-taking. Further, Eoin Murray, Head of Investment at Federated Hermes states regarding monetary policy and specifically quantitative easing (QE), "QE and ultra-low rates have insulated many companies, and unwary investors, from the dangers that normally lurk; they are now treading a dangerous path... Central bankers have inadvertently managed to stem natural attrition, something which is paramount for healthy capital markets, with a knock-on effect on the flow of money into new enterprises. Eventually, the natural order must prevail" (13D Research, 2017).

With the onset of the Covid-19 pandemic in 2020, many firms borrowed simply to survive because the pandemic shutdown their business operations. Carnival Corp., Marriott International Inc., Delta Air Lines Inc., Gap Inc., and Avis Budget Group Inc. are several of the many companies that have placed billions of dollars in the loan and bond markets during 2020 (Smith and Hill, 2020). The combination of the U.S. Federal Reserve's low interest rate

monetary policy and the onset of Covid-19 has created a recipe for companies to become more indebted, including companies that were already heavily in debt prior to the pandemic. As a result, the circumstances are in place to expect increasing numbers of U.S. zombie firms and a negative impact to corporate productivity.

A prolonged low-interest rate environment by itself does not account entirely for the continued existence of zombie firms. Another factor involves “structural policy weaknesses” concerning developed countries’ “insolvency regimes” (McGowan et al., 2017). In the Japanese context, the structural policy weakness concerns the close-knit relationship between business firms and their banks. Banks that are reluctant to write-down non-productive loans, enforce loan covenants, or enforce payment of non-performing loans will not have the means or incentive to lend to more productive firms. Thus, the loans invested in zombie firms crowd out loans that can be made to more productive firms (i.e., “zombie congestion”). The zombie congestion effect is not restricted to the Japanese economy, but the congestion effect applies to other business firms operating in developed countries. McGowan et al. (2017) state that zombie firms are holding back growth in many countries including South Korea, the United Kingdom, and Italy. The authors also find that zombie firms invest less and hire fewer workers than otherwise, and the negative effect on investment is stronger for young firms. Taken together, these results suggest zombie firms continued existence create a barrier to entry for more productive and start-up firms.

McGowan and Andrews (2018) suggest policy reforms in many western countries can address the problem of the prolonged existence of zombie firms. The reforms involve developing best practices to identify firms heading towards zombie status and a variety of reforms that expedite the exit or restructuring of zombie firms. The goal is to let the market dispose of non-viable firms and promote the restructuring of viable business enterprises. This topic involves reforming country-specific legal structures (e.g., bankruptcy laws) and is beyond the scope of this paper.

The zombie firm’s phenomenon does not pertain exclusively to public companies. In a *Forbes* article, *Forbes* found that returns are down and liquidity is getting worse for private equity (PE) firms (Tucker, 2026). Typically, PE firms hold portfolios of companies. The objective is to buy low and sell high by flipping the companies. Presently, PE firms are holding onto their companies for a much longer period and thus not generating the cash flows from the sales. Coupled with declining fees earned from managing their investments, PE firms are languishing and resemble zombie firms (Tucker, 2026). The study of PE firms and private credit markets is an interesting area to study, but is not the focus of this research paper.

In summary, Banerjee and Hofmann (2018) provide these “Key Takeaways” regarding the zombie firms’ effects:

- The prevalence of zombie firms has ratcheted up since the late 1980s.

- The increase in zombie firms can be linked to reduced financial pressure, reflecting in part the effects of lower interest rates.
- Zombie firms are less productive and crowd out investment in and employment at more productive firms.
- When identifying zombie firms, it appears to be important to take into account expected future profitability in addition to weak past performance.

Zombie Firms' Effects on Profitability and Asset Efficiency

Research into the detrimental economic effects of zombie firms finds that their presence in the economy reduces overall productivity and crowds out investment to more productive firms (Banerjee and Hofmann, 2018; McGowan et al., 2017). From a U.S. perspective, the negative zombie firms' effects can be quantified by examining the differences in U.S. public firms' profitability and asset efficiency ratios with and without zombie firms' inclusion. Specifically, a Dupont Analysis, the disaggregation of return on equity (ROE) into its components of profit margin, asset turnover, and leverage provides the tool to analyze the zombie firms' effects. The expectation is that the presence of zombie firms in the U.S. economy reduces overall corporate profitability and asset efficiency. The ROE ratio is expressed as follows:

$$\begin{aligned}
 \text{Return on Equity} &= \frac{\text{Net Income}}{\text{Total Revenues}} \times \frac{\text{Total Revenues}}{\text{Average Total Assets}} \times \frac{\text{Average Total Assets}}{\text{Average Stockholders' Equity}} \\
 &= \begin{array}{ccc} \blacktriangledown & \blacktriangledown & \blacktriangledown \\ \text{Profitability} & \text{Activity Ratio} & \text{Leverage Ratio} \\ \text{Ratio} & \text{(Asset Turnover)} & \end{array} \\
 &= \begin{array}{ccc} \blacktriangledown & \blacktriangledown & \blacktriangledown \\ \text{Measures the} & \text{Measures the} & \text{Measures the} \\ \text{Profit Margin} & \text{Efficiency of} & \text{Usage of Debt} \\ \text{Generated} & \text{Asset Utilization} & \end{array}
 \end{aligned}$$

The first two ratios are critical to a firm's success. The profitability ratio measures profit margin or the firm's ability to generate a profit from each revenue dollar. Competitive pressures tend to reduce or squeeze profit margins. The activity ratio or asset turnover ratio measures the firm's ability to efficiently employ its assets. Duplicating another firm's efficiency can be difficult because it requires a variety of technical, marketing, or other skill sets that may not be easily copied. Decomposing the Dupont Analysis into its profit margin and asset turnover components has been useful in prior research, for example in predicting future return on assets and stock returns (Soliman, 2008). Thus, decomposing the Dupont Analysis can be

employed to study the impact of zombie firms on U.S. public companies' profitability and asset efficiency.

The FASB's Statement of Financial Accounting Concepts No. 8 (SFAC No. 8) provides objectives and fundamental concepts that guide the development of financial accounting and reporting standards. One of a series of concept statements in the FASB's Conceptual Framework, the SFAC No. 8 (FASB, 2018) states, " That information helps capital and other markets to function efficiently in allocating scarce resources in the economy and society." The SFAC No. 8 stresses the importance of financial information that is useful in economic decision-making. The decision-making should result in a more efficient allocation of resources in the economy. In the context of studying the zombie firms' impact, employing a Dupont Analysis derived from publicly available financial information isolates the impact of the zombie firms' presence on corporate profits and asset efficiency. This knowledge of identifying zombie firms assists investors' decision-making in deploying their limited resources.

Research Design and Methodology

This research paper examines the zombie firms' negative impact on profitability and asset efficiency of U.S. publicly traded firms over the 2006 to 2016 period. Although the study period pre-dates the onset of the Covid-19 pandemic, the results from this study are highly relevant today because the pandemic's onset likely increases the number and extent of zombie firms listed on U.S. markets. Further, the increase in interest rates during the post-pandemic period has increased firms' interest charges and adversely affected their ability to sustain their operations.

The first step in the research design is to determine the necessary data for this study. Collecting ten years of firms' operating data for each firm year means data is collected over the 1997 to 2016 period (i.e., by definition, a zombie firm has 10 consecutive years of operating income). This study follows the methodology of the OECD's studies (e.g., McGowan et al., 2017). Firms without operating income, 10 consecutive years of data, and an interest coverage ratio are removed from the sample. In addition, financial institutions are excluded due to their unique regulatory environment. Over the 2006 to 2016 period 22,967 firms remain (see Table 1).

The next step in the research design is to identify the zombie firms. Zombie firms are defined as firms that have operating income for at least 10 consecutive years and have an interest coverage ratio less than 1 for 3 consecutive years. The interest coverage ratio is defined as the times interest earned ratio and is calculated as: $(\text{Net Income} + \text{Interest Expense} + \text{Income Tax Expense}) / \text{Interest Expense}$. Over the 2006 to 2016 period, there are 3,576 zombie firms with the peak occurring in 2015 at 17.8%. The percentage of zombie firms to the total number of sample firms clearly increases over the 2006 to 2016 period (see Table 2.).

The definition of zombie firms used in this study is employed by McGowan et al. (2017), an OECD sponsored study and is preferred because of the availability of firm-level data in determining the interest coverage ratio (i.e., availability of public companies' data). Given the unique attributes of zombie PE firms, the definition of a "zombie PE firm" may require modification (see Bannerjee and Hofmann, 2018).

The zombie firms' presence in the overall population of public companies is expected to have a negative impact on each component comprising the Dupont Analysis (i.e., profit margin, asset turnover, and leverage). The methodology used to test these zombie firms' effects is a difference in means test (i.e., t-test). The test is performed by following the procedure below for each component of the Dupont Analysis:

1. For each year of the sample period calculate the median for each component of the Dupont Analysis (profit margin, asset turnover, and leverage) for all firms (zombie included).
2. For each year of the sample period calculate the median for each component of the Dupont Analysis (profit margin, asset turnover, and leverage) for all firms *excluding* zombie firms (zombie excluded).
3. Calculate the means of the medians for the zombie included and zombie excluded groups.
4. Calculate the difference in means between the zombie included and zombie excluded groups.
5. Test the difference in means for statistical significance.

The difference in means test is performed for the difference in means between the zombie inclusive and non-zombie samples. The two-tailed test is chosen because it covers differences in both directions and reduces the likelihood of drawing a false conclusion. This statistical test captures the effect of the zombie firms' presence on each component of the Dupont Analysis.

The expected results for this test are that the zombie firms' presence has a negative effect on profit margin, asset efficiency, and leverage. That is, the inclusion of zombie firms in the economy reduces corporate profit margins and asset efficiency to a statistically significant degree. Further when examining leverage, zombie firms are expected to carry more debt, thus the leverage gap widens with the inclusion of zombie firms.

This study's hypotheses are specifically stated as follows:

H₁: The zombie firms' presence significantly reduces U.S. public firms' overall profitability.

H₂: The zombie firms' presence significantly reduces U.S. public firms' overall asset efficiency.

H₃: The zombie firms' presence significantly increases U.S. public firms' leverage.

Overall, the expected results should support the conjecture that the zombie firms' presence reduces corporate profitability, lowers the efficient deployment of public corporations' assets, and increases leverage.

Table 1: Sample Size After Data Cleansing

<u>Year</u>	No. of Firms <u>Raw Data</u>	No. of Firms after Removing <u>Missing OIAD</u>	No. of Firms after Removing Firms without 10 Consecutive <u>Years of Data</u>	No. of Firms after Removing Firms without Interest <u>Coverage Ratio</u>	No. of Firms after Removing Financial <u>Institutions</u>
2006	5,253	4,443	2,389	1,960	1,708
2007	5,768	4,572	2,576	2,085	1,816
2008	6,002	4,702	2,708	2,212	1,917
2009	6,314	4,858	2,805	2,313	2,009
2010	6,752	5,127	2,897	2,378	2,068
2011	7,304	5,437	2,978	2,449	2,125
2012	7,782	5,925	3,046	2,514	2,167
2013	8,097	6,294	3,477	2,935	2,225
2014	8,277	6,390	3,562	3,036	2,295
2015	8,378	6,364	3,589	3,079	2,317
2016	<u>8,294</u>	<u>6,103</u>	<u>3,590</u>	<u>3,091</u>	<u>2,320</u>
Totals	78,221	60,215	33,617	28,052	22,967

Table 2: Classifying Firms Into Zombie and Non-Zombie Firms

<u>Year</u>					
	<u>No. of Firms</u>	<u>No. of Zombie Firms</u>	<u>% of Zombie Firms</u>	<u>No. Non-Zombie Firms</u>	<u>% of Non-Zombie Firms</u>
2006	1,708	209	12.2%	1,499	87.8%
2007	1,816	227	12.5%	1,589	87.5%
2008	1,917	267	13.9%	1,650	86.1%
2009	2,009	323	16.1%	1,686	83.9%
2010	2,068	342	16.5%	1,726	83.5%
2011	2,125	332	15.6%	1,793	84.4%
2012	2,167	317	14.6%	1,850	85.4%
2013	2,225	361	16.2%	1,864	83.8%
2014	2,295	393	17.1%	1,902	82.9%
2015	2,317	413	17.8%	1,904	82.2%
2016	<u>2,320</u>	<u>392</u>	16.9%	<u>1,928</u>	83.1%
Totals	22,967	3,576		19,391	

Results and Discussion

Descriptive statistics for the variables are presented in Table 3, Panel A (zombie firms included) and Panel B (zombie firms excluded).

The descriptive statistics show that the zombie firms' presence substantially reduces average profitability. The mean profit margins are negative for both the zombie firms included and excluded samples, but with the zombie firms included sample the loss is 4.8 times revenues (see Table 3, Panel A). However, for the zombie firms excluded sample, the mean negative profit margin is approximately 1%.

For the asset turnover ratio, the zombie firms' presence reduces asset efficiency by approximately 3% (see Table 3, 1.0730 vs. 1.0430), supporting the lack of productivity concerns stated in the OECD sponsored studies.

The leverage ratio is defined as average total assets divided by average stockholders' equity. On the one hand, zombie firms are smaller in asset size as the average (mean) total assets are approximately \$1.7 billion lower for the zombie firms included sample. On the other hand, the higher mean leverage ratio for the zombie firms included sample suggests zombie firms carry more debt.

Table 4 (Panels A and B) present the median profit margin, asset turnover, and leverage ratios for the zombie firms included and zombie firms excluded samples, respectively. Over the 2006 to 2016 period, each year median profit margin is lower for the zombie firms included sample. The mean for the median profit margins is 0.040 for the zombie firms included sample vs. 0.053 for the zombie firms excluded sample. The difference in means represents a 32.5% lower profit margin for the zombie firms included sample. In addition, the difference in means is statistically significant at the 0.01 significance level (see Table 5). Thus, H_1 is supported by the t test results, that is, the zombie firms' presence significantly reduces U.S. public firms' overall profitability.

Table 3: Descriptive Statistics

Panel A: Zombie Firms Included (n=22,967)

Variable	Mean	Standard Deviation
Profit Margin	-4.8339	118.3320
Asset Turnover	1.0430	1.3537
Leverage	2.8852	63.5640
Average Total Assets (millions \$)	10,671.0200	34,386.2900

Panel B: Zombie Firms Excluded (n=19,391)

Variable	Mean	Standard Deviation
Profit Margin	-0.0121	13.3236
Asset Turnover	1.0730	1.3659
Leverage	2.7433	59.7904
Average Total Assets (millions \$)	12,338.9600	36,947.9200
Notes:		
Profit margin = Net Income / Total Revenues		
Asset Turnover = Total Revenues / Average Total Assets (Asset Efficiency)		
Leverage = Average Total Assets / Average Total Stockholders' Equity		

Table 4: Median Profit Margin, Asset Turnover, and Leverage Ratios

Panel A: Zombie Firms Included

Year	Total # of Firms	Median Profit Margin	Median Asset Turnover	Median Leverage
2006	1,708	0.048	0.955	2.057
2007	1,816	0.048	0.899	2.063
2008	1,917	0.032	0.886	2.090
2009	2,009	0.028	0.787	2.051
2010	2,068	0.045	0.817	2.013
2011	2,125	0.043	0.838	2.060
2012	2,167	0.041	0.810	2.092
2013	2,225	0.041	0.780	2.086
2014	2,295	0.042	0.759	2.102
2015	2,317	0.036	0.727	2.143
2016	<u>2,320</u>	0.037	0.714	2.178
Total Firms	22,967			
Mean		0.040	0.816	2.085

Panel B: Zombie Firms Excluded

Year	Total # of Firms	Median Profit Margin	Median Asset Turnover	Median Leverage
2006	1,499	0.057	0.992	2.109
2007	1,589	0.058	0.939	2.116
2008	1,650	0.045	0.917	2.186
2009	1,686	0.041	0.831	2.130
2010	1,726	0.059	0.855	2.102
2011	1,793	0.057	0.880	2.126
2012	1,850	0.053	0.836	2.158
2013	1,864	0.056	0.807	2.154
2014	1,902	0.055	0.784	2.183
2015	1,904	0.051	0.759	2.226
2016	<u>1,928</u>	0.055	0.741	2.248
Total Firms	19,391			
Mean		0.053	0.849	2.158
Notes:				
Profit margin = Net Income / Total Revenues				
Asset Turnover = Total Revenues / Average Total Assets (Asset Efficiency)				
Leverage = Average Total Assets / Average Total Stockholders' Equity				

Table 5: Profit Margin - Difference in Means With and Without Zombie Firms

	WITH Zombie Firms	WITHOUT Zombie Firms
Mean	0.040	0.053
Variance	3.9176E-05	3.2492E-05
Observations	11	11
Pearson Correlation	0.9130	
Hypothesized Mean Difference	0	
df	10	
t Stat	-17.0153	
P(T<=t) two-tail	1.0354E-08	
t Critical two-tail	2.2281	
The “Mean” represents the mean for the median profit margins over the 11-year period 2006 to 2016, each for the zombie firms included sample (n = 22,967) and zombie firms excluded sample (n = 19,391). Conclusion: The two tailed test suggests that the difference in means is statistically significant with the zombie firms excluded sample possessing higher profit margin.		

Table 6: Asset Turnover - Difference in Means With and Without Zombie Firms

	WITH Zombie Firms	WITHOUT Zombie Firms
Mean	0.816	0.849
Variance	5.5056E-03	6.0422E-03
Observations	11	11
Pearson Correlation	0.9971	
Hypothesized Mean Difference	0	
df	10	
t Stat	-16.4447	
P(T<=t) two-tail	1.441E-08	
t Critical two-tail	2.2281	
The “Mean” represents the mean for the median asset turnover ratios over the 11-year period 2006 to 2016, each for the zombie firms included sample (n = 22,967) and zombie firms excluded sample (n = 19,391). Conclusion: The two tailed test suggests that the difference in means is statistically significant, with the zombie firms excluded sample possessing higher asset efficiency.		

The results are similar for the asset turnover ratio, that is the zombie firms' presence reduces asset turnover (i.e., asset efficiency). Median asset efficiency is lower each year for firms in the zombie firms included sample vs. the zombie firms excluded sample (see Table 4). The mean for the median asset turnover ratio is 0.816 for the zombie firms included sample vs. 0.849 for the zombie firms excluded sample. The difference in means represents a 4% lower asset efficiency for the zombie firms included sample. This difference in means is statistically significant at the 0.01 significance level (see Table 6). H_2 is supported by these results, that is, the zombie firms' presence significantly reduces U.S. public firms' asset efficiency. In addition, these results parallel the OECD's findings (e.g., McGowan et al., 2017) and confirm that the zombie firms' presence has a detrimental effect on productivity. However, the zombie firms' presence is not the only factor influencing the decline in asset efficiency. The results in Table 4 (Panel B, zombie firms excluded sample) show that the asset turnover ratio declined over the 2006 to 2016 period from 0.992 to 0.741, representing a 25.3% decline in asset efficiency, a much steeper decline than the 4% decline associated with the zombie firms' inclusion. Thus, factors other than the zombie firms' presence exist over the 2006 to 2016 period that influence the U.S. public firms' decline in asset efficiency.

The decline in U.S. public companies' asset efficiency is not unexpected given the increasing percentage of zombie firms in the U.S. economy over the 2006 to 2016 period (see Table 2) and the OECD's findings that low productivity is associated with the prevalence of zombie firms (McGowan et al. 2017). The U.S. Bureau of Labor Statistics (Sprague, 2017) examines the relation between labor productivity, output, and hours worked over 11 business cycles (i.e., 1948 fourth quarter to 2016 third quarter). Labor productivity growth is determined as the growth rate in output minus the growth rate in hours worked. They find that U.S. productivity in the 2007 to 2016 period lags that of prior business cycles. Specifically, labor productivity (i.e., real output per labor hour) has grown at a 1.1% annualized rate during the 2007 to 2016 period, whereas the average is 2.3% over the 11 business cycles in the 1948 to 2016 period (Sprague, 2017). In addition, output (i.e., value of goods and services produced) has grown at a 1.4% rate during the 2007 to 2016 period, but during the 1948 to 2016 period output growth averaged 3.4% (Sprague, 2017). The declines in labor productivity and output growth rates during the 2007 to 2016 period mirrors the increase in the number of zombie firms and the decline in asset efficiency.

The combination of this study's results and the U.S. Bureau of Labor Statistics findings suggest that zombie firms contribute to the low productivity in the U.S. economy and an inefficient allocation of resources. However, the evidence does not suggest that the inefficient allocation of capital is solely attributable to the greater presence of zombie firms. Rather, the decline in asset efficiency occurred even after removing the zombie firms' presence (see Table 4, Panel B). Other sources of labor productivity growth are lagging. Sprague (2017) cites the following factors as sources of labor productivity growth:

- Technological advances in production.
- Increases in the quality and quantity of physical capital and equipment that businesses purchased and utilized.
- The introduction of more streamlined industrial organization.
- Strengthening of worker skills through attainment of experience and education.
- Better utilization of or increases in, capacity, energy, and materials.
- Relative shifts of inputs from low to high productivity industries.
- Increased efforts of the workforce, and
- Improvements in managerial efficiency.

Deficiencies in any one or combination of these areas will have a negative impact on productivity. The results from this study suggest that the greater presence of zombie firms plus the lack of one or more factors supporting labor productivity growth are driving the decline in asset efficiency and lower profitability in the U.S. economy during the 2006 to 2016 period.

The results for the difference in means test for the leverage variable shows that the zombie firms excluded sample possesses higher leverage (see Table 7). From Table 4, the median leverage is higher for the zombie firms excluded sample for each year over the 2006 to 2016 period. H_3 is not supported by these results. However, from Table 3 the zombie firms included sample has the higher average (mean) leverage over the same period. This result implies that large zombie firms with significant leverage affect the mean. Overall, leverage is not as an important factor as profit margin and asset efficiency in their impact on zombie firms' return on equity.

Table 7: Leverage - Difference in Means With and Without Zombie Firms

	WITH Zombie Firms	WITHOUT Zombie Firms
Mean	2.085	2.158
Variance	2.0682E-03	2.3289E-03
Observations	11	11
Pearson Correlation	0.9554	
Hypothesized Mean Difference	0	
df	10	
t Stat	-16.9690	
P(T<=t) two-tail	1.063E-08	
t Critical two-tail	2.2281	
The “Mean” represents the mean for the median leverage ratios over the 11 year period 2006 to 2016, each for the zombie firms included sample (n = 22,967) and zombie firms excluded sample (n = 19,391). Conclusion: The two tailed test suggests that the difference in means is statistically significant, with the zombie firms excluded sample possessing higher leverage.		

As a means to validate the results, the following logistic regression model is used to test the association between the components of the Dupont Analysis (profit margin, asset turnover, and leverage) and zombie firms.

$$\text{ZOMBIE}_{i,t} = a + \beta_1 (\text{NI}_{i,t} / \text{TREV}_{i,t}) + \beta_2 (\text{TREV}_{i,t} / (\text{TA}_{i,t} + \text{TA}_{i,t-1})/2) + \beta_3 ((\text{TA}_{i,t} + \text{TA}_{i,t-1})/2) / ((\text{SE}_{i,t} + \text{SE}_{i,t-1})/2) + \beta_4 (\text{SIZE}_{i,t-1}) + \varepsilon_{i,t} \quad (1)$$

Where:

$\text{ZOMBIE}_{i,t}$ = an indicator variable, equal to 1 if the firm is categorized as a zombie firm in year t, otherwise equals 0;

$\text{NI}_{i,t}$ = the firm’s net income in year t;

$\text{TREV}_{i,t}$ = the firm’s total revenues in year t;

$(\text{TA}_{i,t} + \text{TA}_{i,t-1})/2$ = the firm’s average assets for year t;

$(\text{SE}_{i,t} + \text{SE}_{i,t-1})/2$ = the firm’s average stockholders’ equity for year t; and

$\text{SIZE}_{i,t-1}$ = the natural log of the firm’s total assets at time t-1.

The expected results are that a firm classified as a zombie firm is associated with declining odds for higher profit margin and asset turnover ratios. For leverage, the

results in Table 7 suggest zombie firms do not possess a higher likelihood of greater leverage.

The results for the logistic regression model are presented in Table 8. Both the profit margin and asset turnover variables are statistically significant at 0.01 significance level and are negative as predicted. Further, the odds ratio < 1 indicates that the odds of a firm classified as a zombie increase with both declining profit margin (Table 8, odds ratio = 0.98) and asset efficiency (Table 8, odds ratio = 0.612). The SIZE variable is also statistically significant at 0.01 and is negative suggesting that the firm's size declines with the odds of the firm classified as a zombie.

Conclusion

This research paper examines the detrimental effects of U.S. public companies categorized as zombie firms on the components of return on equity, especially profitability and asset efficiency. A zombie firm is defined as a firm with operating income for at least 10 consecutive years and has an interest coverage ratio less than 1 for 3 consecutive years. Prior research focusing on the Japanese and European economies shows that the zombie firms' presence saps productivity growth and creates barriers for more productive firms to enter the economy (Caballero et al., 2018). In the U.S. context, the zombie firms' presence has increased in recent years (see Table 2) and has had a similar negative impact. By breaking down the return on equity into profit margin, asset efficiency, and leverage components the zombie firm effects can be examined by comparing samples with and without zombie firms.

The greatest effect is on profit margin where the zombie firms included sample has a 32.5% lower profit margin. For asset efficiency, the zombie firms included sample is 4% lower. Further, the decline in asset efficiency consists of a lower trend over the study period (2006 to 2016) that excludes zombie firms meaning other factors lacking in the economy are driving the lower productivity growth. Sprague (2017) with the U.S. Bureau of Labor Statistics suggests that the following factors are sources of productivity growth:

- Technological advances in production.
- Increases in the quality and quantity of physical capital and equipment that businesses purchased and utilized.
- The introduction of more streamlined industrial organization.
- Strengthening of worker skills through attainment of experience and education.
- Better utilization of or increases in, capacity, energy, and materials.
- Relative shifts of inputs from low to high productivity industries.
- Increased efforts of the workforce, and
- Improvements in managerial efficiency.

In addition, the results do not support a statistically significant association between leverage and the likelihood of zombie firm categorization.

Overall, this study contributes to the academic research into zombie firms and if the percentage of zombie firms continue to rise in the economy, then more detrimental effects on productivity and economic growth can be expected.

Table 8: Logistic Regression Results for Model 1 (n = 22, 967)

$\text{ZOMBIE}_{i,t} = a + \beta_1 (\text{NI}_{i,t} / \text{TREV}_{i,t}) + \beta_2 (\text{TREV}_{i,t} / (\text{TA}_{i,t} + \text{TA}_{i,t-1})/2) + \beta_3 ((\text{TA}_{i,t} + \text{TA}_{i,t-1})/2) / ((\text{SE}_{i,t} + \text{SE}_{i,t-1})/2) + \beta_4 (\text{SIZE}_{i,t-1}) + \varepsilon_{i,t} \quad (1)$					
Parameters	β	SE β	Wald's χ^2	P	Odds Ratio e^β
Intercept	8.6428	0.1817	2,263.393	<.0001	NA
NI / TREV	-0.0197	0.00274	51.7661	<.0001	0.98
(TREV/(TA + TA _{t-1})/2)	-0.4906	0.0275	317.6044	<.0001	0.612
((TA + TA _{t-1})/2) / ((SE + SE _{t-1})/2)	0.000296	0.000256	1.3374	0.2475	1.00
SIZE	-0.5054	0.00903	3130.857	<.0001	0.603
Overall Model Evaluation -- Testing Global Null Hypothesis of $\beta =$					0
Test	χ^2	P			
Likelihood Ratio	5,523.754	<.0001			
Score	5,422.232	<.0001			
Wald	3,371.156	<.0001			
Where:					
ZOMBIE _{i,t} = an indicator variable, equal to 1 if the firm is categorized as a zombie firm in year t, otherwise equals 0;					
NI _{i,t} = the firm's net income in year t;					
TREV _{i,t} = the firm's total revenues in year t;					
(TA _{i,t} + TA _{i,t-1})/2 = the firm's average assets for year t;					
(SE _{i,t} + SE _{i,t-1})/2 = the firm's average stockholders' equity for year t; and					
SIZE _{i,t-1} = the natural log of the firm's total assets at time t-1.					

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